Exploring the barriers to predicting alien pathogen invasions

Helen Roy (and many others)

RISKý Researching Invasive Species in Kýpros
DARWIN INITIATIVE
Akrotiri Environmental Education Centre
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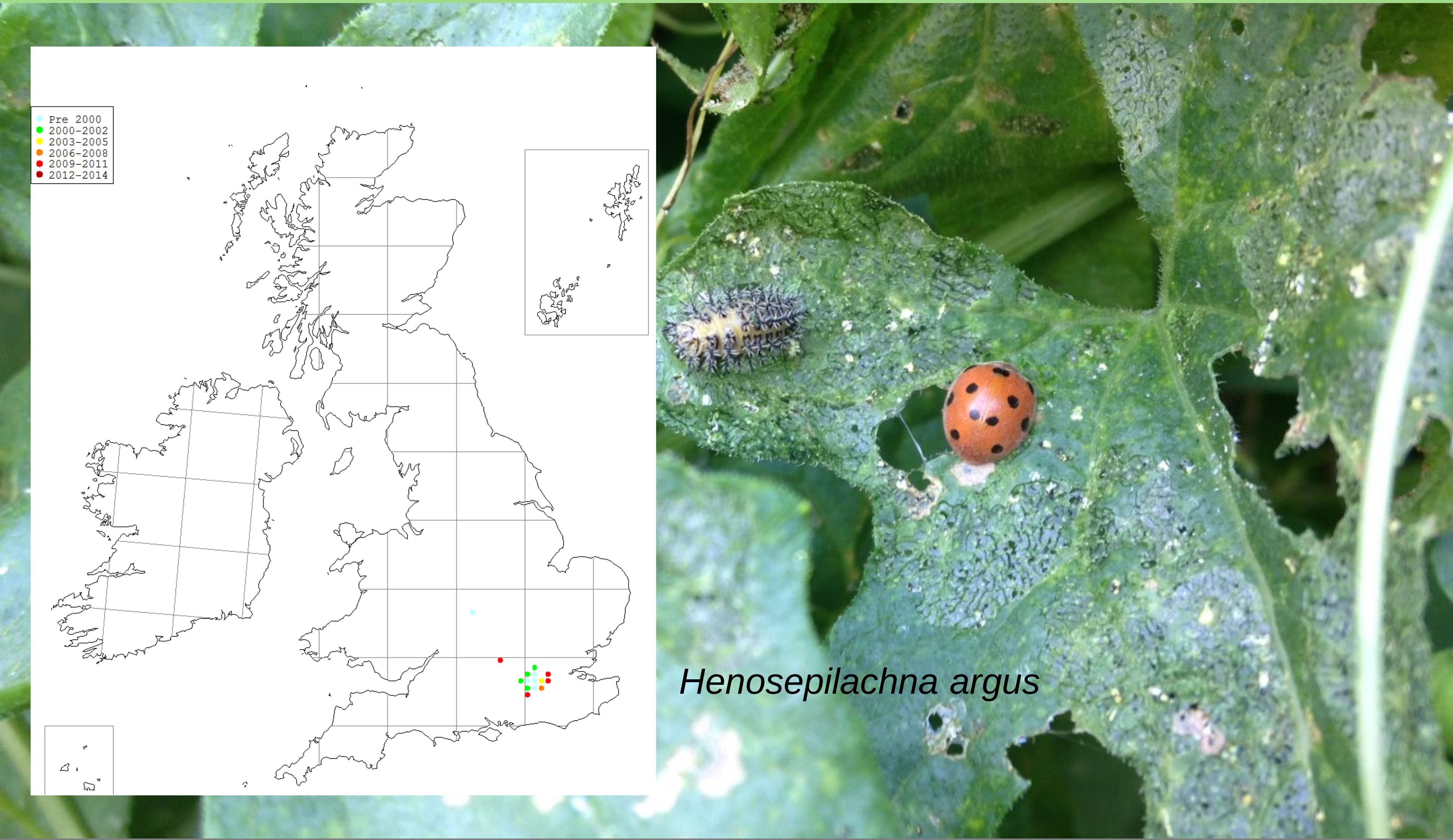
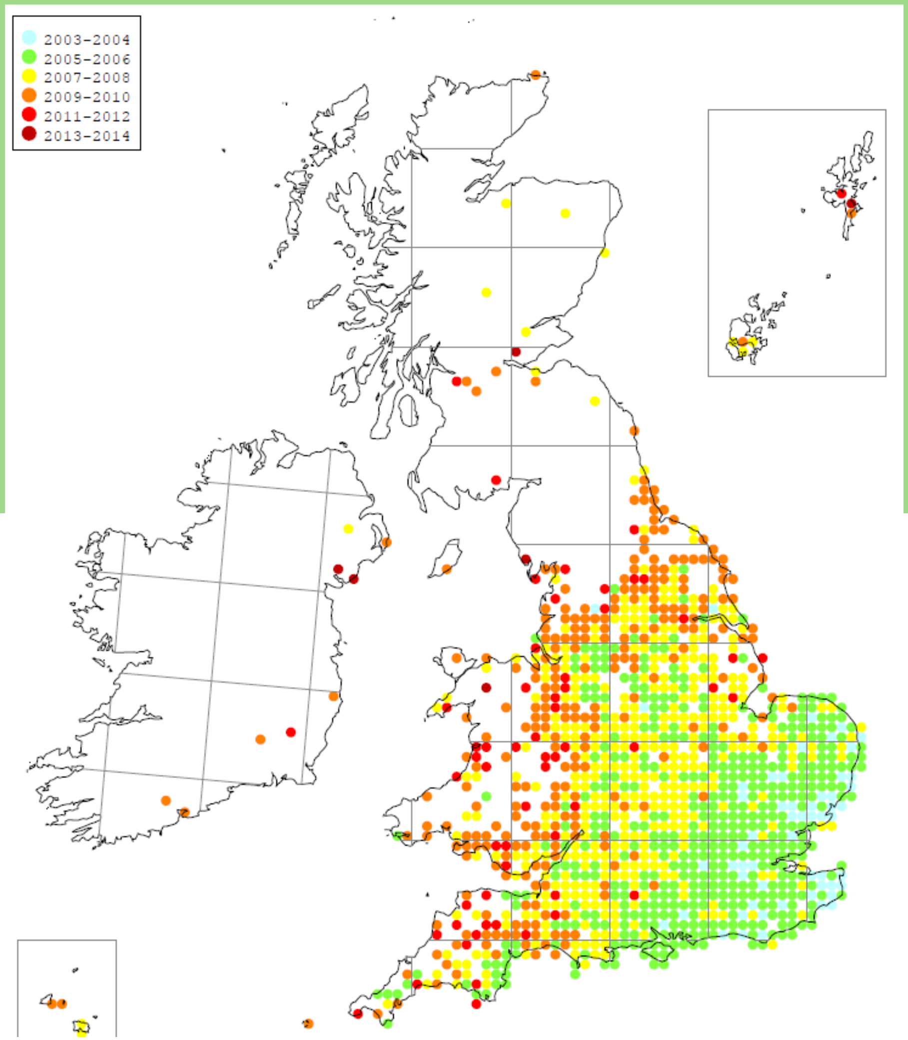
Non-Native Species



Henosepilachna argus

Species introduced (aided by humans) outside native range to a new region

Invasive Non-Native Species



Harmonia axyridis

Non-Native Species that threatens biodiversity, ecosystems or the way we live

nature COMMUNICATIONS

ARTICLE

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DOI: 10.1038/ncomms14435

OPEN

No saturation in the accumulation of alien species worldwide

Hanno Seebens *et al.*#

RESEARCH HIGHLIGHTS THIS WEEK

lower levels of microbes with antimicrobial activity than did their healthy counterparts.

