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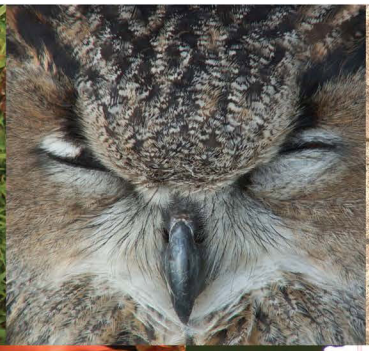
Human Perceptions, Attitudes and Approaches to Management

EDITED BY IAN D. ROTHERHAM & ROBERT A. LAMBERT



Invasive and Introduced Plants and Animals

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Edited by
Ian D. Rotherham and Robert A. Lambert

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List of Acronyms and Abbreviations

APHIS	Animal and Plant Health Inspection Service
AS	alien species
BBWF	British Birdwatching Fair
BOU	British Ornithologists' Union
CBD	Convention on Biological Diversity
CDC	Centers for Disease Control
CFK	Cape Floral Kingdom
CCW	Countryside Council for Wales
Defra	Department for Environment, Food And Rural Affairs
DOC	Department of Conservation
DOI	Department of the Interior
ELI	Environmental Law Institute
FWS	Fish and Wildlife Service
GERME	Gestion des Espaces Ruraux Médiation et Ecologie
GISP	Global Invasive Species Programme
GRN	Grassland Restoration Network
IAS	invasive alien species
ICAO	International Civil Aviation Organization
IPPC	International Plant Protection Convention
ISSRs	inter simple sequence repeats
IUCN	International Union for the Conservation of Nature and Natural Resources
mph	multiprimer haplotypes
NAPPRA	not authorized [for importation] pending pest risk analysis
NISC	National Invasive Species Council
NNS	non-native species
PETA	People for the Ethical Treatment of Animals
POET	Preserve Our Eucalyptus Trees
RAPDs	Randomly Amplified Polymorphic DNAs
RISC	Recording Invasive Species Counts
RSPB	Royal Society for the Protection of Birds
RTA	road traffic accident
SCOPE	Scientific Committee on Problems of the Environment

SNH	Scottish Natural Heritage
SNP	Scottish National Party
SOC	Scottish Ornithologists' Club
SSSI	Site of Special Scientific Interest
SWT	Scottish Wildlife Trust
USDA	US Department of Agriculture
WTO	World Trade Organization

Part I
Setting the Scene

1
Balancing Species History, Human Culture and Scientific Insight: Introduction and Overview

Ian D. Rotherham and Robert A. Lambert

Here we set the wider scene and context to the subject matter of this book. This is in terms of issues and perceptions of both alien and introduced (or reintroduced) species. We raise issues of what is native and what is natural, and the ways in which these and our perceptions of nature have changed over time. Our intention is to stimulate the reader to question ideas and received wisdom, and to try to establish the interface between objective science and subjective sociocultural fashions and values.

> *When the late Sir Henry Tizard learnt that I had been asked to write a book about weeds and aliens he remarked in his characteristic manner, 'I do hope you will tell us more than just how to kill them.'* Sir Edward Salisbury (1961)

Writing in 2009, Christopher Lever stated that, 'humans are inveterate and incorrigible meddlers, never content to leave anything as they find it but always seeking to alter and – as they see it – to improve'. He noted that, 'invasive alien species are, after habitat destruction, the most important cause of loss of biodiversity through the extinction or reduction of native species'. Very usefully Lever also considered the dual issues of both non-native introductions and escapes, and native reintroductions. In discussing alien, exotic and invasive fauna and flora it is important to begin with definitions (see Rotherham, 2005a). It is worth considering what the term 'alien' means. Dictionary definitions (Anon., 1983) suggest:

- 'Belonging to another person, place or family, especially to a foreign nation or allegiance. Foreign in nature, character or origin' (1673).

- 'A stranger or a foreigner. A resident foreign in origin and not naturalized' (1330).
- 'One excluded from citizenship, privileges etc' (1549).
- 'A plant originally introduced from other countries' (1847).

Clement and Foster (1994) used 'alien' in a broad sense to denote all plants whether or not they were believed to have arrived as a result of human activities. They include plants referred to by other authors as adventives, casuals, ephemerals, exotics, introductions and volunteers.

Ellis (1993) wrote a very useful pocket-sized introduction to invasive plants in Britain. He suggests that for many an alien plant is essentially one that is not native. In this case a native plant is one that arrived in Britain prior to the closure of the English Channel around 7–8000 years ago, and so an alien is a species arriving after such a date.

An exotic is taken as 'originating in a foreign county' or 'having a strange or bizarre allure, beauty or quality', and invasive is simply 'relating to an invasion' the latter being 'any encroachment or intrusion' (Anon., 2000). Issues such as the changes to, or reinstatement of, national boundaries clearly impact on such interpretations of 'native' or 'non-native' (see Warren, Chapter 5). For most invasive exotic or alien species a key factor is that they occur 'in the wild'. However, there is an often neglected issue (problematic for species subject to legislative controls) of defining exactly what 'in the wild' might really be. While this might seem absolutely obvious to most practising ecologists, when subject to the rigorous inspection of a court of law the precise definition becomes open to interpretation. As Clement and Foster (1994) noted, the word 'naturalized' has been used to describe a wide range of conditions, some records referring to only a single plant among native vegetation. Moreover, the extent to which trees and shrubs reproduce is seldom recorded; nor is it always clear from the records whether an annual species is persisting from self-sown seed or by repeated reintroduction. They also accepted that an 'alien' plant might be 'a single short-lived plant occurring, unintended, in an artificial habitat or many large, long-established colonies overwhelming the native vegetation'. There are further complications with terms such as 'feral' and 'weed', and in his classic book *The New Naturalist Weeds and Aliens* Salisbury (1961) never really tells the reader what these actually are. One suspects that he himself was unclear as to the precise definitions.

