

# Handbook of Alien Species in Europe

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DAISIE

# Handbook of Alien Species in Europe

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# Who is DAISIE?

DAISIE is not only the project's acronym, it also represents the consortium of 83 partners and 99 collaborators and their joint effort. To acknowledge this concerted work, we all accepted DAISIE as author of this *Handbook*. Consequently, each partner and collaborator may refer to *Handbook of Alien Species in Europe* as part of her/his own scientific output.

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# Prefaces

## **United Nations Environmental Programme: DAISIE is More Than a Scientific Reference**

Among the 22 indicators that underpin the international target to ‘reduce the rate of loss of biodiversity’ is one covering trends in invasive alien species. This *Handbook*, the fruit of a three year European Union-funded project, will make a significant contribution to a wider understanding of these trends as they relate to the continent of Europe.

In doing so it will assist countries, including governments; business and industry; academia and civil society to deliver on commitments under the UNEP Convention on Biological Diversity as well as those emerging from such fora as the World Summit on Sustainable Development held in Johannesburg in 2002.

The *Handbook* should also serve to inspire others elsewhere in the world to carry out or support similar comprehensive and forward-looking assessments in order to get to grips with the issue of whether globally, as well as regionally, biodiversity is waxing or waning.

The *Handbook* takes a modern and digestible approach to the issues by flagging up 100 of the most invasive alien species in Europe and confirming the significant impact such invaders can have on native plant and animal communities. For example over 70% of these 100 invasive species have reduced native species diversity or have altered the invaded community and close to a fifth have affected the prospects for endangered species.

The *Handbook*, a product of the Delivering Alien Invasive Species Inventory for Europe or DAISIE Consortium, is however more than just a much needed scientific reference: it is also a fascinating and compelling read. Through words, graphs and images the book chronicles how wave after wave of curious and exotic species have been entering Europe’s terrestrial, freshwater and marine environment stretching back well over a century and in some cases, such as the brown rat, six centuries or more.

The aliens, some of whom have hitched rides on ships, planes or trucks and others, lifted from one continent to another as a result of accidental or deliberate introductions, in part shed light on the Europe’s changing patterns of trade with the rest of the world while also underlining the folly and in some cases the vanity of humanity.

The Canada goose for example, which is considered an economic liability by some and a nuisance by others, was introduced into Britain in the 17th century by King James II to add to his waterfowl collection in St James Park.

The *Handbook* also underlines the environmental and economic impacts that life-forms in the wrong place at the wrong time can make. The coypu, a native of Patagonia, has become established over large parts of Europe after being brought in for fur ranching. Damaged linked with the alien rodent includes massive destruction of reed swamps and predation of the eggs of aquatic and often endangered native birds. Control activities in Italy over a five year period managed to remove over 220,000 coypus at a cost of €2,614,408. However damage to the riverbanks from coypus over the same time exceeded €10 million and impact on agriculture reached €935,138.

The *Handbook* also underlines that aliens such as fungi and plants can be more widely destructive and perhaps more difficult to control if they take hold. The two forms of Dutch elm disease, both of which are thought to originate in Asia, have over recent decades decimated elms in many parts of Europe and a great deal of time and money has been spent trying to breed disease-resistant trees.

Meanwhile the common ragweed, a native of North America and introduced via agricultural products and later via horses during World War I, is now well established in many European countries including France, Switzerland, Hungary and the Balkans. It is linked to hay fever, asthma and other illnesses that can be a costly medical burden in some place such as the Rhone Valley. This is a proof, if proof were needed that it is far better and cheaper to prevent alien species from entering an ecosystem or another continent's environment than trying to eradicate them after the event.

The *Handbook* raises some profound concerns over the future not least from the way climate change – if unchecked – may aggravate the impact of some aliens in Europe. In doing so it underscores that in addressing one environmental challenge, in this case global warming, there are multiple benefits including the conservation of biodiversity upon which a great deal of human well-being including livelihoods, health and economic activity depend.

I would like to congratulate the many scientists who have contributed to the *Handbook* and would commend policy-makers but also the general public to put it in their ministerial in-trays and on their living room coffee tables as this is engaging and essential reading.