The team identified several *Staphylococcus* species, and the peptides they make, that specifically kill *S. aureus*. Only the strains with antimicrobial activity were able to lower *S. aureus* levels when applied to people's skin.

Sci. Transl. Med. 9, eaah4680 (2017)

BIOMATERIALS

A super-strong underwater glue

A synthetic adhesive inspired by the sticky proteins made by mussels can bind to wet surfaces more tightly than even live mussels can.

Previous mussel-mimicking adhesives were strong when dry, but less effective underwater. Jonathan Wilker and his colleagues at Purdue University in West Lafayette, Indiana, created a polymer with some of the same structural elements as the sticky protein threads that mussels make to attach themselves to rocks and other surfaces.

Previous adhesives had catechol chemical groups attached to a synthetic polystyrene backbone, but the new material incorporates these groups into the backbone, as mussels' adhesive proteins do. This may explain the polymer's high degree of stickiness underwater, the authors say.

ACS Appl. Mater. Interfaces http://doi.org/bz8n (2017)

EVOLUTION

How humans adapt to arsenic

People living in Chile's Atacama Desert have different versions of a gene that allow them to cope with the region's naturally high levels of arsenic.

Arsenic from rocks seeps into the desert's scarce water sources, exposing people in the Camarones Valley to levels … limit of 10 micrograms per litre set by the World Health Organization. Mauricio Moraga at the University of Chile in Santiago and his colleagues compared the DNA of 50 people from this region with that of 92 individuals from other areas of the country that have lower levels of arsenic. They identified mutations that increased the efficiency with which the arsenic methyltransferase enzyme processes the element, and found these to be more common in the people of the Camarones Valley.

Nearly 70% of the Camarones people carried the most protective variant, considerably more than in other populations. These people have evolved over just 7,000 years under natural selection to tolerate arsenic, the authors say.

Am. J. Phys. Anthropol. http://doi.org/bz4s (2017)

NEUROSCIENCE

Predicting smell from structure

Algorithms can predict a molecule's odour on the basis of its chemical structure.

Pablo Meyer at IBM's Computational Biology Center in Yorktown Heights, New York, and his colleagues, asked 49 people to smell hundreds of molecules (**pictured**) and rate them on intensity, pleasantness and 19 other descriptors, such as 'fruit', 'musky' and 'bakery'.

The researchers gave these ratings, along with information on the substances' chemical structures, to 22 teams of computational scientists, who competed to build the best predictive, machine-learning algorithms. After initially developing and training their algorithms on a partial data set, the teams tested their algorithms' abilities to predict people's perception of the remaining molecules.

Across all models, 'garlic' and 'fish' were the best-predicted attributes, at about 70% accuracy. Such tools could be used by the flavour and fragrance industry to formulate products, the authors say.

Science 355, 820–826 (2017)

ANTHROPOLOGY

Skulls show migration history

A study of skulls of early people in South America suggests that there were multiple waves of migration into the New World more than 10,000 years ago.

Wide variation in the skull shape of modern South American people has triggered debate over whether this results from rapid changes after the arrival of people in the region, or from successive migrations that introduced diversity. Noreen von Cramon-Taubadel at the University at Buffalo in New York and her colleagues compared the shape of Palaeoamerican crania (**pictured**) from the Lagoa Santa site in Brazil with those from modern populations. The team used the data to develop a model of ancestry, and found that the most recent common ancestor of the Palaeoamericans and contemporary Native American groups lived outside the Americas.

This adds weight to the theory that people moved into the Americas at many different times from northeast Asia across the Bering land bridge.

Sci. Adv. 3, e1602289 (2017)

ECOLOGY

Alien species on the rise

The number of new instances of non-native species documented is increasing around the globe — growth that shows no sign of slowing.

The introduction of alien species can disrupt ecosystems and even cause local extinctions. Hanno Seebens at the Senckenberg Biodiversity and Climate Research Centre in Frankfurt, Germany, Franz Essl at the University of Vienna and their colleagues assembled a data set of 45,813 records, dating back to the 1500s, detailing the first arrival of an alien species. They show that such 'first records' have increased in the past 200 years, from an average of 7.7 per year between 1500 and 1800 to a record 585 in 1996. The rise in these records in the past 200 years was found in all taxa, with the exception of mammals and fishes, in which rates have declined in recent decades.

Alien numbers will probably continue to rise for years to come, despite efforts to curb them.

Nature Commun. http://doi.org/bzw2 (2017)

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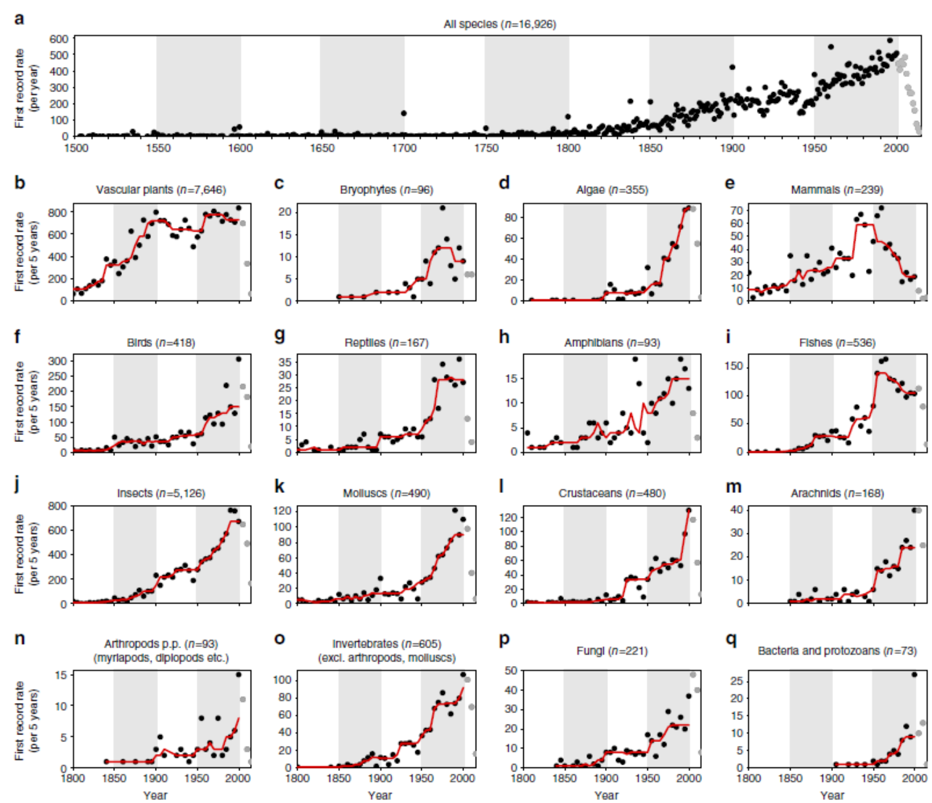
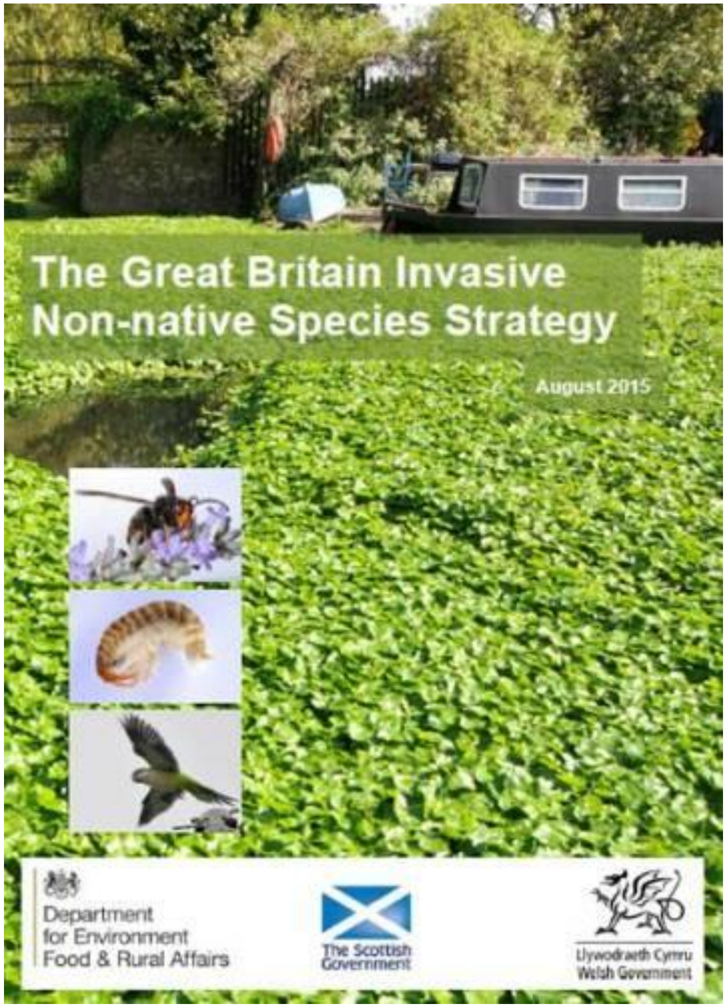