However, using accepted concepts and academic traditions it is possible to describe the history of invasions and the impacts of exotic species, species history being a well-established subdiscipline of environmental history, and invasion biology also a well-recognized scientific field. While the general principles and processes are well-known, the more subtle issues of values, perceptions and attitudes are less widely recognized. We argue that human interactions with invasive species, both alien and native, are often of fundamental importance (Rotherham, 2005c, 2009). This may be through a plant or animal being introduced to a potentially new area, and/or in modifications to existing landscapes and ecosystems to precipitate and facilitate bio-invasion. Human sociocultural

values and attitudes have shaped many invasions (Coates, 2006). Moreover, perceptions and attitudes towards invasions and invasives are important and often, we suggest, subjective rather than objective; not fixed, but varying with both time and place (Warren, 2002; Coates, 2006). These are key issues in human responses to the undoubted problems generated by some invasive species, and misunderstanding probably compounds, rather than solves, the adverse impacts. Considering what is alien, what is a problem, what should be done in response to damaging bio-invasions, are all reasonable questions, but the answers are not simple and our responses are influenced by entrenched or fluctuating perceptions as well as science. The importance of perception in addressing alien invasions is discussed in this volume for the Mediterranean area by Gherardi (Chapter 12), for the American prairie by Allison (Chapter 17), and for the USA more generally by Gobster (Chapter 16). Javelle, Kalaora and Decocq (Chapter 18) also examine how perceptions of alien species in French forests vary over time and even between stakeholders, with major consequences for control programmes. Peoples' interactions with their local environment are such that they may not even 'see' the problem in the first instance; some invaders are simply invisible to some sectors of the population.

National situations interact across political frontiers with wider global issues of alien species and diverse human cultural perceptions of them, and this vision has often dominated in both ecological and social historical scholarship, influenced through increasing globalization and modern environmental attitudes. Similarly, the problems faced in intensively studied countries such as Great Britain often mirror those which occur in other Western countries around the world. Though conservation organizations are often reluctant or unwilling to enter the societal debate (the non-scientific debate, if you like), perceptions and attitudes towards invasions and invasives are important, and often subjective rather than objective. Discussions about aliens also relate to perceptions of just what is 'natural' and 'wild': loaded concepts with significant subjectivity, that are increasingly open to debate and challenge. This is particularly the case in developed countries where people live mostly in what are, at best, seminatural habitats and largely cultural landscapes shaped both by nature and human history. To address some of these problems botanists have recently adopted the term 'archaeophytes' to cover long-established non-native plants. There may also be a time period after which a species may be accepted almost as an 'honorary native', again a totally subjective non-scientific label.

For plants in particular the mode of arrival or of introduction is central to both definition and to an understanding of the issues. Ellis (1993) took alien plants to be those introduced by people, both deliberately or accidentally. But he also notes that in reality, and with a longer time perspective, most native flora could be considered 'alien invaders'. This is due to the dynamic and fluctuating nature of vegetation in a landscape with long-term changes of key factors such as climate. This latter point may become increasingly important in the years to come. Alien or exotic species can be 'casual', 'persistent', or 'established', and are often also described as either 'introduced' or 'naturalized', the latter implying a self-sustaining and expanding population. This serves to

emphasize that much important conservation management is based substantially on subjective human needs, opinions and priorities, not necessarily on hard-nosed ecological science.

Many current conservation problems and issues in terms of exotic and invasive alien plants and animals originate with western European imperial expansion, and thereafter with mostly northern hemisphere-led globalization. Media and scientific expressions of concern have led to some actions, more often a proliferation of policies and strategies but, with some notable exceptions, little effective implementation. This is despite wide recognition and well-supported assertions about the negative impacts of many invaders on both ecology and economy. Professional conservationist Graham Madge (below) was writing specifically about the British experience, but this viewpoint applies globally too.

> *Government documents are long on rhetoric but very thin when it comes down to well-defined actions and accountable responsibility. Invasives are a significant threat to a large proportion of the world's biodiversity.* Graham Madge, Royal Society for the Protection of Birds (RSPB), quoted online 13 October 2008, www.newsforums.bbc.co.uk

Yet these issues are not so simple. The often ignored debate on exactly what is an alien species and what is native has a big impact on what might be considered a problem. Dates and mechanisms of arrival, of human influence and sometimes of extinction too all have a bearing on what we consider is 'in' (acceptable) and what is 'out' (unacceptable). Borowy (Chapter 10) presents an interesting overview of reactions to alien and exotic species and the influences of 19th-century acclimatization societies on attitudes in Europe and around the world. She asserts that invasion biology has yet to make a convincing case for foreign species being inherently more damaging than native species, some of which also behave in ways that contradict peoples' economic and ecological expectations. 'At the end of the day, plants and animals may not be so different from people: there are all kinds of them everywhere, good and bad and mostly in the grey area in between with good sides for some and bad sides for others' (Chapter 10).

Increasingly too in the modern era, conservationists have sought to reverse losses and extinctions through the 'reintroduction' of species to habitats within their former range (see Lambert, Chapter 11). In Great Britain this has led to hugely successful returns (mostly by human hand in reintroduction schemes or active translocation schemes, but also through natural recolonization) by birds such as red kite (Lovegrove, 1990; Carter, 2007) and osprey (Brown and Waterston, 1962), and localized human-instigated recovery by sea eagles in Scotland (Love, 1983). In almost all such cases the species involved are high-profile iconic birds with huge public appeal, and thus sustainable tourism implications that can yield substantial regional economic benefits in remoter rural areas, alongside their conservation value. Yet these anthropogenic interventions are not

without their controversies, and proposals to establish the sea eagle in East Anglia triggered media frenzy and a vociferous local campaign opposed to the suggestion. The coastline of Norfolk and Suffolk is now real contested ground.

Other species 'quietly' reintroduced over recent decades include otter (King et al, 1976) and barn owl, both with considerable success and generally without huge public debate. However, even the widespread recovery of the otter has not been totally without issue, with clear evidence of persecution, often with a suggestion of economic interests such as fish farms, for example on the River Don in South Yorkshire. For species such as barn owl, the major concerns were whether or not the issues associated with declines had really been addressed sufficiently to facilitate re-establishment and recovery, after initial reintroduction had taken place.

