Unravelling the Ecology of Non-native Species to Inform European Strategy

Helen Roy and many more

International Conference on Aquatic Invasive Species
Fort Lauderdale, Florida, 22-26 October 2017

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Researchers on the move…85 STSMs

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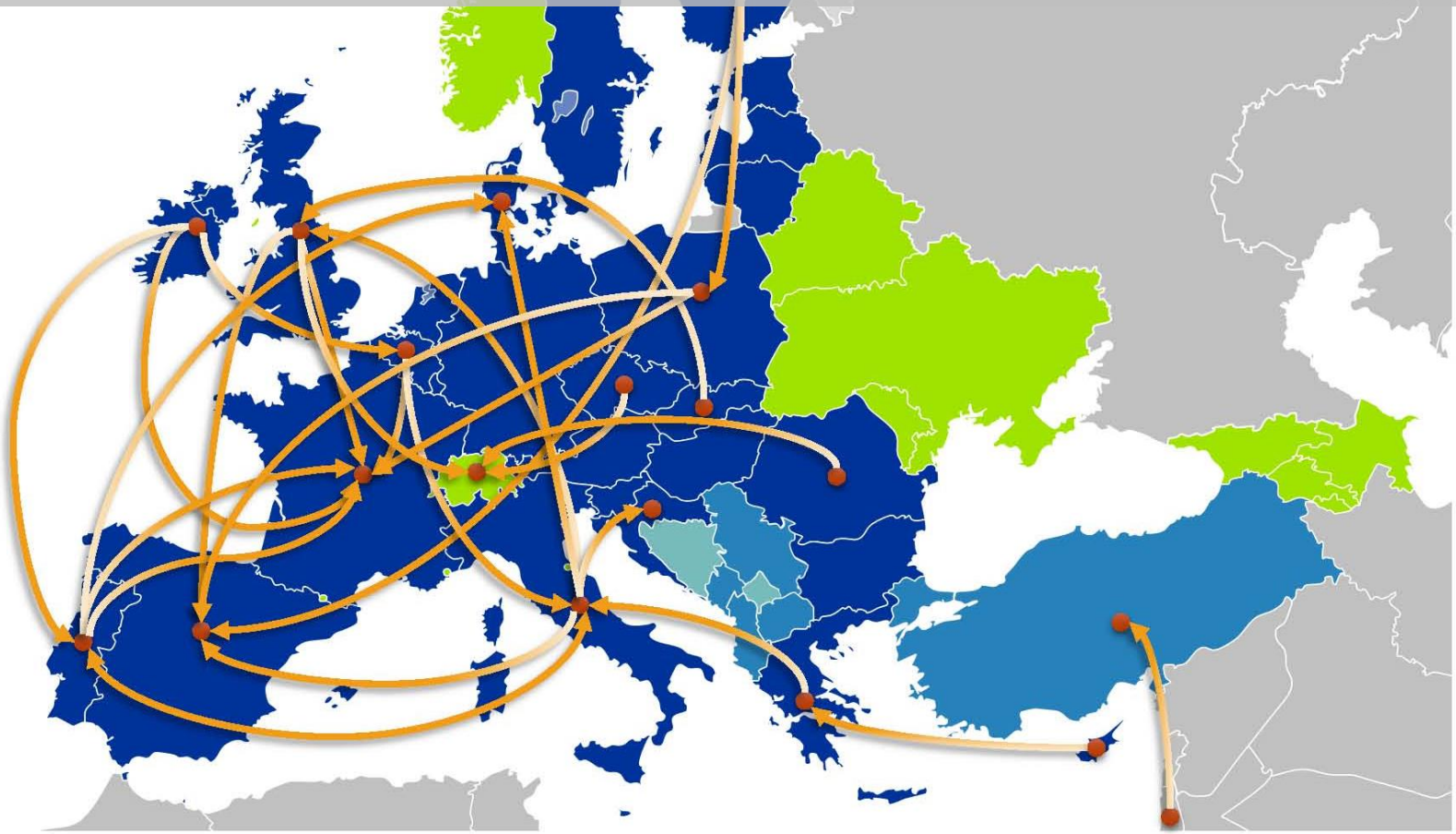

nature COMMUNICATIONS

ARTICLE

Received 16 Feb 2016 | Accepted 28 Dec 2016 | Published 15 Feb 2017

DOI: 10.1038/ncomms14435 OPEN

No saturation in the accumulation of alien species worldwide

Hanno Seebens *et al.*#

RESEARCH HIGHLIGHTS THIS WEEK

MAURICIO ECHA

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/bz8s (2017)