Action Against Invasive Non-Native Species



SUSTAINABLE DEVELOPMENT GOALS

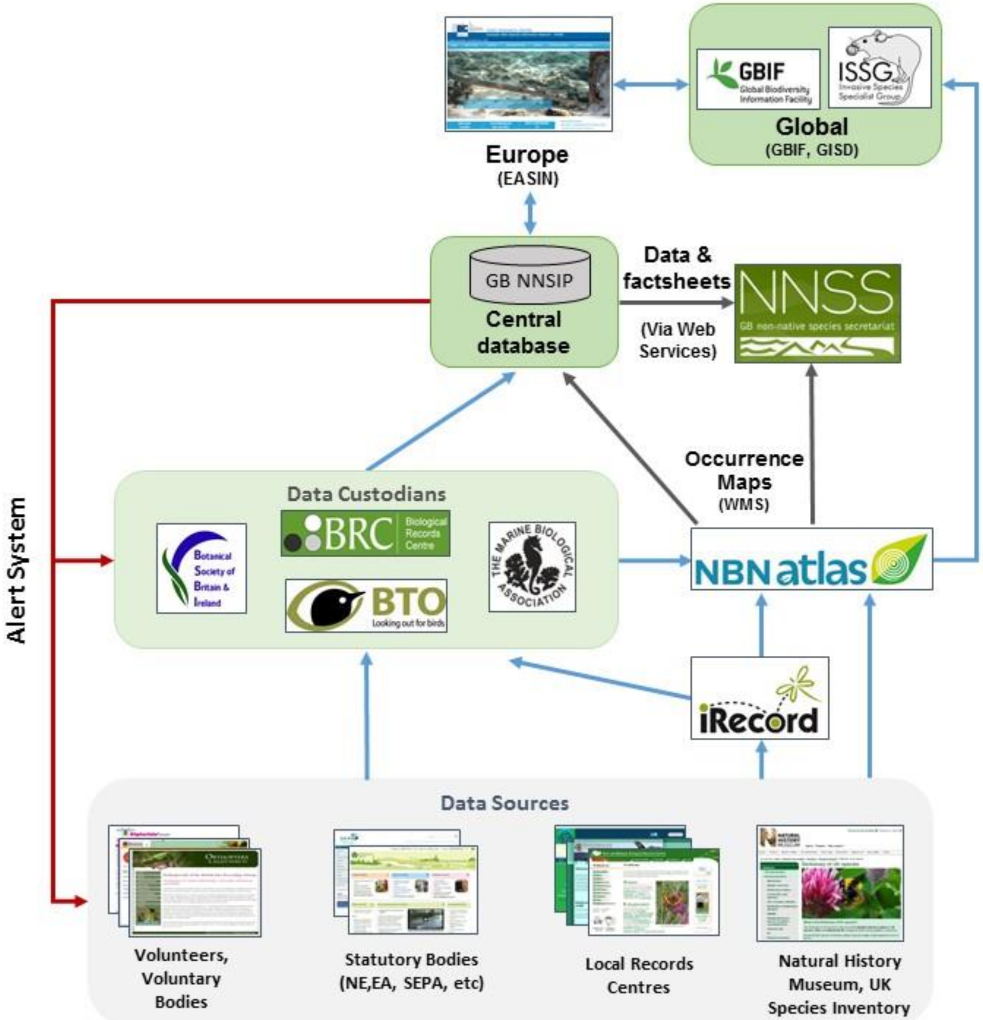
Convention on Biological Diversity

ONE HEALTH
ONE PLANET ONE FUTURE

ipbes
Science and Policy for People and Nature

European Commission
ENVIRONMENT

Documenting invasions in Britain - GBNNSIP



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Department for Environment Food & Rural Affairs

JNCC Joint Nature Conservation Committee


About 2000 established
non-native species in GB

Scorecard 2017 for Great Britain

- 1506 established non-native plants
- 469 established non-native animals
- 273 established non-native species designated as having negative ecological or human impact:
  - 101 (6.7%) established non-native plants
  - 172 (36.7%) established non-native animals

Roy et al. (2014) *Biological Invasions*; Roy et al. (2017) Tracking changes in the introduction and distributions of non-native species in Great Britain. Final Report - Defra

Where are all the microbes?

Biol Invasions
DOI 10.1007/s10530-014-0687-0

INVASION NOTE

GB Non-native Species Information Portal: documenting the arrival of non-native species in Britain

Helen E. Roy · Chris D. Preston · Colin A. Harrower · Stephanie L. Rorke · David Noble · Jack Sewell · Kevin Walker · John Marchant · Becky Seeley · John Bishop · Alison Jukes · Andy Musgrove · David Pearman · Olaf Booy

Received: 17 September 2013 / Accepted: 25 March 2014

The list excluded garden plants, cultivated crops, pests of stored crops, human parasites and pests of human habitation unless they were thought likely to be found in the wild. **Microorganism (with the exception of a small number of marine phytoplankton) and macrofungi were also not included.**

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Global Change Biology

Global Change Biology (2014) **20**, 3859–3871, doi: 10.1111/gcb.12603

Horizon scanning for invasive alien species with the potential to threaten biodiversity in Great Britain

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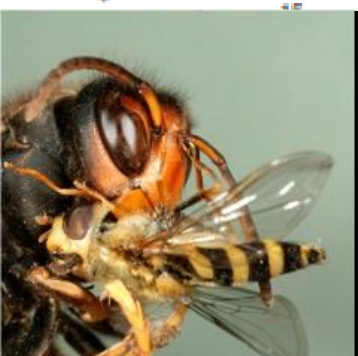
Our aim was to create an ordered list of IAS (all plant and animal taxa, **excluding microorganisms,** across environments) that are likely to arrive, establish and have an impact on native biodiversity within the next 10 years.