But perhaps the most controversial proposals for reintroduction have been with regard to large mammals, and sometimes keystone ecological species. Native wild boar (see Goulding, Chapter 19), European beaver (Conroy et al, 1998; Coles, 2000), wolf and lynx (Dennis, 1998) have all been subject to regional proposals, huge media speculation, a degree of public hysteria, and even one romantic novel that we are aware of that markets itself as 'a battle for the hearts and minds of the public' (Plant, 2000). Yet at the same time, as the sociocultural, economic, political and scientific debates rage, the wild boar has established itself unofficially (Goulding, Chapter 19), and there is evidence of breeding wild lynx (David Siddon, personal communication). We even have strong evidence of black leopards deliberately released into the English countryside and suggestions that they have bred successfully. Around Sheffield in South Yorkshire, they were kept as 'guard dogs' for scrap-metal works in the 1970s and let loose into the Peak District when the Dangerous Wild Animals Act of 1976 came into force (Julian Gillott, personal communication). These now present the authorities and scientists with dilemmas as to whether a former native species such as wild boar, absent for some centuries, but ecologically very significant, is native or alien. For the big cats, the issue is often more fundamentally of disbelief.

At the same time as these debates are taking place, exotic species and management techniques devoted to them dominate huge swathes of the landscape. Exotic conifers are imposed on large areas of both upland and lowland as productive forest; and in the lowlands especially, game management for exotic birds such as common pheasant and red-legged partridge has a massive topographical and cultural influence. In the uplands, while game management is mostly for the native (endemic subspecies) red grouse (itself a cultural icon from the Glorious Twelfth to whisky bottle labels), the drainage and burning regimes to produce monoculture heather are a culturally imposed feature of landscape modification to serve an economic purpose, and to benefit one species that is valued over others. Yet many of these landscapes are understood by the wider public to be 'native' and 'natural', and even cherished and embraced as 'wilderness'. Similar issues apply across the planet from Australia and New Zealand, to North America, to Africa and the Mediterranean. In North American prairie restoration for example, there remain serious problems

in establishing effective long-term management in the absence of long-extinct large mammals. Since the large herbivores which drove the ecology of the natural prairie are lost to extinction, there are emerging scientific and environmentalist arguments for introducing the nearest extant animals such as the African elephant and other grassland ungulates. Exciting, yes? A touch scary, yes? But how native is that? (see also Allison, Chapter 17, on the prairie and alien species). The chapters in this book address these fundamental matters embedded in the ongoing dialogue about the issues, perceptions and problems surrounding native reintroductions and exotic invaders.

Problem species and their impacts

The scale of impacts of alien species is massive (see Simberloff, Chapter 8), and the relationships between people and invasions are undoubtedly complex (see McNeeley, Chapter 2). According to a recent newspaper report (Bruxelles, 2010) the National Trust estimates the cost of current controls of invasive exotic plants in Great Britain to be around £2.7 billion per year. In response to this threat, the Department for Environment, Food And Rural Affairs (Defra), chiefly responsible for these matters, has announced a new campaign called 'Be Plantwise'. This is the first part of a two-pronged attack on alien invaders and it aims to raise awareness among millions of domestic gardeners of problem species and the consequences of deliberate or accidental release. This is obviously a good idea, and in a nation obsessed by tending the cultural space that is one's garden, it will reach a wide audience, a powerful gardening constituency, but as a campaign it could be criticized as mere gesture-politics: doing something without spending real money. To properly address the long-term problems of invasive exotic species will require finance not forthcoming from central government. It also seems that we are not considering wider landscape management issues and problem species, but focusing on the label 'invasive aliens'. There is little sign of the debate moving towards sustainable conservation land management, supported by a wider community of stakeholders, public and private, scientific and popular. In particular, while an information campaign based on education is especially important in terms of garden escapes, the conservation problems run deeper than just exotics and include aggressively invasive native plants too. Problems such as invasive bracken, birch and even holly are simply ignored because they are 'native', and because in some instances we admire them or associate them with our sociocultural and religious lives (for example, holly at Christmas time). Perceptions of both native and alien species vary over time as does what is or is not a problem (Coates, 2006; Rotherham, 2003). Moreover, linked partly to this ambivalent attitude towards nature, people have often been crucial in both triggering escape and facilitating invasion (Rotherham, Chapter 15; Rotherham, 2001a, 2001b, 2005b).

At a worldwide level the scale of the impacts, and therefore of the challenges facing the delivery of coherent responses, are truly massive. Dr Sarah Simons, Executive Director of the Global Invasive Species Programme (GISP), recently stated that:

> *Despite the enormous costs, not only to biodiversity but also food security, human health, trade, transport and more broadly, economic development, invasive species continue to receive inadequate attention from policy makers and in 2010, there is simply no excuse for not tackling one of the greatest threats to the environmental and economic well-being of our planet.*

Indeed, there is no denying the global impacts of aggressively invasive and often exotic species, especially on once isolated fragile island ecologies and areas of high endemic biodiversity. But problem species include regionally native ones too, and it seems that in many cases the triggers of invasion and of damaging impacts are human-induced environmental changes. These include moves away from traditional land management, and often economically driven controls, and also climate and other environmental changes such as gross eutrophication. To tackle effectively the consequences of aggressive invasions we needed to consider the phenomena 'in the round' and to address wider contextual issues too.

Obvious examples of other natives (along with bracken) causing problems include gorse on many heathland and grassland sites, hawthorn and blackthorn, and even birch, invading grasslands, heaths, moors or bogs. Willow and poplar both cause huge damage to buildings. Both Ted Green of the Ancient Tree Forum and Professor John Rodwell ('godfather' of the British National Vegetation Classification) now argue that sycamore, often the most despised of exotic trees in England, is actually native. Beech, non-native in northern England and Scotland, along with mature larch and other species also not native, are glorious additions to many sylvan landscapes. In England, native clematis (old man's beard) can be a pernicious weed of southern woods, as can native ivy. Wild rhododendron (introduced from Gibraltar in 1764) can be surprisingly good for many wildlife species including winter roosts of birds, breeding nightingales and cover for deer, badgers and otters (Rotherham, 2001b). Moreover, the impacts of exotic invasive rhododendron on ancient woods are not unique to this alien species. The adverse effects are because it is 'invasive', not necessarily because it is 'alien'. Native holly, abandoned and no longer cut for leaf fodder in traditional 'holly hags', now spreads invasively across many ancient coppices. This transforms the woodland ecosystem and eliminates woodland ground flora, yet there is no call to arms to remove it. One wonders why? In urban Sheffield, otters, back on the River Don since the early 21st century, are hiding out under dense stands of Japanese knotweed (Rotherham, 2009).