EVOLUTION

How humans adapt to arsenic

ROBERTO LEIVA

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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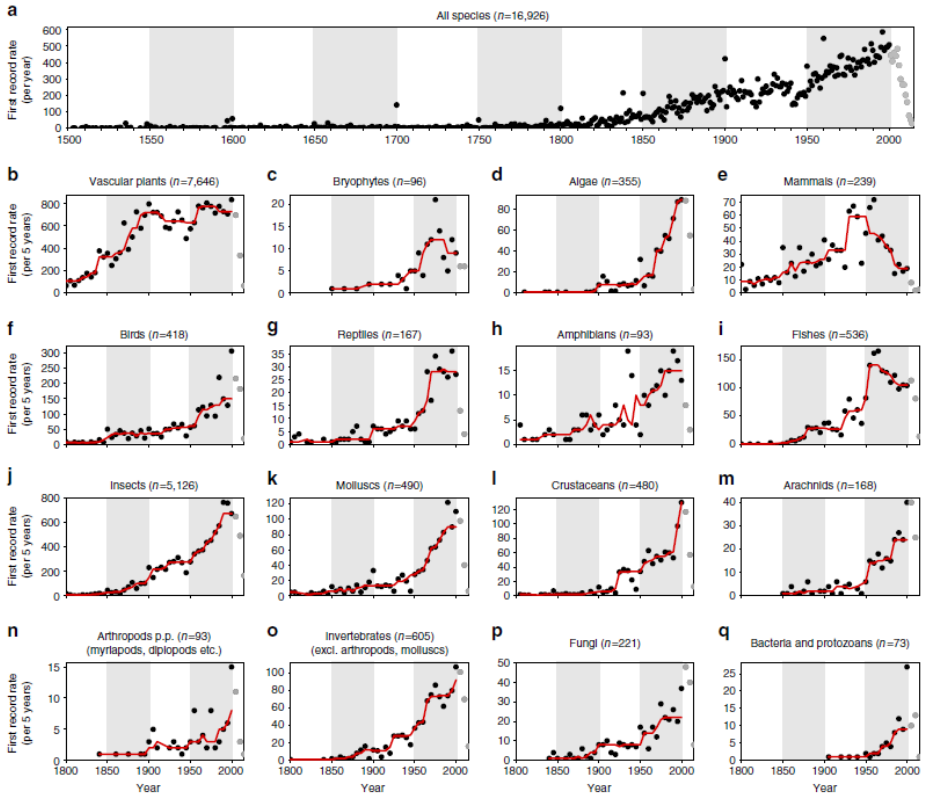

Importance of “big data”

INNS cost Europe

>12 billion € / year

(based on documented impact of 125 IAS out of over thousand considered as invasive in Europe)

Climate and invasion = deadly duo?

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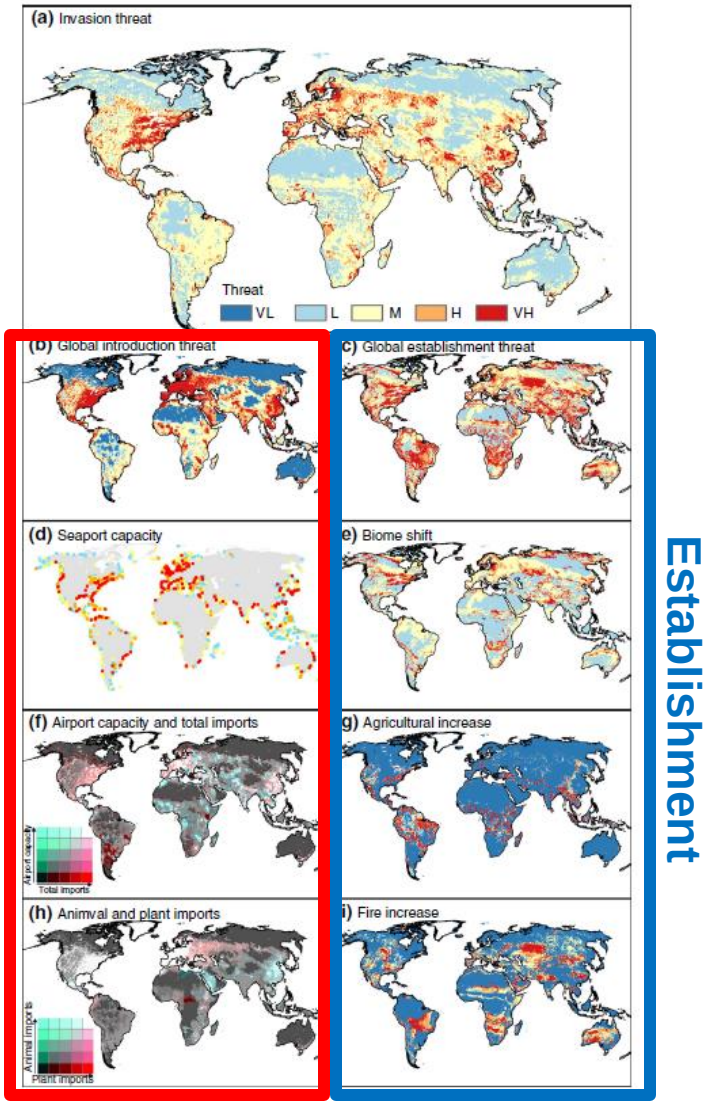
Unravelling patterns of invasion



nature COMMUNICATIONS

ARTICLE

Received 2 Sep 2015 | Accepted 7 Jul 2016 | Published 23 Aug 2016

DOI: 10.1038/ncomms12485 OPEN

Global threats from invasive alien species in the twenty-first century and national response capacities

Regan Early[1], Bethany A. Bradley[2], Jeffrey S. Dukes[3,4], Joshua J. Lawler[5], Julian D. Olden[6], Dana M. Blumenthal[7], Patrick Gonzalez[8,9], Edwin D. Grosholz[10], Ines Ibañez[11], Luke P. Miller[12], Cascade J.B. Sorte[13] & Andrew J. Tatem[14,15,16]

Invasive alien species (IAS) threaten human livelihoods and biodiversity globally. Increasing globalization facilitates IAS arrival, and environmental changes, including climate change, facilitate IAS establishment. Here we provide the first global, spatial analysis of the terrestrial threat from IAS in light of twenty-first century globalization and environmental change, and evaluate national capacities to prevent and manage species invasions. We find that one-sixth of the global land surface is highly vulnerable to invasion, including substantial areas in developing economies and biodiversity hotspots. The dominant invasion vectors differ between high-income countries (imports, particularly of plants and pets) and low-income countries (air travel). Uniting data on the causes of introduction and establishment can improve early-warning and eradication schemes. Most countries have limited capacity to act against invasions. In particular, we reveal a clear need for proactive invasion strategies in areas with high poverty levels, high biodiversity and low historical levels of invasion.