COMMISSION IMPLEMENTING REGULATION (EU) 2016/1141

of 13 July 2016

adopting a list of invasive alien species of Union concern pursuant to Regulation (EU) No 1143/2014 of the European Parliament and of the Council

THE EUROPEAN COMMISSION,

Having regard to the Treaty on the Functioning of the European Union,

Developing the list of IAS of Union concern

on the prevention and management of the introduction and spread of invasive alien species [1], and in particular of Article 4(1) thereof,

(2) The Commission has concluded on the basis of the available scientific evidence and the risk assessments carried out pursuant to Article 5(1) of Regulation (EU) No 1143/2014 that all criteria set out in Article 4(3) of that Regulation are met for the following invasive alien species: *Baccharis halimifolia* L, *Cabomba caroliniana* Gray, *Callosciurus erythraeus* Pallas, 1779, *Corvus splendens* Viellot, 1817, *Eichhornia crassipes* (Martius) Solms, *Eriocheir sinensis* H. Milne Edwards, 1854, *Heracleum persicum* Fischer, *Heracleum sosnowskyi* Mandenova, *Herpestes javanicus* É. Geoffroy Saint-Hilaire, 1818, *Hydrocotyle ranunculoides* L. f., *Lagarosiphon major* (Ridley) Moss, *Lithobates (Rana) catesbeianus* Shaw, 1802, *Ludwigia grandiflora* (Michx.) Greuter & Burdet, *Ludwigia peploides* (Kunth) P.H. Raven, *Lysichiton americanus* Hultén and St. John, *Muntiacus reevesi* Ogilby, 1839, *Myocastor coypus* Molina, 1782, *Myriophyllum aquaticum* (Vell.) Verdc., *Nasua nasua* Linnaeus, 1766, *Orconectes limosus* Rafinesque, 1817, *Orconectes virilis* Hagen, 1870, *Oxyura jamaicensis* Gmelin, 1789, *Pacifastacus leniusculus* Dana, 1852, *Parthenium hysterophorus* L., *Perccottus glenii* Dybowski, 1877, *Persicaria perfoliata* (L.) H. Gross (*Polygonum perfoliatum* L.), *Procambarus clarkii* Girard, 1852, *Procambarus fallax* (Hagen, 1870) f. *virginalis*, *Procyon lotor* Linnaeus, 1758, *Pseudorasbora parva* Temminck & Schlegel, 1846, *Pueraria montana* (Lour.) Merr. *var. lobata* (Willd.) (*Pueraria lobata* (Willd.) Ohwi), *Sciurus carolinensis* Gmelin, 1788, *Sciurus niger* Linnaeus, 1758, *Tamias sibiricus* Laxmann, 1769, *Threskiornis aethiopicus* Latham, 1790, *Trachemys scripta* Schoepff, 1792, *Vespa velutina nigrithorax* de Buysson, 1905.

Ash dieback

Leaf loss, bark lesions and crown dieback

- Young ash trees are killed very rapidly by the disease
- Older trees often resist the disease for longer periods but succumb with prolonged exposure

First observed in Poland in 1992 and has since spread to 21 European countries. (first discovered in Britain in February 2012)

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Prioritisation workshop

ALIEN Challenge

cost EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

COST is supported by the EU RTD Framework Programme

ESF provides the COST Office through an EC contract

“Enhancing the understanding of invasive alien pathogens” including 38 experts (pathologists and ecologists with expertise ranging from conservation biology and invasion ecology to wildlife epidemiology and disease management) from 13 European countries addressed the overarching aim to advance the understanding of alien pathogens threatening wildlife

Barriers to understanding

ALIEN Challenge

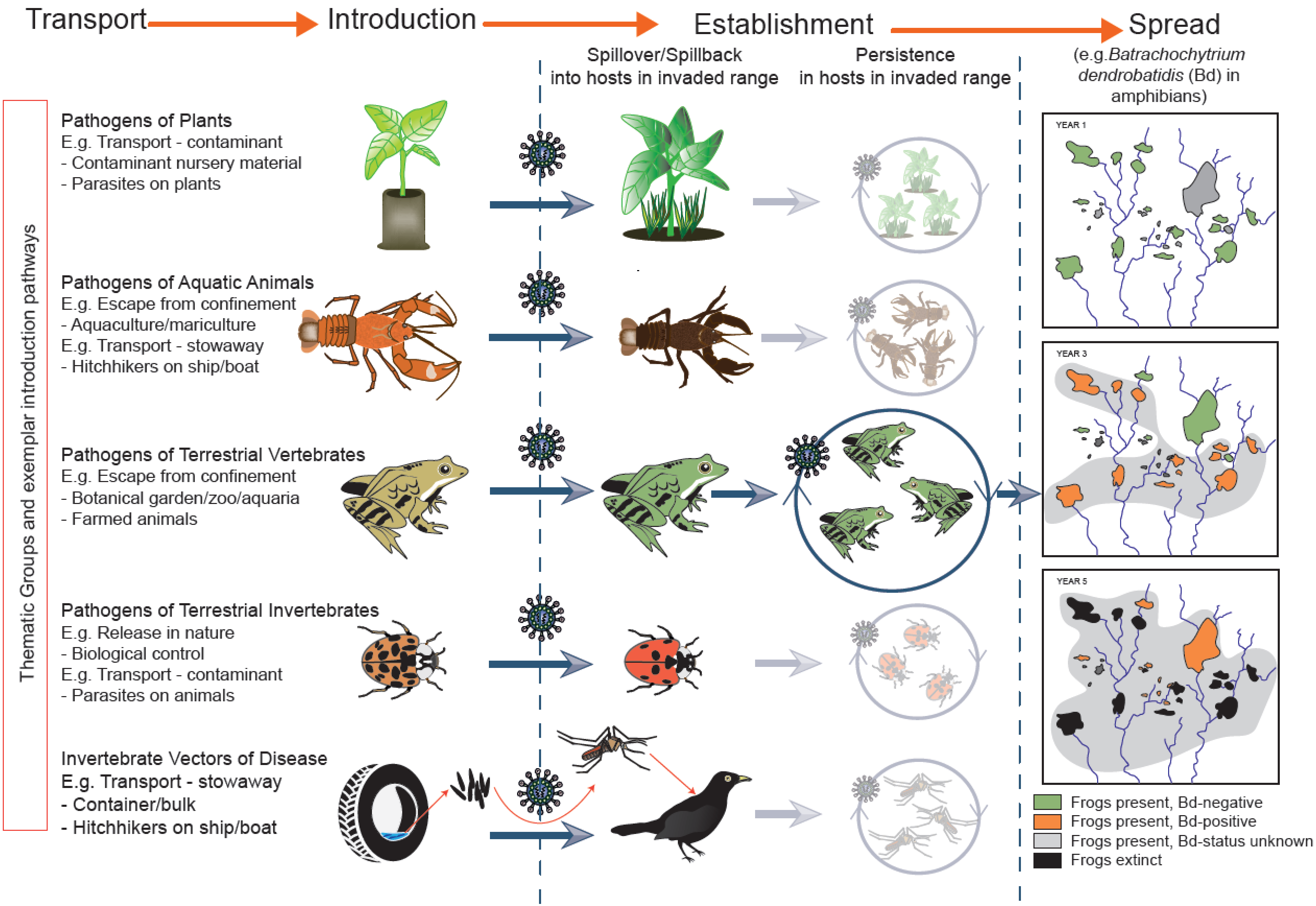
COST EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY

COST is supported by the EU RTD Framework Programme

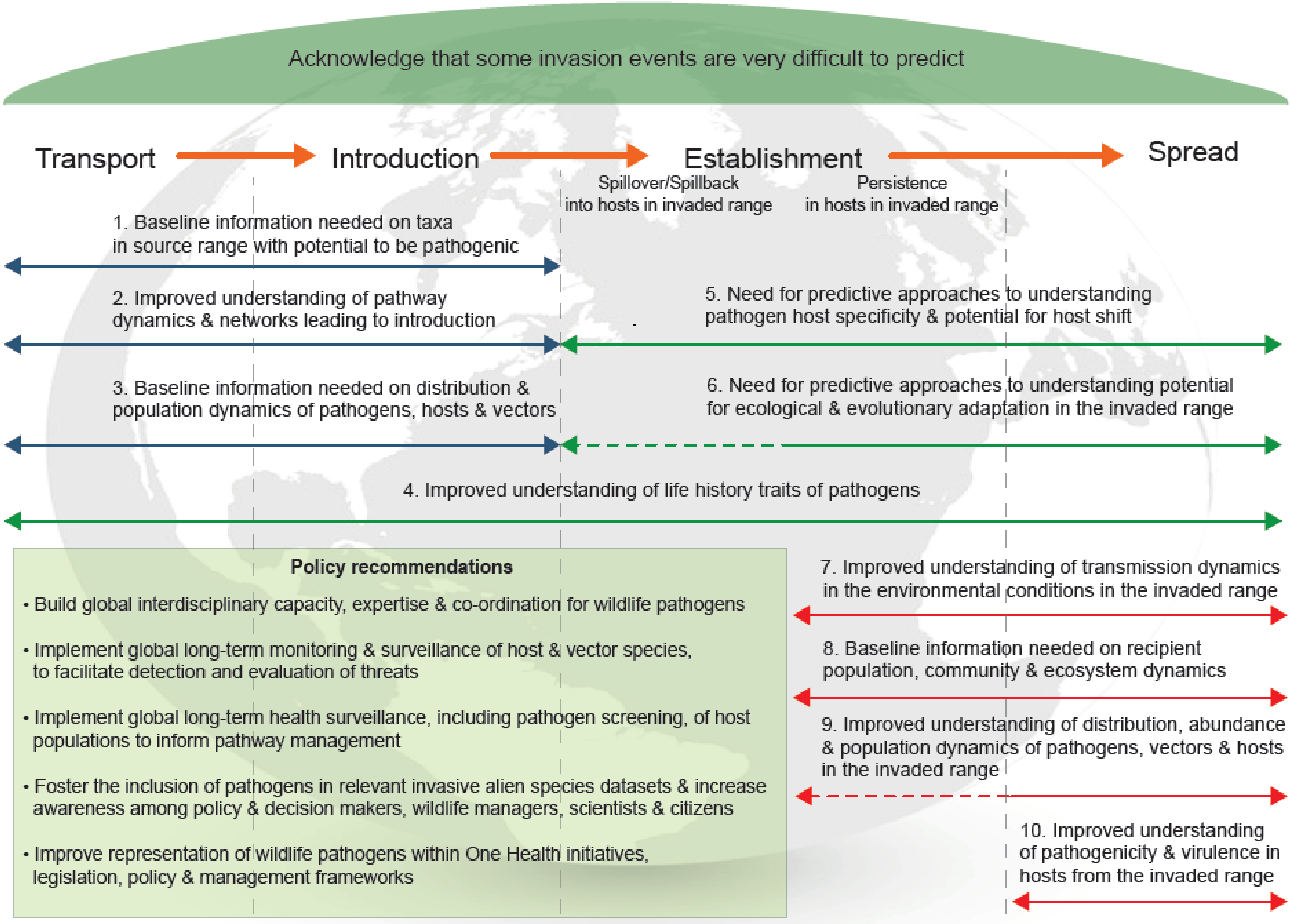
ESF provides the COST Office through an EC contract

What are the three most significant barriers to identifying and ranking emerging threats within your pathogen group?

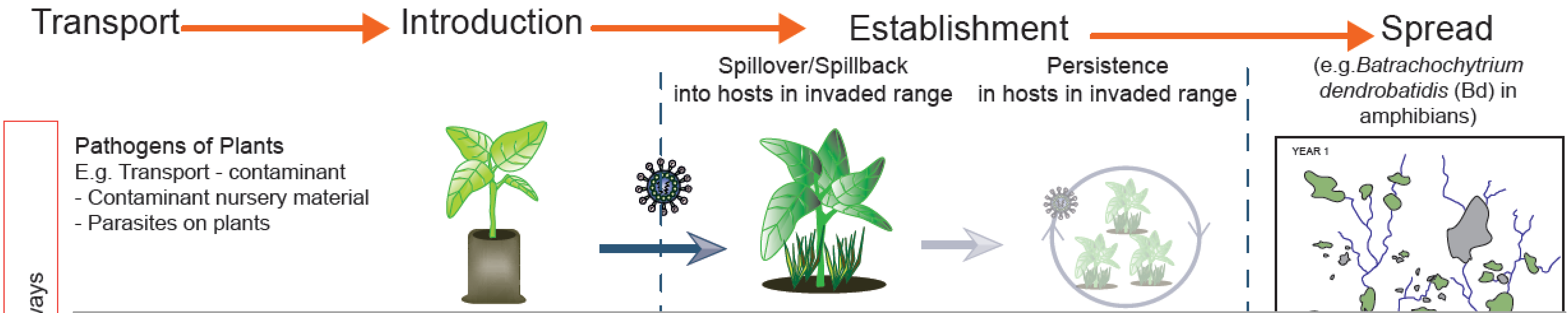
Invasions and wildlife disease



Barriers and opportunities



Hymenoscyphus fraxinus



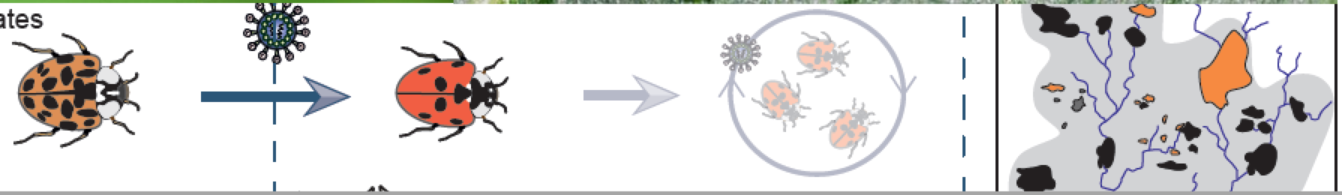
Hymenoscyphus fraxinus was not known to be pathogenic in its native range, far East Asia, but led to widespread dieback of the ash species *Fraxinus excelsior* and *F. angustifolia* within the invaded range