In terms of mammals, native roe deer can cause similar damage to alien Muntjac deer. Both red squirrel and grey squirrel can damage trees; even badger, one of our most iconic conservation species, can undermine buildings, gardens and occasionally railway lines! Red deer are native but may cause serious overgrazing, damage to trees, woods and forests, and road-traffic accidents. Many species, in the wrong place at the wrong time, can and will cause problems to nature and to people. Alien species are often particularly invasive but then so are many native species. An interesting issue is raised by the

culturally significant brown hare, listed as a Red Data Book and Biodiversity Action Plan species but which is alien, a Norman introduction. The rabbit also is alien, but especially following the cultural severance of abandonment of traditional grassland management (Sheail, 1972), is vital in maintaining many species-rich wildflower pastures, and hugely important as food for predators such as common buzzards. And of course, in 1902 Beatrix Potter gave her fictional rabbit a blue waistcoat, a trug with carrots in it, and the name Peter, and single-handedly generated a huge sentimental cultural association between humans and rabbits, particularly from our formative experiences as readers of the genre of children's nature literature (Potter, 1902). This one book has sold 45 million copies worldwide and been translated into 36 languages. The rabbit has many friends. Enemies of the rabbit, most especially the Anti-Rabbit Research Foundation in Australia (since 1998 known as the Foundation for a Rabbit-free Australia), return to the power of children's literature to counter the rampant sentimentality for the British invader down under. Aussie kids are urged (through popular primary school books) to cherish and embrace the native desert marsupial Bilby at Easter time, and to shun the more traditional (but culturally invasive) Easter Bunny (Kessing and Garnett, 1994; 1999). They eat chocolate Easter Bilbies as part of scientifically sponsored cultural ecological restoration. There may be a tendency to chuckle at this evidence, but this is serious stuff in an invaded land such as Australia (Coman, 1999). Severing cultural ties with rabbits needs to be done at a young age, before the powerful and mentally invasive Beatrix Potter-effect can take hold! (See also Coates, Chapter 3).

Controls and controversy

Attempts to remedy damage and to stop or limit invasions can be problematic and control of alien species is frequently controversial, even when based on good science. In the UK, control or removal of planted (alien) conifers (sometimes 100–200 years old) on sand dunes is causing serious concern and even uproar in west Lancashire, and also at Newborough Warren in North Wales. Here after a lot of money has been spent to conserve the 'native' red squirrel, they may be sacrificed to remove planted conifers from the dunes. The Countryside Council for Wales (CCW) has decreed that these aliens should be cleared to free up the ancient sand dune systems; but many locals are dismayed that their squirrels will be lost. There are concerns about the dilution of the genetics of wild daffodils by hybridization with nasty garden escapees in that most cherished of English landscapes, the Wordsworthian Lake District. Similarly in most regions of Britain worries about Spanish bluebells seem totally overstated. Yet the creeping invasion of woodland by variegated yellow archangel has a massive impact on ecology and generates no interest from conservation bodies. Other invasives such as sweet cicely, which is also alien, again often gets no response from conservation bodies. Similarly Norway maple is still widely planted in landscaping schemes and is now colonizing everywhere but triggers no action to control its spread, and Russian vine is another accident waiting to happen, but generates no interest at all.

Shutting the stable door

Wild boar, the European eagle owl, the Monk parakeet and 60 other species have been added to the list of non-native species that pose a threat to Britain's indigenous animals. The Chinese water deer, the snow goose and 13 other birds, the slipper limpet and 7 other invertebrates, 35 plants including 2 kinds of rhododendron, and 2 types of algae have also been included on the list, created jointly by Defra and the Welsh Assembly government. In a statement about the additions, invasive, non-native species were described as 'one of the greatest threats to wildlife worldwide'. Wildlife Minister Huw Irranca-Davies said:

> *It is essential that our native species are given the protection they need to flourish; 2010 is the International Year of Biodiversity and it's more important than ever to do all that we can to halt the loss of biodiversity … Stopping the spread of invasive non-native species makes a real difference to the survival of our own native plants, birds and animals.*

The Wildlife and Countryside Act (1981) prohibits the introduction into the wild of any animal which does not normally live or visit Britain or any plant or animal on the list, which is detailed in Schedule 9. Doing so carries a maximum punishment of two years in jail and a £5000 fine. Seven animals were removed from the list, including the Mongolian gerbil and the Himalayan porcupine, as these are no longer thought to be a threat. The former native wild boar is back in the wild in Britain in places such as the Weald in Kent and the Forest of Dean about 700 years after being hunted to extinction. It is an ecological agent for good in the management of robust woodland ecosystems, but in more fragile wetland ecosystems can be very destructive and a key predator of waterbird nests. In time, wild boar could be harvested sustainably for food and as an iconic sporting trophy, generating income which could be pumped back into woodland conservation. Would this be acceptable to the public? At the moment, the wild boar is an animal only encountered by landowners, foresters, surprised dog walkers, and naturalists keen to track one down. They have not yet fully invaded the public psyche, despite an elusive TV appearance on the hugely popular BBC Natural History Unit's *Autumnwatch* in November 2007. Calls from enthusiasts for a formal reintroduction into the UK have met with official resistance.