Early et al (2016) Nature Communications DOI: 10.1038/ncomms12485

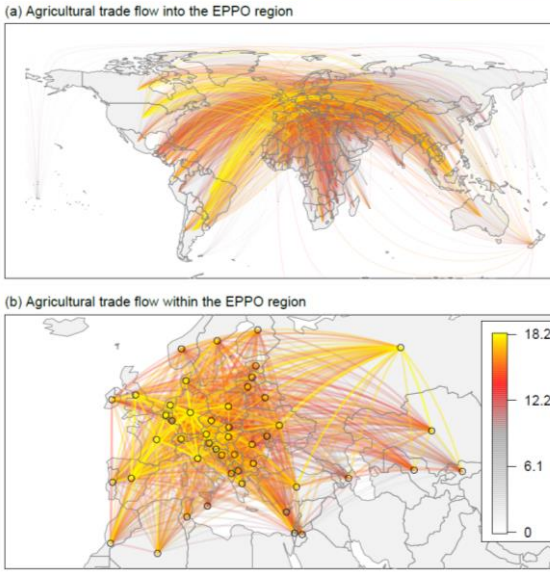
Global trade networks are the key to distribution of invasive non-native species

Submitted by on Wed, 12/07/2017 - 11:29

Scientists at the Centre for Ecology & Hydrology (CEH) have conducted an analysis of invasive non-native species occurrence in 48 countries to show that global trade networks play a key role in the distribution of invasions across Europe.

The CEH team of Dr Daniel Chapman, Dr Beth Purse, Professor Helen Roy and Professor James Bullock looked at more than 420 non-native plant pest species – including 173 invertebrates, 166 pathogens and 83 plants – to show that invasion was strongly linked to agricultural imports from countries in which the focal species were present.

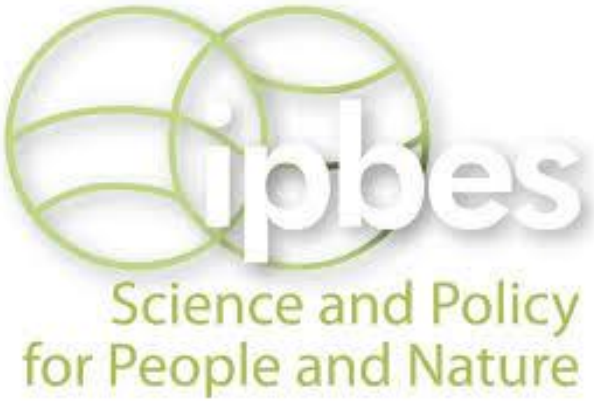
The scientists used sophisticated statistical models to consider trade in all agricultural products, as well as live plants, forest products, fruit and vegetables and seeds. This showed that invasion was more strongly linked to the structure of global trade networks than to other possible ways in which the species could be spread, such as by airline routes or simply through geographic proximity.



Chapman D, Purse B V, Roy H E, Bullock J M. Global trade networks determine the distribution of invasive non-native species. Global Ecology Biogeography 2017;00:1–11.

Global Action Against Aquatic Invasive Species

Convention on
Biological Diversity



Informing the new European Regulation

European Commission

ENVIRONMENT

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- NATURE & BIODIVERSITY
- EU Biodiversity Policy
- EU Nature Legislation
- Natura 2000 Network
- Species protection
- Green Infrastructure
- Invasive Alien Species
- Farming for biodiversity
- Global biodiversity

Invasive Alien Species

Invasive Alien Species are animals and plants that are introduced accidently or deliberately into a natural environment where they are not normally found, with serious negative consequences for their new environment. They represent a major threat to native plants and animals in Europe, causing damage worth millions of euros every year.

NEW New EU Regulation to address invasive alien species and protect biodiversity

The new Regulation on invasive alien species was published in the Official Journal on 4 November 2014. It will enter into force on 1 January 2015.. The new regulation seeks to address the problem of invasive alien species in a comprehensive manner so as to protect native biodiversity and ecosystem services, as well as to minimize and mitigate the human health or economic impacts that these species can have.

Invasive species, threatening biodiversity in Europe

Factsheet

REGULATION (EU) No 1143/2014 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

of 22 October 2014

on the prevention and management of the introduction and spread of invasive alien species

THE EUROPEAN PARLIAMENT AND THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty on the Functioning of the European Union, and in particular Article 192(1) thereof,

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(1)

A system to address invasive alien species should be underpinned by a centralised information system collating the existing information on alien species in the Union and allowing access to information on the presence of species, their spread, their ecology, invasion history and all other information necessary to underpin policy and management decisions and allowing also the exchange of best practices.

rn.

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(2) Invasive alien species represent one of the main threats to biodiversity and related ecosystem services, especially in geographically and evolutionarily isolated ecosystems, such as small islands. The risks such species pose may intensify due to increased global trade, transport, tourism and climate change.