Microsporidia

Transport → Introduction → Establishment → Spread

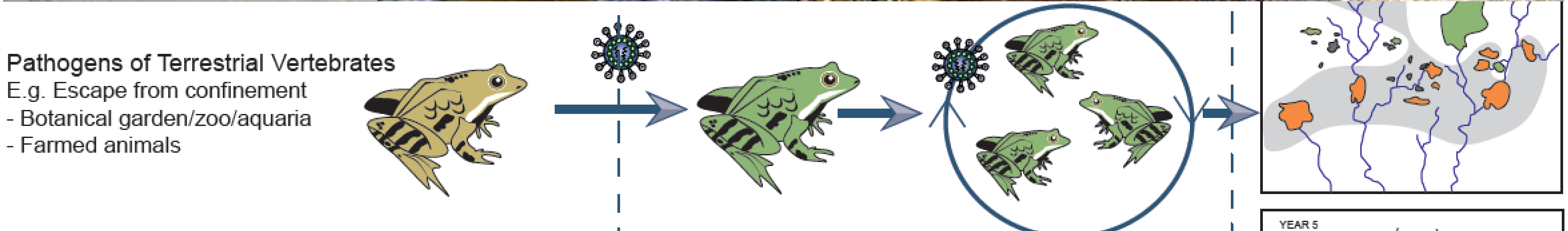
Thematic Groups and exemplar introduction pathways

Pathogens of Terrestrial Invertebrates
E.g. Release in nature
- Biological control
E.g. Transport - contaminant
- Parasites on animals



The invasive alien *Harmonia axyridis* (harlequin ladybird) is host to microsporidia, which in laboratory experiments infect native ladybirds but the ecological relevance is unclear.

Chytrid fungus



Batrachochytrium dendrobatidis has been described as the "worst wildlife pathogen ever recorded" with nearly half of all amphibian species in decline worldwide owing to this skin-infecting fungus

First discovered in 1997 and subsequently named in 1999

Highly pathogenic across a diverse range of amphibians (> 500 species) and has been found on all continents where amphibians occur.

Nature correspondence

Correspondence

Technology alone won't save climate

A dragon was buried at the Paris climate meeting (COP21): 'climate sceptics' disappeared. Now we face a second, equally formidable dragon: unreasonable optimism about 'new' energy technologies. This optimism supports economic-growth models driven by innovation, but depends on an unimaginable scale and rate of deployment.

Defeating the second dragon requires that we reconsider our habits of energy usage. Thirty years of engine-efficiency gains have been eclipsed by our preferences for ever-larger cars that are often 20 times heavier than the passengers — but these are habits, not needs.

We could continue to live well in rich economies with, say, one-quarter of the energy. For instance, we could run the boiler for one-quarter of the time and quarter our movement of mass — the total of all vehicles, freight and people, measured in tonne-kilometres. We could also make buildings and goods with half the material (without risking safety) and keep them for twice as long.

'Success' today is largely associated with derivative measures of increasing gross domestic product, profitability, speed or salary. Yet our value systems are based on integral measures of quality and stock: reputation, heritage, journeys and relationships. We need to expand the dialogue of climate mitigation to reflect these values. Challenging our habits of energy use should be the first priority of climate policy.

Julian Allwood *University of Cambridge, UK.*
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Formalize recycling of electronic waste

India urgently needs a formal recycling policy for its mountain of electronic waste. Boosted by illegally imported discards from the West, this waste is expected to reach a total of around 30 million tonnes by 2020.

Western electronic waste comes largely from countries' weak legislation on its handling and management (G. Agoramoorthy and C. Chakraborty *Nature* **485**, 309; 2012). Although people in India informally recycle an estimated 95% of electronic waste for profit, the practice could soon be overwhelmed.

India's government proposed draft regulations for this waste in June 2015, to be formalized after a public consultation. These are already proving effective, but there is still a pressing need for national policy to alleviate damage to the environment. This would create employment and commercial opportunities, address health and safety concerns, and forge a path towards sustainability.

Devika Kannan, Kannan Govindan *University of Southern Denmark, Odense, Denmark.* **Madan Shankar** *Anna University, Chennai, India.*
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International accord on open data

The accord *Open Data in a Big Data World* has been produced by representative bodies of global science collaborating as Science International (see go.nature.com/tpq3tu). It sets out the principles for maximizing benefit from the digital data revolution in shaping the future conduct of science.

Openness is the bedrock for benefit. Whole science systems, not merely the habits of researchers, need to adapt. It will be necessary for public funders of research to fund open-data management, for publishers to ensure that open data are deposited concurrently with the publication of derived scientific claims, for disciplinary societies to debate how their disciplines should adapt, and for universities to create incentives and support for open-data processes.

The accord recognizes potential pathologies: that the data deluge could overwhelm the open scrutiny of scientific claims, and that a countervailing trend towards privatization of knowledge could be at odds with the ethos of scientific inquiry and our need to use ideas freely.

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Control wildlife pathogens too

Policies to control diseases caused by invasive alien species should be extended to cover endangered wild species, ecosystems and their services — not just humans, livestock and cultivated plants.

Of the 100 invasive alien species listed by the International Union for Conservation of Nature as the 'world's worst', one-quarter have environmental impacts that are linked to diseases in wildlife (M. J. Hatcher *et al. Front. Ecol. Environ.* **10**, 186–194; 2012). Identifying and managing this threat calls for coordinated interdisciplinary expertise.

Priorities are to collect baseline information on the distribution and population dynamics of pathogens, hosts and vectors; to determine the relative importance of invasion pathways; and to develop methods for predicting host shifts, pathogen–host dynamics and the evolution of alien pathogens (see also go.nature.com/ux4wpp).

This integrated strategy is geared towards the goals set by the Convention on Biological Diversity for managing invasives.

Helen Roy* *NERC Centre for Ecology and Hydrology, Wallingford, UK.*
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*On behalf of 4 correspondents (see go.nature.com/upyjwi for full list).

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other disposal options for the 34 tonnes of plutonium (see, for example, go.nature.com/2ctk4o), which will remain in bunkers at Savannah River and in Texas until a solution is found.

