INVASIVE ALIEN SPECIES AND PROTECTED AREAS: GLOBAL LESSONS

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Abstract: Invasive alien species (IAS) are found in all taxonomic groups and virtually every ecosystem type, in any region of the world has been affected to some extent. In protected areas (PAs), as elsewhere, impacts from invasive alien species take the form of impacts on ecosystem function, impact on ecosystem structure, and impacts at the level of species communities or habitats as well as at the level of species. While the underlying causes of IAS threats to protected areas are significant and global in nature the threat can effectively be dealt with at the local site level, especially through prevention, early detection and rapid response.

Key words: Invasive alien species, biodiversity impacts, threats to protected areas.

INTRODUCTION

Economic globalisation has resulted in an exponential increase in the movement of species from one part of the world to another through trade, transport, travel and tourism. While many of the deliberate movements of species into new ecosystems are beneficial to people, nevertheless tremendous damage results from alien species that become detrimental. IUCN- The World Conservation Union defines an 'Invasive Alien Species' (IAS) as an alien species which becomes established in natural or semi-natural ecosystems or habitat, is an agent of change, and threatens native biological diversity (IUCN 2000). Invasive alien species are found in all taxonomic groups: they include introduced viruses, pathogens and other micro-organisms, fungi, algae, mosses, ferns, higher plants, invertebrates including insects, molluscs and crustaceans, bryozoans, fish, seaweeds, amphibians, reptiles, birds and mammals (e.g. Lowe *et al.* 2000, UNEP 2001, and see *www.issg.org/database*).

Biological invasions by alien species are now considered one of the main factors in biodiversity loss and endangered species listings world wide (OTA 1993), and almost certainly the worst one on islands (Clout 1999, Clout and Lowe 2000). The Convention on Biological Diversity (CBD) recognises the importance of this global issue and calls on contracting parties to: "*prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats and species"* (Article 8 (h)). The Millennium Assessment confirms that IAS have been one of the main drivers of biodiversity loss over the last 50 to 100 years, and assesses that the

trend in the impact (at global level) will continue or increase in all biomes (UNEP 2005a,b).

Invasive alien species in protected areas

The threat to protected areas (PAs), caused by IAS has been publicised for at least two decades (e.g. Macdonald *et al.* 1989, Usher 1988), and is increasingly recognised by those assessing the state of protected areas (Mulongoy and Chape 2004, Carey *et al.* 2000, Pomeroy *et al.* 2004). A survey of participants at the Vth IUCN World Parks Congress, in Durban, South Africa, September 2003, showed that participants rated invasive alien species as one of the key threats to PA resources

Table 5. Key threats to PA resources

	All respondents (%)
Inappropriate adjacent land use	46.5
Overharvesting for commercial purposes	33.0
Invasive species	31.6
Infrastructure development	28.2
Agricultural encroachment	26.1

Figure1 Participants' survey, Vth World Park Congress from IUCN (2005)

(IUCN 2005) Fig 1

Not surprisingly, the theme of invasive species was reflected also in the "emerging issues" (IUCN 2005) of the World Parks Congress:

> *Management of invasive alien species is a priority issue and must be mainstreamed into all aspects of protected area management.*
>
> *The wider audience of protected area managers, stakeholders and governments needs urgently to be made aware of the serious implications for biodiversity, protected area conservation and livelihoods that result from lack of recognition of the IAS problem and failure to address it.*

Promoting awareness of solutions to the IAS problem and ensuring capacity to implement effective, ecosystem-based methods must be integrated into protected area management programmes. In addition to the consideration of benefits beyond boundaries, the impacts flowing into both marine and terrestrial protected areas from external sources must be addressed.

PATTERN OF BIOLOGICAL INVASION AND IMPACTS.

Pattern of biological invasion

Most alien species do not trigger new biological invasions. While there is no generally applicable rule yet that can be applied to estimate the likelihood that, once alien organisms have "arrived" in a new ecological region, they will result in biological invasion, there is general agreement on the pattern, in time, for those that do (Fig 2). The usual pattern of invasion starts with a lag phase (Crooks and Soulé