Yet Steve Carver at the University of Leeds comments:

> *It is very worrying to have Defra include native species, albeit largely extinct in the UK save recent reintroductions, in a list of non-native species that threaten UK biodiversity. Where did they get their scientific advice/evidence from on this? I've been trying to get the full list online but can't seem to find it (any hints?). If wild boar is included then it sounds ill thought out … or is it just a political move? Certainly, wild boar inclusion goes*

> *against Article 22 of the EC Habitats Directive and Article 11 of the EC Birds Directive, doesn't it? Does it include beaver and lynx I wonder? Or is it just a list of species already here and perceived as a problem?*

So it seems that the scientific logic underpinning some of these decisions is very questionable. Furthermore, quite a number of these animals and plants are already here, will be hard or impossible to remove anyway, and in at least some high-profile cases are actually natives. To this must be added the fact that many species now accepted and cherished, like brown hare for example, are clearly not native, and other exotics such as rabbit and common pheasant are hugely influential in domestic ecology and the wider management and imagery of the British countryside. This muddled thinking detracts from the need to take serious action to address those species (like exotic signal crayfish and native bracken) that clearly are very damaging. In most cases, beyond public statements of policy, little real action is taken. Prohibitive legislation has played a role. The Destructive Imported Animals Act of 1932 was domestic declaration of official war on the North American muskrat (musquash) brought to the UK in the 1920s for fur-farming; the preamble mapping out the reason for its promulgation in Parliament is a fascinating insight into cultural values and attitudes towards foreigners in the hard times of the early 1930s: 'an act to make provision for prohibiting or controlling the importation into and the keeping within Great Britain of destructive non-indigenous animals, for exterminating any such animals which may be at large and for purpose connected with the matters aforesaid'. Importing, keeping or releasing a muskrat attracted a £20 fine (around £980 at today's values), and for more than four animals an additional £5 fine per beast (Public Acts, 1932). The Act received royal assent on 17 March 1932 (Hansard PD, 1932). The muskrat was gone from Britain by 1939, by which time 4388 had been killed (Gosling and Baker, 1989), success coming from a combination of good technological planning and rapid response. Sagoff (Chapter 6) considers in detail problems surrounding programmes for controlling damaging aliens in the USA and the degree to which expenditure and enforcement can be justified when human health is not a factor. These are complex sociocultural, economic and political issues and choices.

Specific actions, however apparently laudable in principle, remain controversial in both specialist and public arenas, and problematic in practice. A prime example is the British government-sponsored cull of North American ruddy ducks, one of the less welcome legacies from the Slimbridge Wildfowl Collection in Gloucestershire belonging to Sir Peter Scott (a pioneer of conservation). The British population of wild ruddy ducks descends from Slimbridge escapees after seven adults were brought here in 1948 by Scott. According to *The Observer* (Sunday 7 February 2010):

> *A controversial UK cull of ruddy ducks, a US native that has been compared to a 'feathered lager lout' for its displays of*

> *thuggish and amorous behaviour, has cost the British taxpayer more than £740 for each dead bird. Figures from the Department for Environment, Food and Rural Affairs (Defra) show that shoots of the chestnut-coloured bird have cost taxpayers £4.6m, yet only 6200 have been killed. The disclosure has sparked an outcry from ornithologists and animal activists, who have protested since the cull began five years ago. They say that the bird, targeted because it had interbred with the threatened white-headed duck in Spain, should have been left alone. The cull is due to end in August.*

The newspaper also quoted Lee Evans, founder of the British Birding Association and the radical twitchers' UK400 Club, who is a passionate believer that the cull should be abandoned in the face of poor science and public outrage within the powerful domestic birding community: 'It's appalling and pointless, a complete waste of taxpayers' money. What's the point of it all? Our ruddy ducks don't go to Spain, but the French ducks do, and the French are not culling their birds. These marksmen are getting away with murder.' Data suggests that by the winter of 2008/2009, the UK population of the ruddy duck had been reduced by almost 90 per cent (Henderson, 2009). A section of the British birding community has been very vocal in its fierce opposition to the ruddy duck cull, using the web, blogs and popular birding hobby magazines such as *Birdwatch* and *Birdwatching* or the letters sections of the more scientific *British Birds* and *British Wildlife*.

Without effective international cooperation then surely this project is doomed to failure. One consequence witnessed across much of England is that county bird recorders simply withhold the locational details of ruddy duck breeding and wintering sites in their patch. Regardless of any merits of the case for control, it seems that key arguments with some grassroots ornithologists have yet to be won. Without their support it is highly unlikely that any control programme could be effective. There is now a very subtle ruddy duck information counterinsurgency going on across the UK, with keen British birders and private landowners in a collusion of silence, to keep the cullers at bay. This is a sort of David-versus-Goliath confrontation with government and powerful NGOs being challenged by individual action. Not so much a cry of 'power to the people' as 'power to the birder!' So we question whether the cull has produced any noticeable, long-term, sustainable effects or had any real impact on the white-headed ducks in Spain; or has it been an expensive waste of time? Lessons of history show that to be effective control programmes need to bring together key stakeholders for closely coordinated action. The government-sponsored eradication of coypu from the Fens and Broads of eastern England after 1981 remains one of the few success stories in modern Britain; with landowners, government agencies and conservation bodies working together towards the common objective of removal, founded on a long-term study of population ecology (Gosling et al, 1981) and an incentive scheme for trappers to overcome the basic economic problem that 'trappers would be reluctant to

work themselves out of a job' (Gosling and Baker, 1989). Another observation is that too often, even if we want control in order to avoid demonstrable ecological damage, the efforts are too little, too late. No doubt the 'ruddies' could have been dealt with within the first five years of establishment, but that didn't happen. Now, even if doubtful ornithologists (the celebrity television naturalist Bill Oddie is a vocal supporter of the ruddy duck as a charming species of waterfowl) and public could be won round, it is inconceivable that government would fund this level of activity in any sort of sustainable way. This is compounded by evidence that the British cull has been an expensive failure and that the European population is not being controlled. It may be a naive question, but surely the money would have been better spent in Spain helping to control hybrids within the white-headed duck's range, and on associated education and awareness-raising programmes? Many British birders argue that Spain should focus its energies on protecting white-headed duck habitat by halting blind and wholesale economic development of coastal wetlands into mass tourist resorts. They also point out that wild ruddy ducks have reached the Azores archipelago (in the North Atlantic Ocean), so might we be actually standing in the way of the very first wave of emigration as a species seeks to widen its geographical ecological frontiers?