Edwin Lyman *Union of Concerned Scientists, Washington DC, USA.* **Frank von Hippel** *Princeton University, New Jersey, USA.*
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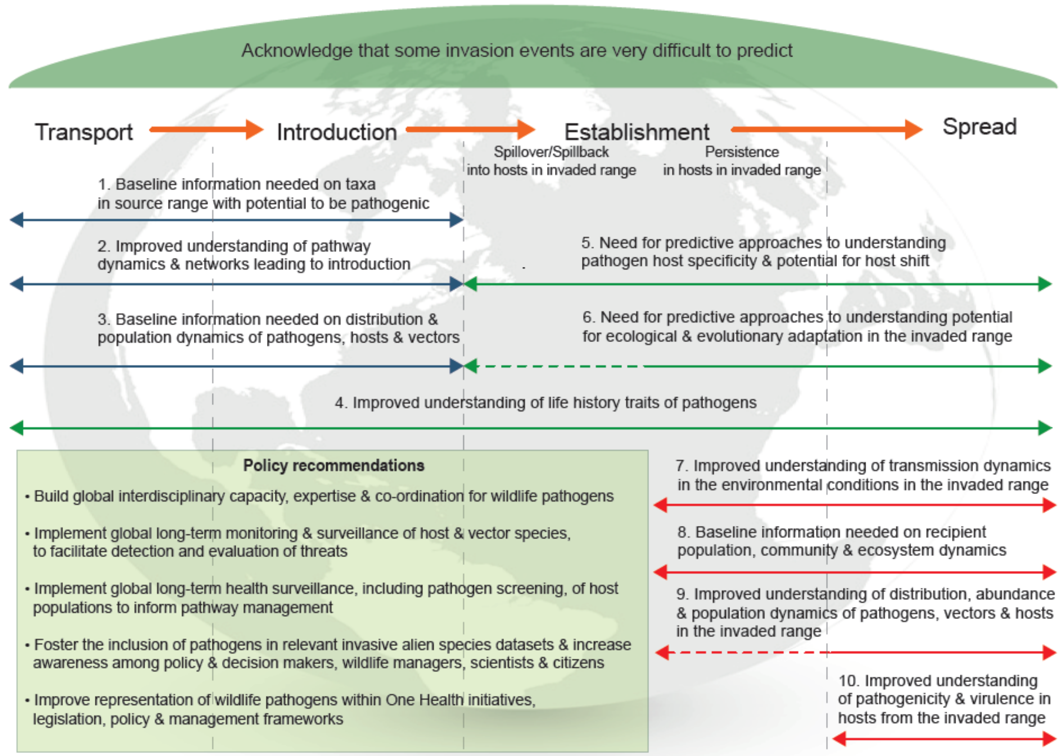

Conservation Letters

Conservation Letters
A journal of the Society for Conservation Biology
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POLICY PERSPECTIVES

Alien Pathogens on the Horizon: Opportunities for Predicting their Threat to Wildlife

Helen E. Roy[1], Helen Hesketh[1], Bethan V. Purse[1], Jørgen Eilenberg[2], Alberto Santini[3], Riccardo Scalera[4], Grant D. Stentiford[5], Tim Adriaens[6], Karolina Bacela-Spychalska[7], David Bass[5,8], Katie M. Beckmann[9], Paul Bessell[10], Jamie Bojko[5,11], Olaf Booy[12,13], Ana Cristina Cardoso[14], Franz Essl[15,16], Quentin Groom[17], Colin Harrower[1], Regina Kleespies[18], Angeliki F. Martinou[19,20], Monique M. van Oers[21], Edmund J. Peeler[5], Jan Pergl[22], Wolfgang Rabitsch[15], Alain Roques[23], Francis Schaffner[24], Stefan Schindler[15,16], Benedikt R. Schmidt[25,26], Karsten Schönrogge[1], Jonathan Smith[27], Wojciech Solarz[28], Alan Stewart[29], Arjan Stroo[30], Elena Tricarico[31], Katharine M.A. Turvey[1], Andrea Vannini[32], Montserrat Vilà[33], Stephen Woodward[34], Anja Amtoft Wynns[2], & Alison M. Dunn[11]

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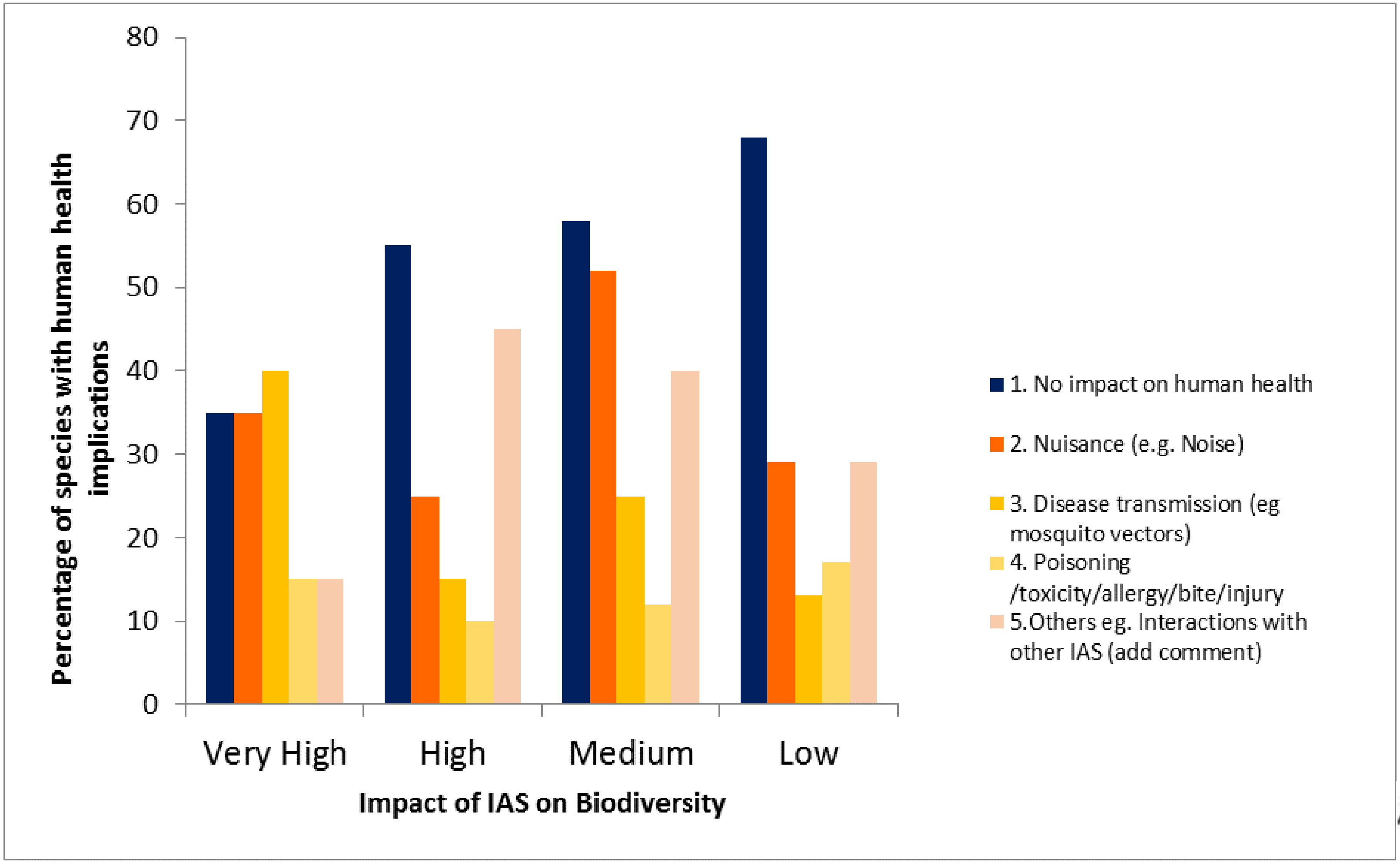
Policy recommendations

- Build global interdisciplinary capacity, expertise & co-ordination for wildlife pathogens
- Implement global long-term monitoring & surveillance of host & vector species, to facilitate detection and evaluation of threats
- Implement global long-term health surveillance, including pathogen screening, of host populations to inform pathway management
- Foster the inclusion of pathogens in relevant invasive alien species datasets & increase awareness among policy & decision makers, wildlife managers, scientists & citizens
- Improve representation of wildlife pathogens within One Health initiatives, legislation, policy & management frameworks