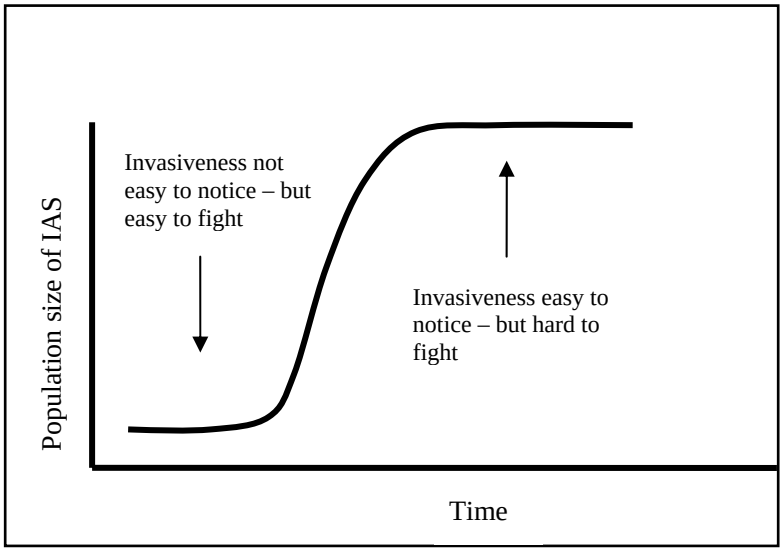

Figure 2 Usual pattern of biological invasion

1999), during which the population is low in abundance and impacts are not noticeable. The lag phase can be short or last over a century. Eventually the population reaches a phase where it increases rapidly – the "explosion phase" or "log" phase - and the impacts usually become very apparent. However, by that time the invasion has usually reached a stage where management is very difficult and/or very costly . This makes it particularly challenging to identify future invaders during the lag phase when they still can be relatively easily eradicated (Mack *et al.* 2000).

Impacts

A variety of impacts of invasive species in nature reserves were reviewed by Macdonald *et al.* (1989), and this publication has a wealth of examples. Some authors consider the biggest ecological threat posed by invasive alien species to be the disruption of entire ecosystems, often by invasive plants. Such biological invasion by plants can result in dense stands excluding or smothering other vegetation, lowering of water tables, changes in the fire regimes, increased nitrogen in soils etc., Such changes can, in turn, favour even more alien invasive plants (see Mack *et al*. 2000 for examples). In addition to impacts on ecosystem structure and functioning, impacts can be at the level of species communities or habitats (e.g. fewer native species and/or more alien species, physical changes in vegetation cover, etc). At the level of species the following types of impacts can occur:

- Predation on native fauna :*Rattus norvegicus* effectively wiped out the puffin population of Ailsa Craig, a protected area in the UK, by preying on eggs and chicks (ICEG 2004).
- Herbivory: damage to native plants through grazing or browsing by invasive animals. For example, by introduced goats, have had devastating effects in the Galápagos archipelago.
- Competition for resources such as light, nutrients, prey, space and niches within a habitat: Kaziranga National Park (India) is a vital habitat for the world's largest population of the Great One-horned Rhinoceros (*Rhinoceros unicornis)* Its grasslands are threatened by two alien species of Mimosa: *M. rubicaulis* and *M. diplotricha* which have spread and hampered the growth of the palatable grasses, thereby threatening the rhinoceros as well as ungulates (Gureja, N. Personal communication. 2003, and also see *www.wti.org.in*).
- Habitat change or physical changes.
- Disease (vector and/or pathogen): *Atelopus carbonerensi the* Venezuelan yellow frog (sapito arlequin de la carbonera) occurs in the Parque Nacional Sierra de La Culata and a few unprotected areas nearby. It is s now extremely rare, and possibly even extinct. Tthe most likely cause of the dramatic decline is chytridiomycosis, an alien pathogen, which was confirmed in this species in 1988. The recent introduction of the alien invasive amphibian *Rana*

catesbeiana in places near the type locality poses the problem of a new predator, as well as being a reservoir for the pathogen. (Hanselmann *et al*. 2004, and see profiles in the Global Invasive Species Database and IUCN red List of Threatened Species:

http://www.issg.org/database/species/ecology.asp?si=80&fr=1&sts=sss

http://www.iucnredlist.org/search/details.php/54495/all

- Hybridisation of alien species with native species: hybridisation with alien mallards threatens the existence – at least as distinct species - of the New Zealand grey duck (*Anas superciliosa superciliosa*) as well as the Hawai'ian duck (*Anas wyvilliana*) (Lever 2005)
- Extinction or extirpation: Invasive alien mammals have been introduced to at least 44 islands in north-west Mexico and are responsible for the ecological extinction of 22 endemic vertebrate species and subspecies, and the local extinction of one or more seabird taxa on 10 islands (Tershy et al 2002)
- Endangerment ; The *2004 IUCN Red list of Threatened Species – A Global Species Assessment* mentions that invasives have been identified as a major threat faced by globally threatened birds and amphibians, affecting 30% and 11% of threatened species (326 and 212 species respectively). Island species are particularly vulnerable to IAS : 67% of oceanic-island globally threatened birds are affected by them. (Baillie *et al.* 2004).