(3) The threat to biodiversity and related ecosystem services that invasive alien species pose takes different forms, including severe impacts on native species and the structure and functioning of ecosystems through the alteration of habitats, predation, competition, the transmission of diseases, the replacement of native species throughout a significant proportion of range and through genetic effects by hybridisation. Furthermore, invasive alien species can also have a significant adverse impact on human health and the economy. Only live specimens, and parts that can reproduce, represent a threat to biodiversity and related ecosystem services, human health or the economy, and therefore, only those should be subject to the restrictions under this Regulation.

Predicting invasions through horizon scanning

European Commission

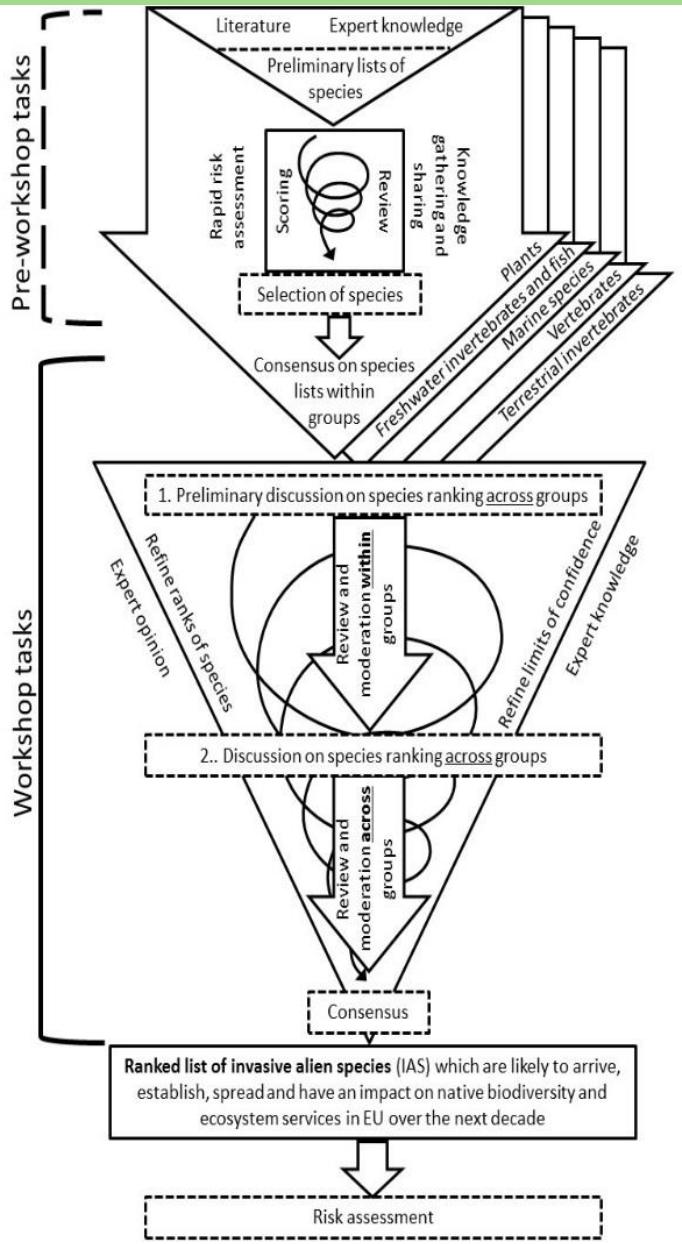
Invasive Alien Species - Prioritising prevention efforts through horizon scanning

ENV.B.2/ETU/2014/0016

Final report

Dr Helen E. Roy

July - 2015



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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