Achim Steiner  
UN Under Secretary General and  
Executive Director UN Environment Programme (UNEP)

## The Council of Europe: DAISIE Is a Much-Needed Initiative

The impact of invasive alien species (IAS) on European ecosystems and native species is one of the most challenging issues in the field of conservation and wise use of biological diversity. While invasive alien species can affect all habitats, both terrestrial and aquatic, islands are particularly vulnerable to that threat, mainly because of their biological richness. They hold a high number of unique (endemic) species and their geographic isolation has created vulnerable habitats that can be easily invaded by new arrivals. Nearly half of the flora of the Canary Islands, for instance, is made up of non-native species. Invasive alien species are quoted as being one of the causes of extinction of species worldwide, mainly through their influence on island biodiversity through predation, competition, hybridisation or as vehicles for pathogens to which native species are not resistant.

Those are some reasons that moved the Council of Europe to promote, within its nature conservation programmes, action to avoid the intentional introduction and spread of alien species, to prevent accidental introductions and to build an information system on IAS. In 1984 the Committee of Ministers of the Council of Europe adopted a recommendation in that sense. Also the Bern Convention (*Convention on the Conservation of European Wildlife and Natural Habitats*), the main Council of Europe treaty in the field of biodiversity conservation, requires its 45 Contracting Parties “*to strictly control the introduction of non native species*”. In 2003, the Bern Convention adopted the “European Strategy on Invasive Alien Species”, aimed to provide precise guidance to European governments on IAS issues. The Strategy identifies European priorities and key actions, promotes awareness and information on IAS, strengthening of national and regional capacities to deal with IAS issues, taking of prevention measures and supports remedial responses such as reducing adverse impacts of IAS, recovering species and natural habitats affected. National strategies have been drafted and implemented following the priorities set in the European Strategy.

One of the points dealt at the European Strategy on Invasive Alien Species was the need to develop national and European information systems. It was recognised that information sharing between states and scientific institutions was a critical factor for prevention, both of new arrivals and spread of introduced aliens. The Strategy pointed out that there was already quite an important amount of expertise and information available and that any European inventory of IAS should count on existing databases. It proposed the European inventory to fill existing gaps and register systematically information on species taxonomy and biology, date and place of introduction, pathways of introduction, range and spread dynamics, risk of expansion to neighbouring countries, invaded ecosystems and impact, as well as the efficiency of measures taken for prevention, mitigation and restoration of affected ecosystems.

It was thus with great pleasure that the Council of Europe welcomed the DAISIE (Delivering Alien Invasive Species Inventories in Europe) project, which was fundamentally aimed to satisfy those recommendations made to governments. The DAISIE project has gathered in relatively short time a formidable amount of very relevant information on alien species in Europe, on existing expertise in our conti-

ment and, what is equally important, on trends. The systematisation of data permits to create a clear picture of the phenomenon of biological invasions, to develop prevention tools (such as Early Warning Systems on new invasions) and promote awareness on how alien species are distorting and affecting Europe's biological diversity. The project has been a scientific success and has also created a much needed instrument for governments and European institutions to control the problem.

As for the future, at the Council of Europe we feel it is vital to maintain a strong information system on IAS on the basis of DAISIE, extend it through similar national initiatives and encourage governments and scientist to continue collecting and analysing information. It is also vital to build stronger links between research and governmental actions and strengthen efforts to convince other partners (e.g., horticultural industry, pet and aquaria trade, hunters and anglers, forest community, etc.) to adopt voluntary codes that may limit the introduction of new alien species and the spread of already known invasive species.

Eladio Fernández-Galiano  
Head of the Biological Diversity Unit of the Council of Europe

## **The European Commission: DAISIE is a Pioneering Work**

The central importance of protecting biodiversity as a basis for safeguarding ecosystem goods and services, as well as ecosystem functions for supporting the life on the Earth, is broadly accepted throughout the world. There is no doubt that human activities have been behind the dramatic acceleration of biodiversity loss in last decades. Identifying and addressing the drivers of this process is an essential step to improve the situation.

Experience from nature conservation practice has shown that simple species based conservation approaches will not achieve the goal, due to the very complex relationships between species within habitats and ecosystems. After habitat loss and fragmentation, known as the most important causes of biodiversity loss, alien species which have developed invasive behaviour may cause very significant damage to natural ecosystems by outcompeting native species. These, so called invasive alien species (IAS), were indeed recognised as one of major drivers of biodiversity decline. It is therefore clear, that the goal of halting biodiversity loss within European Union by 2010 cannot be achieved without addressing the issue of invasive aliens.