All the above impacts on native species, communities and ecosystems, can directly or indirectly impact on protected area values, including conservation, livelihoods and poverty alleviation, or cultural and heritage values.

A complicating factor is that direct and/or indirect impacts on biodiversity or ecosystem functioning, caused by invasive alien species, are often more complex and more "surprising" than the impacts of agricultural weeds on crops. For instance, in the South African St Lucia protected area, *Chromolaena odorata*, an invasive plant, has been linked to Nile crocodiles' sex ratio changes. (Leslie & Spotila 2001) while on Enderby Island, (part of the New Zealand Sub Antarctic World Heritage Site), the invasive rabbits (*Oryctolagus cuniculus cuniculus*) became a threat to the endangered Hooker's sea lion (*Phocarctos hookeri*) because up to 10% of Hooker's sea lion pups died annually, suffocated in rabbit burrows (Torr 2002).

Where do alien species invade?

There is general agreement that the problems of invasive alien species are especially acute in geographically and evolutionarily isolated systems such as islands (Clout 1999, Clout and Lowe 2000) and fresh water protected areas (Saunders *et al.* 2002); This has sometimes led to a false sense of security regarding the risks for continental terrestrial habitats. Unfortunately, parts of the world which are most dominated by invasive plants in large landscape areas (grasslands etc) are found mainly on continents: North and South America and Australia and to a lesser extent in Africa and India (UNEP 2001). Continental forest ecosystems have been badly affected in the Eastern USA(Macdonald *et al.* 2002), and there is now increasing evidence that tropical forests also are not impenetrable or safe from IAS (Macdonald *et al* 2002). In the marine ecosystems, many areas of high ecological value have suffered from marine invasive species. Marine protected areas have no physical barriers to invasion and the threat posed by marine IAS to MPAs is significant (Ricciardi 2006, UNEP 2001).

Undisturbed communities can be invaded (e.g. the replacement of *Ilex* by *Rhododendron* in the oakwoods of Killarney, Ireland, Usher 1988); Successionally advanced plant communities can be invaded (e.g. by shade-tolerant species – see Rejmanek *et al.* 2005 for examples). Being far away from the main centres of civilisation is no bullet-proof protection against IAS either. Even in wilderness areas IAS have been found to be a threat (Mittermeier *et al*. 2003) and Sub Antarctic islands have been devastated by invasive alien mammals and plants in spite of their remoteness (Frenot etc, De Poorter *et al.* 2006).

In other words: ecological communities all over the planet have been invaded to a greater or lesser degree (*www.issg.org/database*, UNEP 2005a,b, UNEP 2001). Areas set apart for the conservation of biodiversity are no exception: alien plants and animals are spreading in protected areas of various types in nearly all parts of the world (UNEP2001). No matter what habitat or ecosystem, it is only a matter of time until invasive alien species will need to be addressed.

FIGHTING BACK AGAINST INVASIVE ALIEN SPECIES

Methods to fight back against IAS are constantly improving, and a growing number of success stories documents the significant biodiversity and livelihood outcomes that can be achieved by IAS management at site level. For instance, in 1989 the kakerori (Rarotongan flycatcher) was one of the world's rarest birds (29 individuals). The Takitimu Conservation Area (Rarotonga, Cook Islands) was created by traditional owners (clans) of the area. Clans manage the area and the ship rat (*Rattus rattus*) is controlled. As a result, in 2002 more than 250 birds were alive and well and the area is a flagship for income generating activities (ecotourism). (UNDP 2002). However, while addressing established populations is often feasible and very worthwhile from the biodiversity point of view, it is never easy or cheap. Control requires ongoing efforts and costs; eradication is possible under certain conditions, but often not affordable or feasible. The key management approach is to apply prevention of new invasions: first by preventing new introductions of potential invasive alien species, and second by implementing early detection and rapid response as a second line of defence.