Changing perceptions over time

What is acceptable and what is alien vary with time (Smout, Chapter 4). In the 1930s, the little owl, now a valued and admired diminutive member of British avifauna, yet introduced from France, was considered a serious threat to native (or valuable economic) species, especially chicks of game species, with calls for its eradication. The little owl lived to fight another day, having been publicly found 'not guilty as charged' in an extensive inquiry into its habits and diet (Hibbert-Ware, 1938). Even more challenging today is that eagle owls naturalized in small numbers in Northern England (and harboured on some remote Ministry of Defence estates) were probably once native to the country. We may even receive migrant eagle owls from the Continent from time to time, as natural invaders. Are they welcome or not, and how influential should the tough stance taken against eagle owls in Britain by some conservationists be? What impact are they having on rare upland breeding birds such as the hen harrier? Are they an iconic enough bird of prey species to pull in waves of nature tourists to structured eagle owl nest-viewing opportunities, offering education, interpretation, good PR possibilities for often-criticized big utility companies and income for rural communities? Well, yes, so eagle owl tourism may be a path that we should not be afraid to take. More problematic are internationally rare animals such as Chinese water deer; they are exotic species in Britain, and add to the overabundance of deer at present, but they constitute a significant proportion of the world population. Neither brown hare (UK national Biodiversity Action Plan species) nor rabbit (keystone species of many British ecosystems) are native; they are not accepted despite their minimal ecological impact. Other animals in the spotlight are beavers and wild boar.

Without these two mammals, many of our wildlife habitats lack major functional elements of their natural composition, an absence critically damaging to other key species. Lowland woods without wild boar lack microdisturbance, and the dispersal of important fungi. How do we respond to attempts either to reintroduce these species or to tolerate escapees? There is public outcry and a clamouring for eradication among some quarters; but if wild boar is recognized as native, then logically it should be protected. This might be with a role as game and an associated close season. In Germany and France people and wild boars seem to get along with minimal fuss, so why not here?

As a conservative species and culture, we dislike change and fluidity. They trouble us, and yet environmental and landscape history show constant ebbs and flows in wildlife populations and associated ecosystems. With enhanced global warming, this dynamism increases. The 'Little Ice Age' for example had huge impacts. Yet we do not have reliable data for most species and have little real information about how they have responded. There are few botanical records before about AD 1600 and many 'natives' would have fluctuated dramatically and continue to do so. In South Yorkshire, the prickly lettuce, hemlock and grass vetchling have all extended their ranges since the late 1980s. Yet even today, there is no information on former or current distribution, and no one has really noticed these dramatic changes in status.

Recombinant ecology

Increased urbanization and global climate change mean aliens do and will have increasingly important roles and functions in future landscapes. This new ecology, promoted by George Barker (formerly of the Nature Conservancy Council), has slowly been recognized, with pioneering work in Eastern Europe and more recently in Britain. 'Recombinant ecology' (Barker, 2000) will need to be understood for conservation management to work with this new suite of possibilities and to address actual problems of exotic species. Each generation of ecologists and decision makers has a different set of species that are acceptable to them in their 'natural' environment, but we often do not see this. As individuals passing through spatial and temporal ecologies, we carry personal perceptions of the environment that influence our reactions. Some deeply held precepts might also be wrong. 'English oaks' from which small children gather acorns to nurture, plant and sustain native botanical inheritance often have Dutch or other European parentage from the thousands of oaks and other species imported from continental nurseries during the 18th and 19th centuries. For the genuine article, you may need to gather from a genuine veteran which predates the imports.

We lack scientific rigour on hybridization between related exotic and native species for bluebells and daffodils, for example. We have teams of volunteers roaming woodlands to eradicate alien white bluebells, who are inadvertently removing rare pink and white forms of native bluebell. Where is the evidence of the problem? Variegated yellow archangel continues its spread with barely a murmur; still sold by garden centres with no warning. This seems irresponsible,

but where would we stop if it were to be banned? There is a whole list of such plants waiting to jump the garden fence and with accelerated environmental change it is getting longer. Indeed this fence, seen in the past as an enclosing barrier, is now a real conduit for ecological change. Over recent decades landscape architects have created new problems, such as planting Norway maple that are now seeding into ancient woodlands – an accident waiting to happen. Science informs us, but our subsequent decisions are subjective. The new emerging subdiscipline of species history, written by environmental historians, historical geographers, biologists, historical ecologists (Harting, 1880; Beirne, 1952; Lambert, 1998; Yalden, 1999, 2003; Lovegrove, 2007), call them what you will, can only help to provide a fuller and richer and more rigorous understanding of both the distant and more recent ecological past, to be used in shaping and planning the future. This does not mean there is no problem; but it may infer that current approaches will not elicit a solution. At a most fundamental level it is necessary to revisit ideas and values and to consider carefully the lessons of history (a blend of the sociocultural history of humanity with the species history of animals), even before we frame the critical conservation questions for the present day. As plant ecologist Jim Dickson mused at a conference hosted by Scottish Natural Heritage in Perthshire in 1996, 'Good science, good history and pragmatism' may be the way forward (Dickson, in Lambert, 1998, p1) as we begin to understand how nature has changed naturally or has been modified by human action.

How we distinguish alien from native, what belongs from what does not, can be incredibly complicated and yet it lies close to the heart of much of this debate. Chew (Chapter 9), Trigger (Chapter 7), Pooley (Chapter 22) and Petrie (Chapter 21) all raise issues and present case studies that question many basic precepts. In this volume Beattie (Chapter 23) also discusses how these perceptions change over time, and stresses the importance of understanding how historical works may misjudge the evidence to present all-too-rigid dichotomies of alien and native. These are important considerations in understanding why we respond as we do to certain species and not to others. Improved awareness of these influences is vital to informed and effective responses to the problems which undoubtedly exist. Indeed, as argued by Osteen and Livingston (Chapter 20), such perceptions influence government budgets and programmes for control and also lead to potential controversies. In a significant contribution to the debate Binggeli (Chapter 13) discusses how there may be reactions to exotic species that vary according to their utilitarian value to local communities rather than their indigenous nature. Indeed there may be conflicts between stakeholders where useful species had adverse effects on native ecology and nature conservation. Such mundane issues may influence perceptions of what is good and what is bad quite dramatically. A key point raised at a recent conference in Sheffield (Rotherham, 2009) concerned the absence of good science underpinning many assessments of invasion problems, in considering historic changes in species distributions, and in terms of understanding vital aspects of species autecology. Bailey (Chapter 14) in his account of Japanese knotweed as an invader demonstrates the value of meticulous

scientific research to help guide and inform our responses to problem species. But for many plants and animals there is a long way to go before we have such insights into their ecology, genetics and physiology. All these factors combine to challenge historians, ecologists, geographers and others to provide a more coherent understanding of the impacts of alien, exotic and introduced species on both people and on Nature.