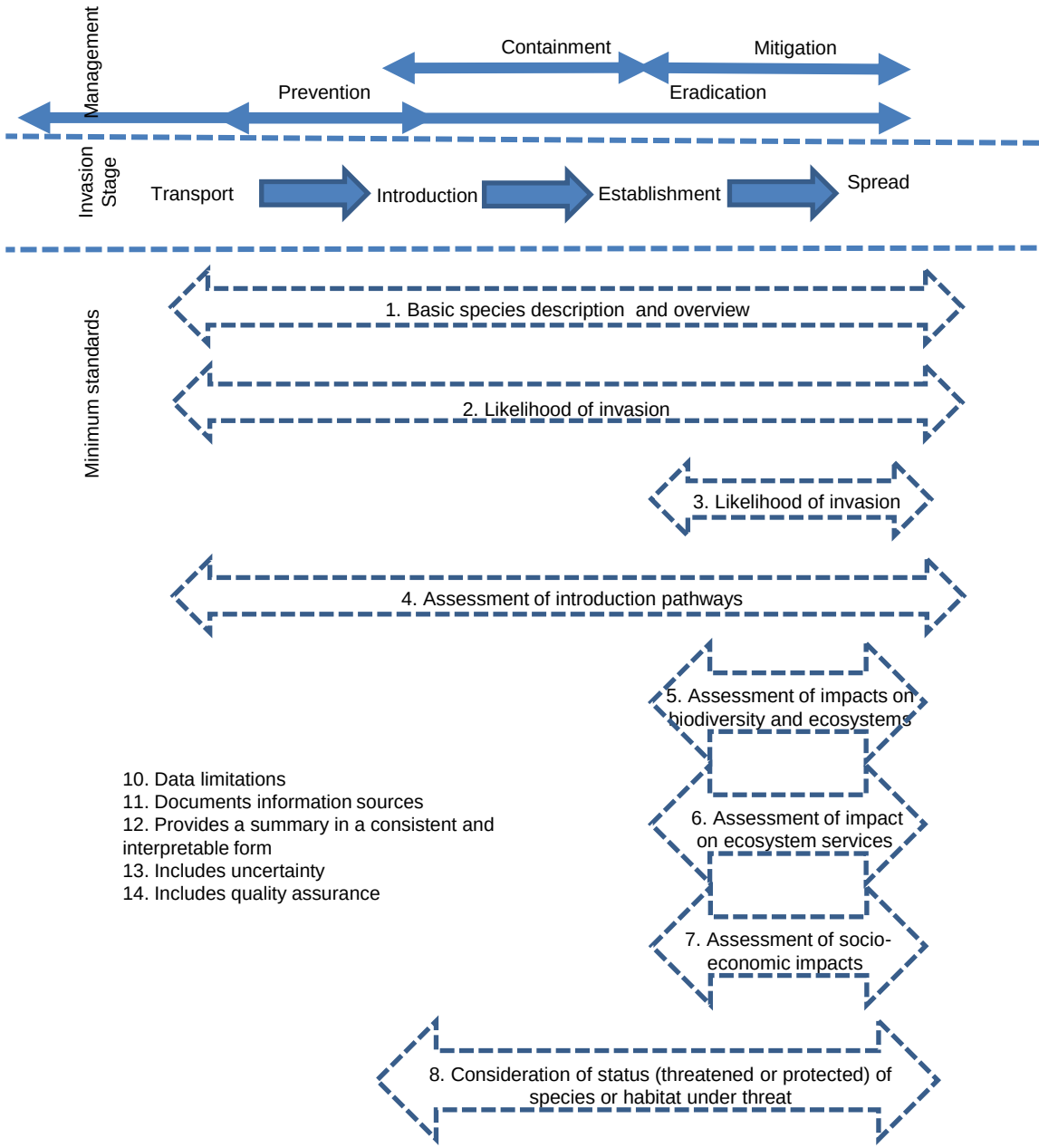
Developing the list of IAS of Union concern

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.

Minimum standards for risk assessment

- Evidence for ecosystem service impacts
- Consideration of climate change
- Socio-economic benefits



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Journal of Applied Ecology

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New on our blog: Establishing minimum standards to inform alien species risk assessments ceh.ac.uk/news-and-media … #IAS #invasivespecies

Lithobates (Rana) catesbeianus (Riccardo Scalera)

7:04 AM - 17 Oct 2017

4 Retweets 4 Likes

You, JP, J. Applied Ecology and European Commission

Helen Roy
@UKLadybirds

Delighted to see our collaborative study on assessing risks of alien species published online today ceh.ac.uk/news-and-media … @CEHScienceNews

Establishing minimum standards to inform non-native spec…
Professor Helen Roy describes the process to agreeing 14 minimum standards that risk assessments of alien species should fulfil in an environmental context…
ceh.ac.uk

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1 14 13

Marianne Kettunen
@makettunen
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#InvasiveAlienSpecies risk assessments should comply with 14 minimum standards, say #IAS experts led by @UKLadybirds

Establishing minimum standards to inform non-native spec…
Professor Helen Roy describes the process to agreeing 14 minimum standards that risk assessments of alien species should fulfil in an environmental context…
ceh.ac.uk

6:31 AM - 17 Oct 2017 from Plymouth, England

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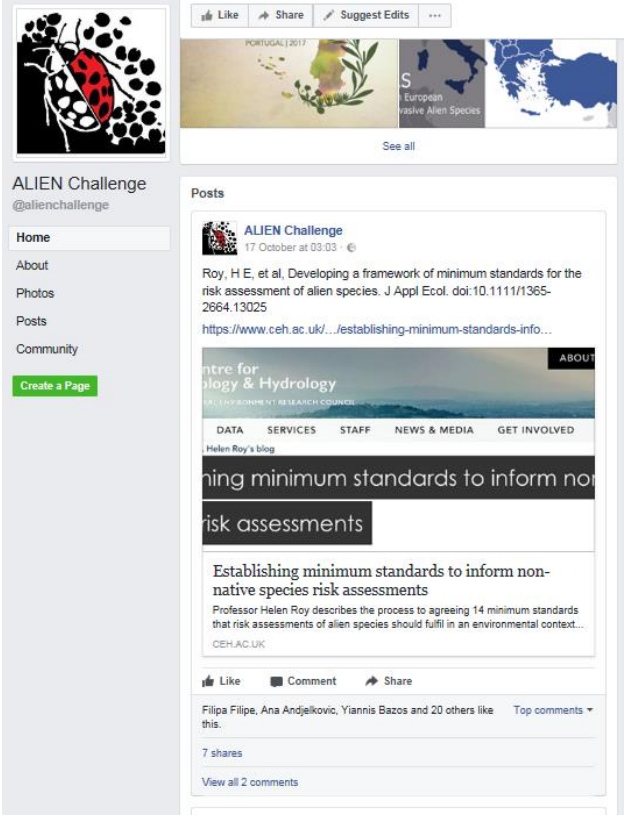