Horizon scanning for Cyprus



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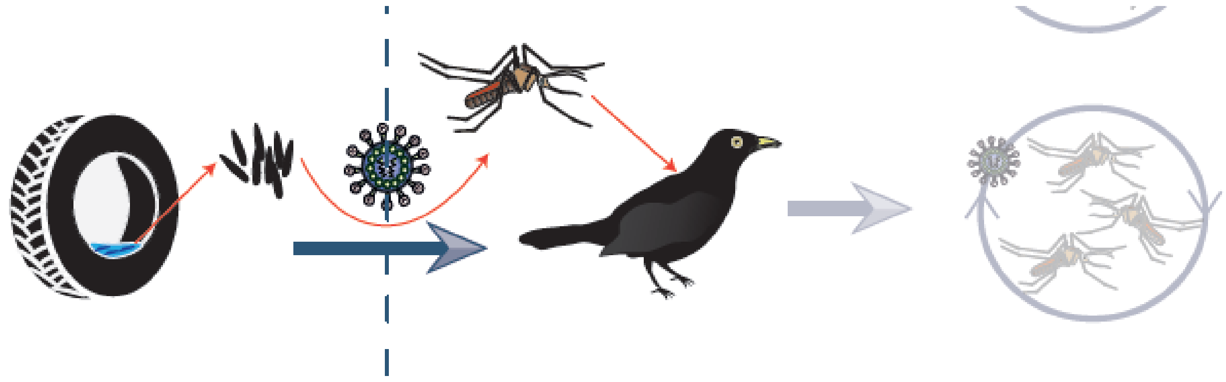
DARWIN INITIATIVE

Horizon scanning for UK OTs

Invertebrate Vectors of Disease
E.g. Transport - stowaway
- Container/bulk
- Hitchhikers on ship/boat



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NATURAL ENVIRONMENT RESEARCH COUNCIL

Funded by UK Government

NERC SCIENCE OF THE ENVIRONMENT

Future directions: embracing pathogens…

ONE HEALTH

ONE PLANET ONE FUTURE

Future directions: celebrating parasites…

The native ladybird with a parasite cocoon

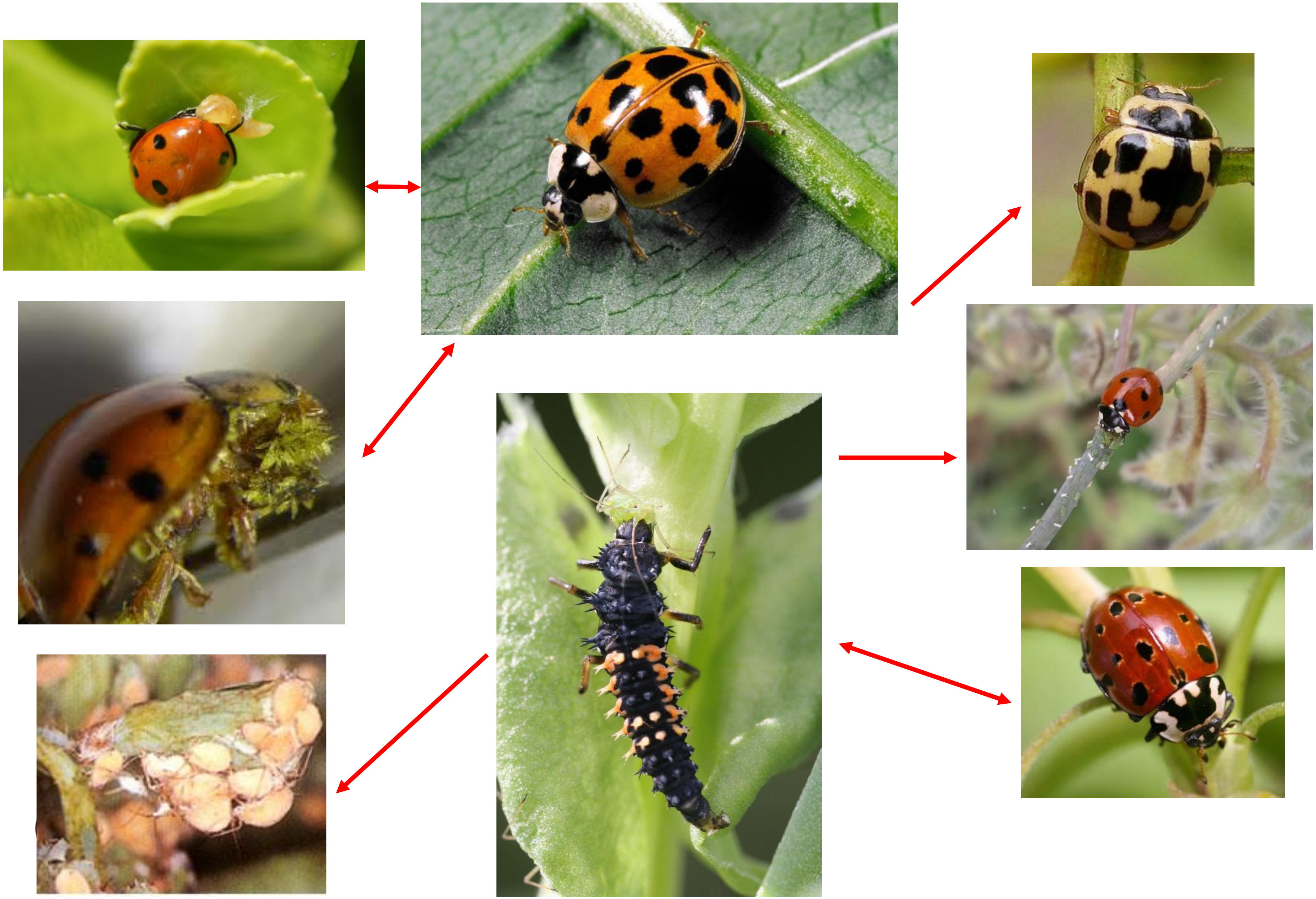
A ladybird mystery

If you have lots of ladybirds in your garden, help scientists from The UK Ladybird Survey find out whether a native ladybird parasite is using the invasive alien harlequin as a host.

The parasitic wasp, *Dinocampus coccinellae*, typically lays its egg in the 7-spot ladybird, forming a yellow cocoon beneath the ladybird and then using it as a 'zombie bodyguard' to protect the developing wasp. However, recent research has shown that it may also parasitise harlequins, but is rarely successful. This potentially decreases populations of the wasp, which could have further consequences for native ladybirds. For more info, visit **ladybird challenge.co.uk**. To record sightings of ladybirds, visit **ladybird-survey.org**

August 2016

…unravelling ecology together…



Excited to announce…

Alien CSI 2018-2022

Increasing understanding of alien species through citizen science

WG1: Engaging people in CS
WG2: Approaches to CS
WG3: Data management and standards
WG4: Analysis and visualisation
WG5: Cross-cutting CS initiative(s) for IAS across Europe

Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL
cost
EUROPEAN COOPERATION IN SCIENCE AND TECHNOLOGY
COST is supported by the EU RTD Framework Programme
ESF provides the COST Office through an EC contract

Thank you

RISKý
Researching Invasive Species in Kýpros

DARWIN INITIATIVE

Akrotiri Environmental Education Centre
Κέντρο Περιβαλλοντικής Εκπαίδευσης Ακρωτηρίου

ALIEN Challenge

cost
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European Science Foundation

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JNCC
Joint Nature Conservation Committee

NNSS
GB non-native species secretariat

Department for Environment Food & Rural Affairs

NBN
National Biodiversity Network

CEH
Centre for Ecology & Hydrology
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University of Reading

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