It is this rich and diverse consideration of the broad sweep of issues relating to species invasions, introductions and reintroduction that this book addresses. In the following chapters we present a range of multidisciplinary contributions with in-depth case studies from around the world and topic-related chapters on particular themes and problems. We believe that only though a more holistic and inclusive approach to this subject, which is both academically interesting, challenging and publicly engaging, can a coherent understanding emerge of this fascinating and complex interaction between people and nature.

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Xenophobia or Conservation: Some Human Dimensions of Invasive Alien Species

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Introduction

The issue of invasive alien species is usually considered primarily a biological concern. But the problem is better seen as an expression of human culture, based on the sense of place that many people have, enlightened self-interest, and basic issues of economics and health. Support for this human perspective comes from four main directions. First, virtually all our planet's ecosystems have a strong and increasing anthropogenic component that is being fed by growing globalization of the economy and society; both people and goods are now moving freely and rapidly across the planet. Second, people are designing the kinds of ecosystems they find productive or congenial, with immigrants often bringing species with them from their native lands. Third, growing travel and trade, coupled with weakening customs' and quarantine controls, enable people to introduce – both inadvertently and intentionally – alien species that may become invasive. Fourth, the issue has important philosophical dimensions, requiring people to examine fundamental ideas, such as 'native' and 'natural'. The great increase in the introduction of non-native species that people are importing for economic, aesthetic, accidental or even psychological reasons is leading to more species invading native ecosystems, often with disastrous results: many become invasive alien species (IAS) that have significant deleterious effects on both ecosystems and economies. This chapter examines some of the important human dimensions of the IAS problem, including historical, economic, cultural, philosophical and political issues. These are addressed in terms of the causes, consequences and responses to the problem of IAS. This introduction shows that successfully addressing the problem of species invasions will call for greater collaboration

between economic sectors and among a wide range of disciplines. The Convention on Biological Diversity and many other international agreements offer important opportunities for addressing the complex global problems of IAS through improved international cooperation in what boils down to an ethical issue: the conservation of native biodiversity.

Human impacts on the ecosystems of our planet continue to grow (MA, 2005). The increasing human population and growing wealth mean that more people consume more of nature's goods and services, pushing against the limits of sustainability. Greatly expanding global trade is feeding this consumption, with large containers of goods moving quickly from one part of the world to another by aeroplane, ship, train and truck.

One critical element in this economic and social globalization is the movement of organisms from one part of the world to another through trade, transport, travel and tourism. Many of these movements into new ecosystems where they are alien (also called non-native, non-indigenous or exotic) are generally beneficial to people. But many others have very mixed effects, benefiting some individuals or interest groups while disadvantaging others. In a few cases, especially disease organisms and forest or agricultural pests, the alien species is clearly detrimental to all, or nearly so. This book addresses the latter groups: invasive alien species (IAS), the subset of alien species whose establishment and spread threatens ecosystems, habitats or species with economic or environmental harm (GISP, 2001).

Farmers have been fighting foreign weeds for generations, and disease organisms have been a major focus of physicians for well over 100 years. But the general global problem of invasive alien species has been brought to the world's attention only relatively recently by ecologists concerned that native species and ecosystems are being disrupted (e.g. Elton, 1958; Drake et al, 1989). Much of the work to date on IAS has focused on their biological and ecological characteristics, the vulnerability of ecosystems to invasions, and the use of various means of control against invasives. However, the problem of IAS is above all a human one, for at least the following reasons:

- People are largely responsible for moving eggs, seeds, spores, vegetative parts and whole organisms from one place to another, especially through modern global transport and travel;
- While some species are capable of invading well-protected, 'intact' ecosystems, IAS more often seem to invade habitats altered by humans, such as agricultural fields, human settlements and roadways;
- Many alien species are intentionally introduced for economic reasons (a major human endeavour); and
- The dimensions of the problem of invasive alien species are defined by people, and the response is also designed and implemented by people, with differential impacts on different groups of people.

People introduce organisms into new habitats unintentionally (often invertebrates and pathogens), intentionally (usually plants and vertebrates), or

inadvertently when organisms imported for a limited purpose subsequently spread into new habitats (Levin, 1989). Many deliberate introductions relate to human interest in nurturing species that are helpful to people for agricultural, forestry, ornamental or even psychological purposes (Staples, 2001). The great bulk of human dietary needs in most parts of the world are met by species introduced from elsewhere (Hoyt, 1992); it is difficult to imagine an Africa without cattle, goats, maize and cassava, or a North America without wheat, soy beans, cattle and pigs, or a Europe without tomatoes, potatoes and maize – all introduced species. Species introductions, therefore, are an essential part of human welfare and local cultures in virtually all parts of the world. Further, maintaining the health of these introduced alien species of undoubted net benefit to humans may sometimes require the introduction of additional alien species for use in biological control programmes; for example the importation of natural enemies of agricultural pests (Waage, 1991; Thomas and Willis, 1998); and these biological controls may themselves become invasive.

Considerable evidence indicates a rapid recent growth in the number and impact of IAS (Mooney et al, 2005). Trade and more general economic development lead to more IAS; Vilà and Pujadas (2001), for example, found that countries more effectively tied into the global trading system tend to have more IAS, being positively linked to development of terrestrial transport networks, migration rates, tourists visiting the country and trade in commodities (Dalmazzone, 2000). The global picture shows tremendous mixing of species, with unpredictable long-term results but a clear trend toward homogenization (Bright, 1998; Mooney et al, 2005). The future is certain to bring considerable additional ecological homogenization as people continue to introduce species. This ecological shuffling will enable some species to become more abundant and others to decline in numbers (or even become extinct), but the overall effect will probably be a global loss of biodiversity at species and genetic levels (McNeely, 2001). How is the great reshuffling of species being driven by human interests and how will it affect them? How should people think about the issue? What stakes are involved? Whose interests are affected? How can the human dimensions best be addressed by scientists, resource managers and policy makers?