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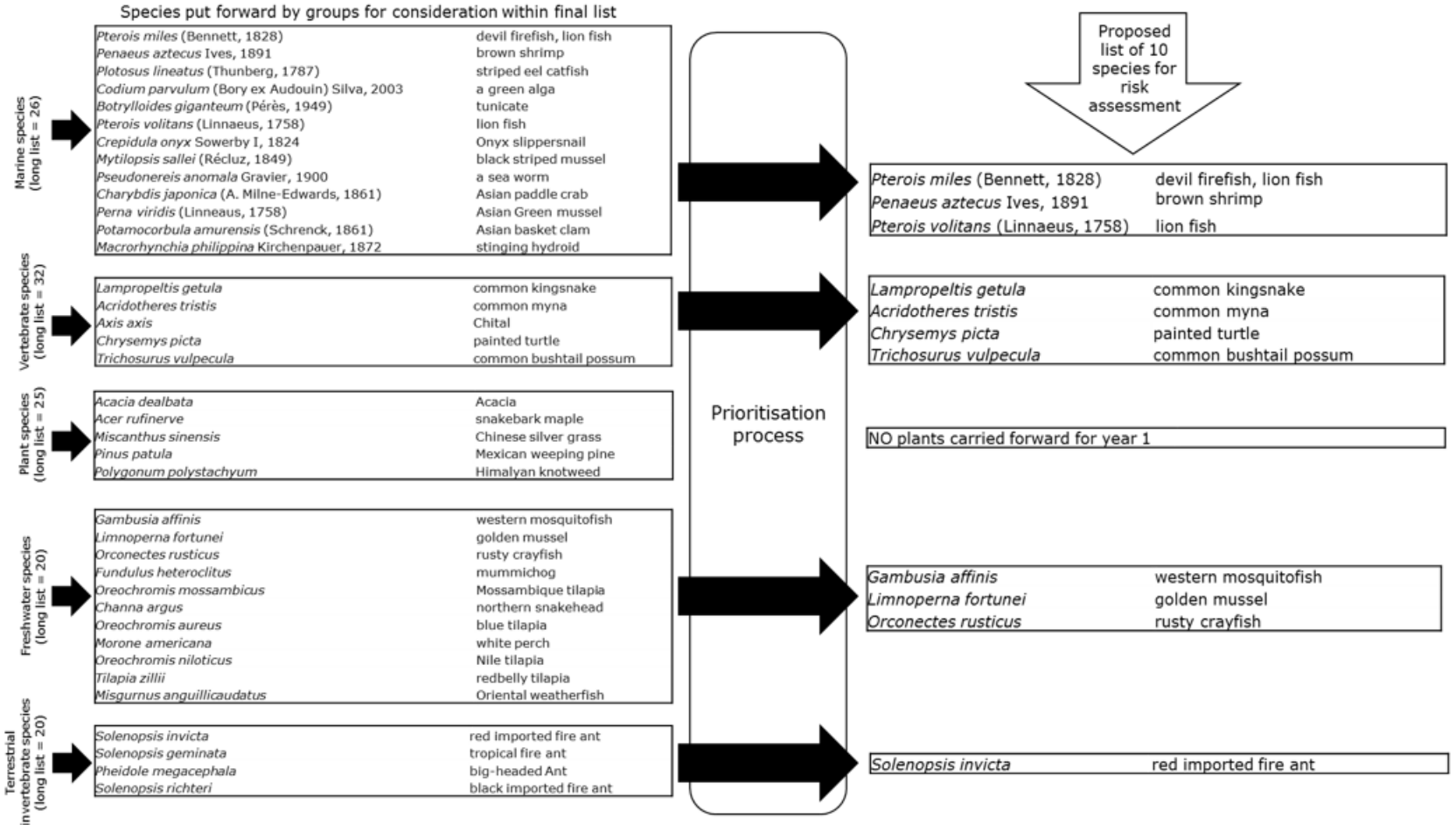
Prioritising species for risk assessment

Figure 1: Selection of the proposed list of ten species for risk assessment highlighting the process leading from long lists of species to within expert group prioritisation and finally across group prioritisation. A crude scoring process (documented in final report of ENV.B.2/ETU/2014/0016) was used to rank the species into broad risk categories and then other criteria were used to produce the final proposed list including current distribution, practicalities and effectiveness of management.



Meet the species





Acridotheres tristis (common myna)

Chrysemys picta (Painted turtle)

Gambusia affinis (Western Mosquitofish)

Lampropeltis getula (common kingsnake)

Limnoperna fortunei (Golden Mussel)

Orconectes rusticus (Rusty Crayfish)

Solenopsis invicta (Red Imported Fire Ant)

Trichosurus vulpecula (Common brushtail possum)

Plotosus lineatus (Striped catfish)