Prevention is the first line of defence. It is the most cost effective approach to protecting biodiversity and other PA values and it is a *sine qua non* of future proofing them, especially in the face of global change. It is particularly relevant, because the actual designation of a site as a protected area can increase the risks of invasion by alien species. In general, the number of visitors to an area has been shown to be associated with the numbers of introduced alien species - e.g. see MacDonald *et al*. (1989) for vascular plants in South African reserves, and Chown *et al.* (1998) for Sub Antarctic islands. Increased numbers of introductions of alien species means increased risk of introducing species that will become invasive. Marine protected areas, for instance are points of significant attraction for marine tourism, including boating, diving and snorkelling, fishing (where allowed) etc. All these activities are likely to lead to increased risks of introducing alien invasive marine species, associated with hull fouling, ballast water, or on fishing gear, wetsuits and bait material. (Méliane 2004). Of particular relevance in the case of terrestrial protected areas is the role of roads as corridors of plant invasions (Pauchard and Alaback 2004). Construction of accommodation, and other facilities is a well known pathway

for introductions, through propagules attached to construction material, equipment, soil etc. (Wittenberg and Cock 2001, Macdonald *et al.* 1989) Even protected area staff can be a source of potentially invasive alien species, notably through plants grown in their gardens (Foxcroft 2000, 2004).

With good prevention, pathways of introduction into PAs can be blocked. For example, in Stirling Range National Park, Australia native plant species are under threat from a disease caused by the introduced pathogen *Phytophthora cinnamomi* (dieback disease). It is spread by the transport of infected soil, mainly by foot access. Prevention measures now include the provision of boot-cleaning stations designed to reduce the spread of the pathogen via trampers (Watson and Barret 2003). For more on prevention methods for various pathways, see Wittenberg and Cock (2001).

The second line of defence, and high priority, is the early detection of an introduced, potentially IAS, allowing for rapid response (e.g. eradication before numbers have become too big, or the area of spread too vast). Any potential invasion that is “nipped in the bud" avoids impacts on biodiversity and livelihoods, and saves management resources. Fig. 3 illustrates this by showing the exponential rise in costs for management of IAS plants, with time since establishment, in sites under management by the New Zealand Department of Conservation (Timmins 2002).

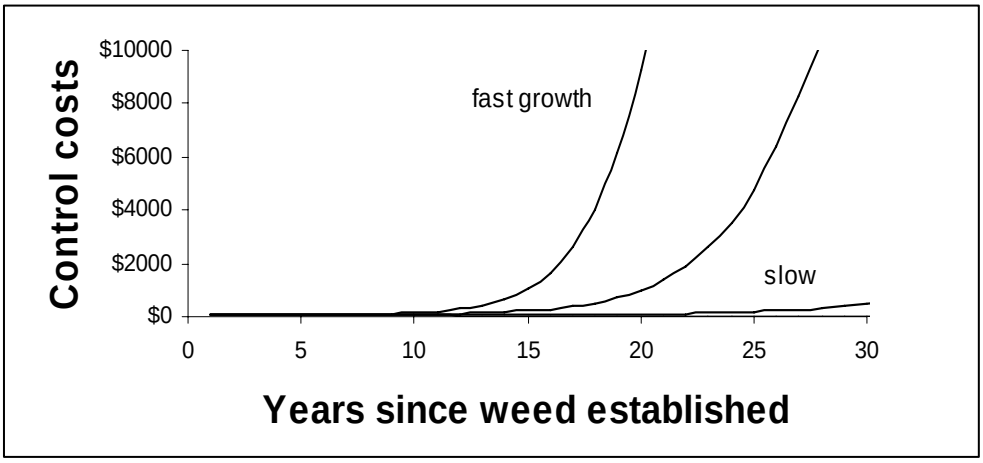

Figure 3 Management costs in function of time since establishment (weed management in the New Zealand Conservation estate - after Timmins 2002)

CONCLUSION

There is much hope-inspiring progress in achieving the key protected areas management outcomes of biodiversity conservation and poverty alleviation (through sustainable livelihoods) but biological invasions, if left unchallenged, would defeat these objectives. Protected areas can not be seen as safe and sound places that, once designated, can be "left for nature to get on with things". On the contrary ongoing intervention is required to safeguard their ecological integrity. Without management to prevent and address invasive alien species, protected areas' ecosystem functions and biodiversity will inevitably be eroded sooner or later. Far from leading to despondency, however, this threat should be an incentive to fully arm protected area managers with the resources and capacity to effectively fight back. Prevention, early detection and rapid response, at the site level (or PA system level) are the key to future-proofing protected areas, the values they contain, and the services they provide. Eradication and control can be deployed to the maintenance or recovery of biodiversity and livelihood values.

While the underlying causes of invasive alien species threats to protected areas are significant and global in nature, protected area managers are far from helpless. Provided there is awareness, capacity and resources, the global threat from biological invasions can be effectively dealt with at the local site level.

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