These are not trivial questions, because the issue of IAS has ramifications throughout modern economies. It involves global trade, settlement patterns, agriculture, economics, health, water management, climate change, genetic engineering and many other fields and concerns. It therefore goes to the very heart of problems that policy makers spend much time debating, ironically usually without reference to IAS. This chapter examines some ramifications of IAS through many dimensions of human endeavour. It shows that IAS are deeply woven into the fabric of modern life, so more effective responses to the problems they pose must incorporate the kinds of human dimensions that are discussed in this chapter and elsewhere in this book.

Historical dimensions

Because of a long geological and evolutionary history, our planet has very different species of plants, animals and microorganisms on the various continents, and in the various ecosystems (Wallace, 1876). As a broad illustration, Africa has gorillas, Indonesia has orang-utans, South America has monkeys but no apes, and Australia has no non-human primates at all. Even within continents, most species are confined to particular types of habitats: gorillas live in forests, zebras mostly in grasslands, and addax in deserts. Oceanic islands and other geographically isolated ecosystems often have their own suites of species, many found nowhere else (termed 'endemic species'); about 20 per cent of the world's flora is made up of insular endemics found on only 3.6 per cent of the land surface area. Geographical barriers have ensured that most species remain within their region, thus resulting in much greater species richness across the planet than would have been the case if all land masses were part of a single continent. This historical biogeographical framework provides the basis for defining concepts of native and alien species. Of course biogeography has always been dynamic, as species expand and contract their ranges and the contents of ecosystems change as a result of factors such as climate change (Udvardy, 1969), so some movement of species is natural, just as climate change is. But just as climate change is accelerating due to human factors (IPCC, 2007), so are people speeding the movement of species around the world.

Homo sapiens apparently evolved in Africa, spreading to Europe and Asia over 100,000 years ago, Australia 40–60,000 years ago, the Americas about 15–20,000 years ago, and the far reaches of the Pacific less than 1,000 years ago. Our species is a good example of a naturally invasive species, spreading quickly, modifying ecosystems through the use of fire, and driving other species to extinction (Martin and Klein, 1984). Wherever people have moved they have also carried other species with them. The Asians who first peopled the Americas, for example, were accompanied by dogs, and Polynesians sailed with pigs, taro, yams and at least 30 other species of plants (with rats and lizards as stowaways).

Trade is known far back in human prehistory, judging from the discovery of stone tools at a considerable distance from where they were quarried. But as long-distance travel became more regular, trade became more important. The Chinese have traded with Southeast Asia for at least several thousand years, and trading routes between India and the Middle East stretch back at least as long. As sailing craft became larger and more reliable, trade increased further and was given a great boost with the voyages of Christopher Columbus that opened up entirely new sources of species (Crosby, 1972), and led to the replacement of the rigid moral strictures of medieval Europe by a new set of merchant values that stressed consumption (Low, 2001).

For at least several thousand years, armies have been an important pathway for moving species from one region to another, with at least some of these becoming invasive (like the armies). The spread of new diseases by armies is well known. For example, measles was carried into the Americas

from Europe by the early conquistadors and perhaps syphilis went in the opposite direction (McNeill, 1976). Rinderpest, a virus closely related to measles and canine distemper, is native to the steppes of Central Asia, but it frequently swept through Europe, carried by cattle moved to feed armies during military campaigns. Africa remained free of this disease until 1887, when it appeared in Eritrea at the site of the Italian invasion, spreading through Ethiopia in 1888, and conquering the entire continent in less than a decade. In some parts of Africa, rinderpest was followed by wars and cattle raids as the tribal pastoralists sought to maintain their herd. Another result was that rinderpest led an ecological revolution against people and cattle and in favour of wildlife species resistant to the disease.

The period of European colonialism ushered in a new era of species introductions, as European settlers sought to recreate the familiar conditions of home (Crosby, 1986). They took with them species such as wheat, barley, rye, cattle, pigs, horses, sheep and goats, but in the early years their impacts were limited by available means of transport. Once steam-powered ships came into common use, the floodgates opened and between 1820 and 1930 more than 50 million Europeans emigrated to distant shores. They were carrying numerous plants and animals that were added to the native flora and fauna (Reichard and White, 2001). More recently, emigrants from Asia and Africa have carried familiar species with them to grow in their new homelands in Europe, Australia and the Americas.

The era of European colonialism also encouraged the spread of plant exploration, in the quest for new species of ornamental plants for botanical gardens, nurseries and private individuals back home, some of which escaped and became invasive (Reichard and White, 2001). The spread of global consumerism was given a significant boost in the early decades of the 20th century through advertising and marketing that was strategically designed to motivate the public to buy more goods (Staples, 2001). This ultimately led to an accelerating search to find new species to grow and market, creating consumer demand for products that previously were unknown. The invasive characteristics of the newly introduced species often came as a surprise, because those responsible for the introduction were unaware of possible negative ecological ramifications.

Many invasive species were carried by the colonial military, especially to Pacific and Indian Ocean islands that had numerous endemic species vulnerable to such invasives. In the 17th and 18th centuries, navies introduced many plants and animals to remote islands as future food sources, and these frequently became invasive (Binggeli, 2001). The military sometimes brought in exotic species of plants to form barriers. For example, the French introduced a cactus (*Opuntia monacantha*) to Fort Dauphin in southeast Madagascar in 1768 to provide what they hoped was an impregnable barrier around the fort. Later, the military also introduced a spineless variety (*O. ficus-indica*) to feed oxen (Decary, 1947). Both these cacti have now colonized much of Madagascar, though most of the French have returned home. The role of the military in the spread of IAS has continued. World War II was a particularly active time for the introduction of weeds in the Pacific. Some species, such as