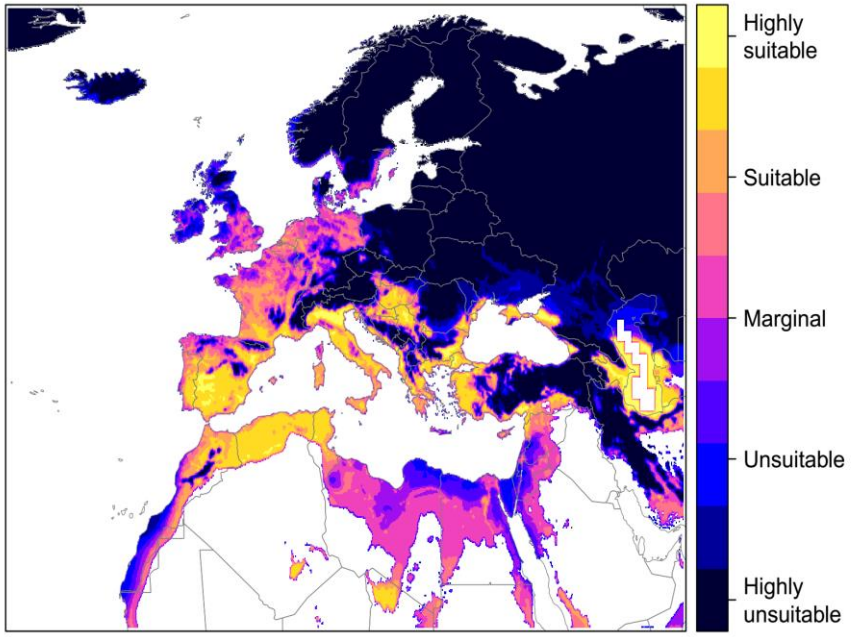




LIFE IAP-RISK

LIFE15 PRE FR 001

Mitigating the threat of invasive alien plants to the EU through pest risk analysis to support the Regulation 1143/2014



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Grappling with impacts

Methods in Ecology and Evolution

BRITISH ECOLOGICAL SOCIETY

Received: 27 April 2017 | Accepted: 12 June 2017

DOI: 10.1111/2041-210X.12844

RESEARCH ARTICLE

Methods in Ecology and Evolution

Socio-economic impact classification of alien taxa (SEICAT)

Sven Bacher[1,2] | Tim M. Blackburn[3,4,5] | Franz Essl[6] | Piero Genovesi[7] | Jaakko Heikkilä[8] | Jonathan M. Jeschke[9,10,11] | Glyn Jones[12] | Reuben Keller[13] | Marc Kenis[14] | Christoph Kueffer[2,15] | Angeliki F. Martinou[16] | Wolfgang Nentwig[17] | Jan Pergl[18] | Petr Pyšek[18,19] | Wolfgang Rabitsch[20] | David M. Richardson[2] | Helen E. Roy[21] | Wolf-Christian Saul[9,10,11] | Riccardo Scalera[22] | Montserrat Vilà[23] | John R. U. Wilson[2,24] | Sabrina Kumschick[2,24]

"...a novel standardised method for classifying alien taxa in terms of the magnitude of their impacts on human well-being, based on the capability approach from welfare economics. The core characteristic of this approach is that it uses changes in people's activities as a common metric for evaluating impacts on well-being..."

Assessment of socio-economic impacts

TABLE 1 Constituents of human well-being and examples of their subcategories (after MEA, 2005). The overarching premise for all constituents is the freedom of choice and action, i.e. the opportunity to be able to achieve what a person values doing and being

Constituents of human well-being	Examples
Safety	Personal safety
	Secure resource access
	Security from disasters
Material and immaterial assets	Adequate livelihoods
	Sufficient nutritious food
	Shelter
	Access to goods
Health	Strength
	Feeling well
	Access to clean air and water
Social, spiritual and cultural relations	Social, spiritual and cultural practice
	Mutual respect
	Friendship

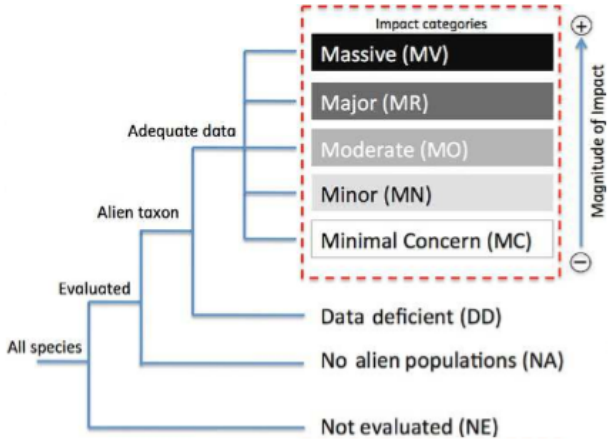


FIGURE 2 Socio-Economic Impact Classification of Alien Taxa (SEICAT) (after Blackburn et al., 2014; Hawkins et al., 2015). Detailed descriptions of the classes are given in Table 2

maximum score found in any of the activities assessed is decisive for the final outcome (analogous to EICAT; Blackburn et al., 2014). It is,