In addition, in many cases it is the very strong economic impact of these species, which requires to be addressed. A few well known invasive species – such as the zebra mussel, the American crayfish, the American mink, the water hyacinth, the giant hogweed or the grey squirrel – cause yearly damages amounting to hundreds of millions of Euros over the European territory. If not prevented or controlled, these costs may multiply in the future as some of these species expand their area of distribution in response to climate change.

Invasive alien species do not recognise national boundaries and cannot be stopped without concerted efforts. Europeans today are more mobile than ever before. Increased mobility for people and goods has many benefits but it also increases opportunities for intentional introduction of highly invasive alien species imported originally as pets, ornamental plants or for another purpose, and for unintentional introductions of stowaways or contaminant organisms through trade or other pathways. Good practice in relation to policies and legislation relating to IAS is occurring in some European regions, but it remains scattered. There are at present no mechanisms to support harmonisation or basic consistency of approaches between neighbouring countries or countries in the same sub-region. The fragmented measures in place are unlikely to make a substantial contribution to lowering the risks posed by IAS to European ecosystems if pan-European policies are not implemented.

Therefore, it is critical to address this global threat at the European level as a shared problem of all Member states. Consequently, invasive alien species are included and addressed in the Action Plan adopted by European Commission together with the Biodiversity Communication in 2006. An EU framework on alien invasive species is under development and should be in place before 2010.

The DAISIE (Delivering Alien Invasive Species Inventories in Europe) project is an important element towards this ambitious endeavour. The project has put together an inventory which provides the first ever pan-European overview of over

11,000 alien animals, fish, birds, plants, insects and other species living in our environment – causing already or potentially damage to our natural heritage as well as to our economy.

I am sure that this pioneering work will serve as a good basis for addressing the problem in Europe, and will also contribute to global solutions. I also do hope that it will remain alive, permanently updated and as a flexible tool supporting efficient implementation of an agreed common approach to the management of IAS.

Ladislav Miko  
Director, Protecting Natural Resources,  
DG Environment, European Commission

## The Editors: an End has a Start

A significant landmark in raising awareness of biological invasions among the public and policy makers in North America was the publication in 1993 of the monograph *Harmful Non-Indigenous Species in the United States* (Office of Technology Assessment 1993). This sweeping document, published by the US Congress, presented the first continental assessment of the degree to which introduced species had spread across the USA, the breadth of ecosystems subsequently impacted by these species and the policy options available to government and managers. Arguably, this synthesis played a pivotal role in the subsequent signing of Executive Order 13112 “Invasive Species” by President Bill Clinton in 1999. The Executive Order placed responsibilities upon Federal agencies “to prevent the introduction of invasive species and provide for their control and to minimise the economic, ecological, and human health impacts that invasive species cause” (USA 1999). Furthermore, Executive Order 13112 established the National Invasive Species Council to oversee implementation and required the initiation of National Invasive Species Management Plans. What is probably startling about the impact of *Harmful Non-Indigenous Species in the United States* is that at that time information on invasive species was remarkably poor with a minimum estimate of the number of alien species with origins outside the USA being little more than 4,500, the majority plants and invertebrates. Yet, while imprecise, these figures identified significant gaps in knowledge and highlighted that even imprecise estimates were sufficient to raise alarm bells.

Fast forward 15 years and to the other side of the Atlantic where another landmark publication appears: the *Handbook of Alien Species in Europe*. In the intervening period much has changed in the global perception of biological invasions, now widely recognised as one of the major pressures on ecosystems (Nentwig 2007). Yet it is only now that Europe has the first continent-wide snapshot of the scale and impact of biological invasions from the Mediterranean Sea to the Arctic tundra. On this occasion data are more robust, drawn from systematic searches and peer reviewed by experts, yet the astounding figure of at least 11,000 introduced species is acknowledged as only a first approximation and an undoubted underestimate (Olenin and Didžiulis 2009). Nevertheless, a picture emerges that is as remarkable as it is worrying.

Biological invasions are not a new phenomenon to Europe. For example, Corsica has been invaded more than twenty times in the last 2,500 years, first by the Phoenicians (565 BC), then Etruscans (540 BC), Carthaginians (270 BC), Romans (259 BC), Vandals (AD 455), Byzantines (AD 534), Goths (AD 549), Saracens (AD 704), Lombards (AD 725), Pisanos (AD 1015), Genoese (AD 1195), Aragonese (AD 1297), Genoese again (1358), Milanese (AD 1468) Franco-Ottomans (AD 1553), French (AD 1768), British (AD 1794) and the German-Italian Axis during the Second World War (Hulme 2004). These human invasions brought in their wake species from other parts of the world, either

intentionally or by accident. Biotic homogenisation in Europe has probably been occurring over millennia, yet the long history of human invasion and trade blurs the distinction between native and alien species. Thus the origin of many species introduced in historical times is uncertain and especially so for marine ecosystems, where often the status and origin of species is unknown. Although this uncertainty frustrates analyses, it also indicates that many archaeophytes and archaeozoans have become integrated in native communities without clear evidence of detriment either to native species or ecosystem processes (e.g., Pyšek et al. 2005).

These historical trends should not encourage complacency regarding the ultimate impacts of invasive species. It is quite possible that recent introductions from outside Europe are likely to be more invasive than alien species that originate from another part of Europe (Lloret et al. 2004). The *Handbook of Alien Species in Europe* illustrates that for most taxa an increasing proportion of introduced species are from other continents, especially the Americas and Asia. Indeed, the trends in the cumulative records of alien species recorded in Europe reveal consistent increases with time (Hulme et al. 2009a). For example, on average 19 invertebrates (Roques et al. 2009), 16 plants (Pyšek et al. 2009) and one mammal (Genovesi et al. 2009) are newly introduced to one or more parts of Europe every year. These numbers may not sound especially threatening but for many taxa, recent rates are higher than those seen at the beginning of the 19th century indicating that the problem of invasions is not diminishing.

A clear signal is that global trade is a major driver of biological invasions in Europe. This is not surprising, since this signal is seen worldwide (Perrings et al. 2005). Accounting for the multitude of pathways by which an alien species is introduced is essential to disentangle the role of species and ecosystem traits in biological invasions as well as predict future trends and identify management options. The *Handbook of Alien Species in Europe* highlights that vertebrate introduction tend to be characterised as deliberate releases (often as game animals), invertebrates as contaminants of stored products or horticultural material, plants as escapes from gardens, while pathogenic fungi are generally introduced as contaminants of their hosts (Hulme et al. 2008b). Several major infrastructural projects linking together seas via freshwaters and canal networks in order to facilitate the movement of goods are a major source of introductions, for example into the Mediterranean from the Red Sea, and from the Caspian and Black Seas to the Baltic (Galil et al. 2009, Gherardi et al. 2009). Once introduced to Europe, species with tiny spores, such as fungi and bryophytes, may be able to spread across the continent without additional human assistance (Desprez-Loustau 2009; Essl and Lambdon 2009) and such unaided spread is likely to be the hardest to contain.

The anthropogenic signal on biological invasions persists after the initial introduction events in that even once established, many alien species remain associated with human modified ecosystems. Alien plants (Pyšek et al. 2009) and invertebrates (Roques et al. 2009) are proportionally more frequent in urban than semi-natural habitats, while birds and amphibians (Kark et al. 2009) as well as mammals

(Genovesi et al. 2009) are most frequently found in arable lands, gardens and parks. Clearly, in such habitats alien species are most likely to be perceived as having economic rather than ecological impacts. For example, in the UK alone, the cost to the timber industry of grey squirrel (*Sciurus carolinensis*) damage to beech, sycamore and oak is \$15 million while two common grain contaminants, wild oat (*Avena fatua*) and field speedwell (*Veronica persica*), are significant agricultural weeds with annual costs of control running to \$150 million (Williamson 2002). However, current appreciation of invasive species impacts on biodiversity in Europe is poor by comparison with North America (Levine et al. 2003 for plants, Roques et al. 2009 for invertebrates). This is evident in the percentage of species with known impacts recorded by the DAISIE (Delivering Alien Invasive Species Inventories in Europe) project that ranges from only 5% for plants, around 15% for invertebrates and marine taxa, to a high of 30% for vertebrates and freshwater species. These percentages most likely reflect the lack of information across large taxonomic groups but also the difficulty of quantifying subtle impacts on ecosystem processes.

So what are the response options to this worrying panorama? The *Handbook of Alien Species in Europe* provides generic information relating to management of particular taxonomic groups as well as more detailed information on control and eradication strategies for 100 of the worst species (Vilà et al. 2009). However such information is only of value if the mechanism for management and policy implementation exists. A key component of Executive Order 13112 in the USA was the establishment of a National Invasive Species Management Plan (USA 1999). The plan is focused upon five strategic goals: prevention; early detection and rapid response; control and management; restoration; and organisational collaboration. Each of the five strategic goals specifies ongoing objectives and the long-term vision for success in that area. Under each strategic goal, objectives describe what is to be accomplished over the next five years, and implementation tasks describe what agencies expect to do in order to accomplish that specific objective. To date, an estimated 67% of the first plan's 57 action items (encompassing over 100 separate elements) have been completed or are in progress.

Such a strategic document appears essential for Europe, effectively putting teeth onto the *European Strategy on Invasive Alien Species* (Council of Europe 2002). DAISIE has set a global precedent in the inventories of alien species and inspires others elsewhere in the world (Steiner 2009), fulfilled a pressing need within Europe (Fernández-Galiano 2009) and significantly raised awareness in European institutions (Miko 2009). While these are major milestones, we believe DAISIE and the *Handbook of Alien Species in Europe* is only the start: the start of the end to the fragmented legislative and regulatory requirements addressing invasive species (Miller et al. 2006). The start of the end to uncoordinated activities led by the different Directorates General (DG) of the European Union that do not appear to appreciate the cross-cutting nature of biological invasions (e.g., separate DGs for Agriculture, Environment, Health, Marine, Research, Transport etc.). The start of the end of piecemeal approaches to tackling invasive species across Europe that fail

to coordinate pre- and post-border actions (Hulme et al. 2008b). The start of the end of underfunding taxonomy, management efforts and basic research on invasive species. And finally, hopefully in the not too distant future, the start of the end of the progressive homogenisation of Europe's flora and fauna.

Philip E Hulme, Wolfgang Nentwig,  
Petr Pyšek and Montserrat Vilà

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# Contents

<b>1 A pan-European Inventory of Alien Species: Rationale, Implementation and Implications for Managing Biological Invasions.....</b>	<b>1</b>
Philip E. Hulme, David B. Roy, Teresa Cunha, and Tor-Björn Larsson	
<b>2 Alien Fungi of Europe .....</b>	<b>15</b>
Marie-Laure Desprez-Loustau	
<b>3 Alien Bryophytes and Lichens of Europe .....</b>	<b>29</b>
Franz Essl and Philip W. Lambdon	
<b>4 Alien Vascular Plants of Europe.....</b>	<b>43</b>
Petr Pyšek, Philip W. Lambdon, Margarita Arianoutsou, Ingolf Kühn, Joan Pino, and Marten Winter	
<b>5 Alien Terrestrial Invertebrates of Europe .....</b>	<b>63</b>
Alain Roques, Wolfgang Rabitsch, Jean-Yves Rasplus, Carlos Lopez-Vaamonde, Wolfgang Nentwig, and Marc Kenis	
<b>6 Alien Invertebrates and Fish in European Inland Waters .....</b>	<b>81</b>
Francesca Gherardi, Stephan Gollasch, Dan Minchin, Sergej Olenin, and Vadim E. Panov	
<b>7 Alien Marine Biota of Europe.....</b>	<b>93</b>
Bella S. Galil, Stephan Gollasch, Dan Minchin, and Sergej Olenin	
<b>8 Alien Birds, Amphibians and Reptiles of Europe .....</b>	<b>105</b>
Salit Kark, Wojciech Solarz, François Chiron, Philippe Clergeau, and Susan Shirley	
<b>9 Alien Mammals of Europe .....</b>	<b>119</b>
Piero Genovesi, Sven Bacher, Manuel Kobelt, Michel Pascal, and Riccardo Scalera	

**10 Introduction to the List of Alien Taxa**..... 129  
Sergej Olenin and Viktoras Didžiulis

**11 List of Species Alien in Europe and to Europe**..... 133

**12 One Hundred of the Most Invasive Alien Species in Europe** ..... 265  
Montserrat Vilà, Corina Basnou, Stephan Gollasch,  
Melanie Josefsson, Jan Pergl, and Riccardo Scalera

**13 Species Accounts of 100 of the Most Invasive  
Alien Species in Europe** ..... 269  
By individual authors

**14 Glossary of the Main Technical Terms Used in the Handbook** ..... 375  
Petr Pyšek, Philip E. Hulme, and Wolfgang Nentwig

**Index**..... 381

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