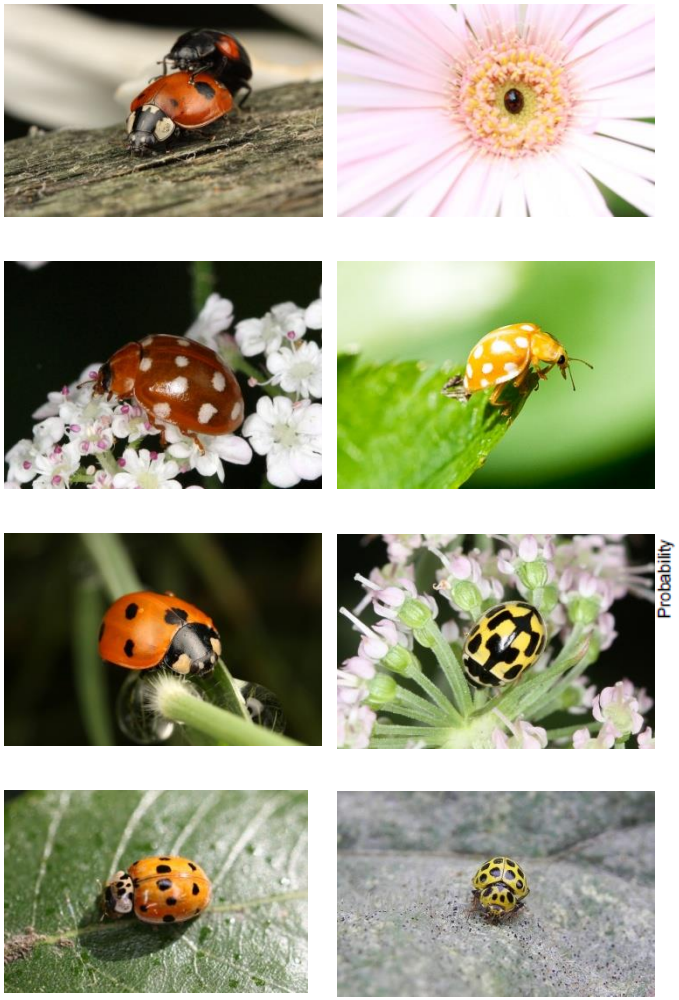
Eleutherodactylus coqui

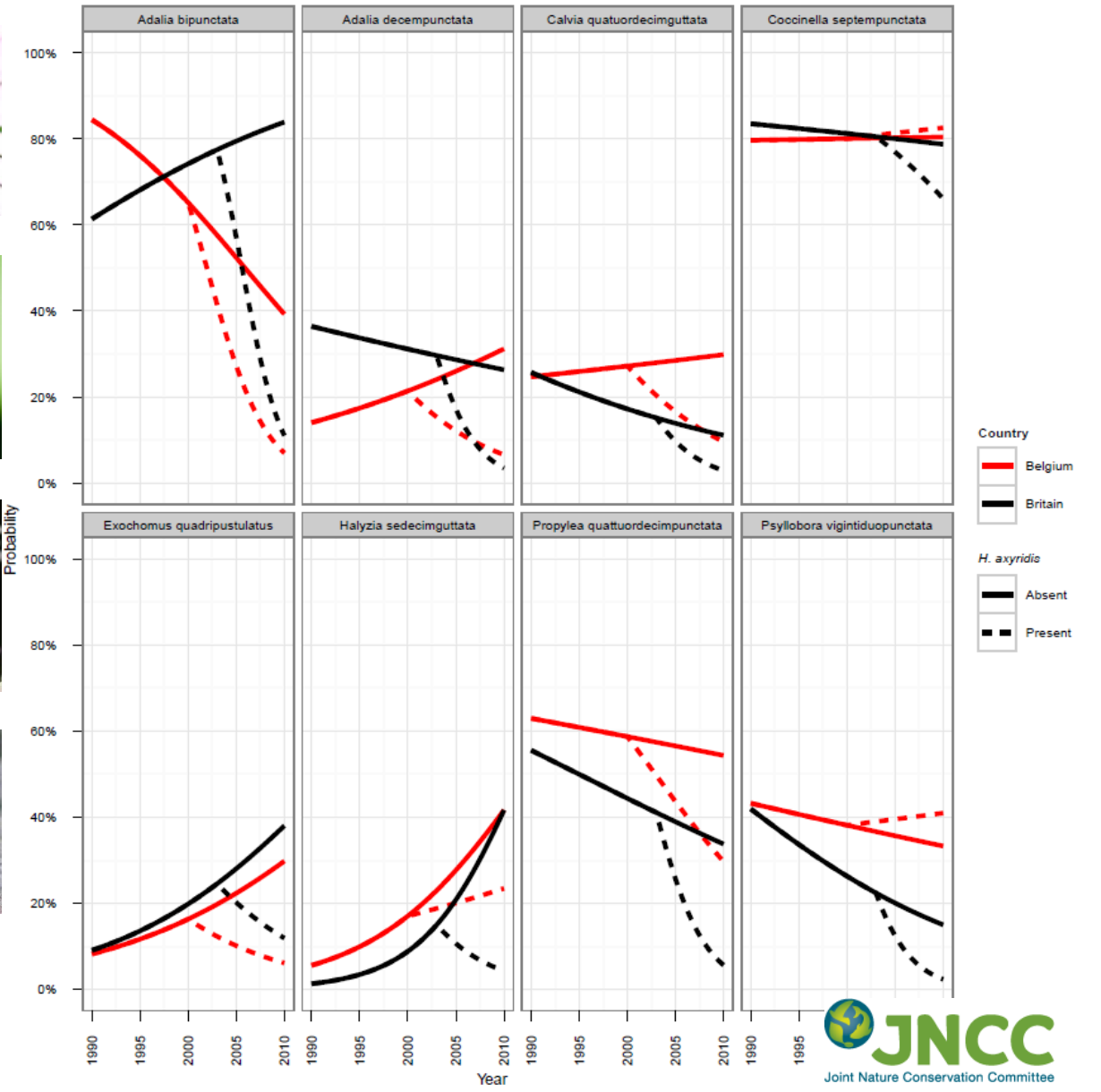
Noise effects trade of property - Hawaii

	SEICAT	Confidence	EICAT	Confidence
Rhinella marina	MR	Low	MR	High
Duttaphrynus melanostictus	MO	Low	MR	Low
Eleutherodactylus coqui	MN	High	MO	High
Eleutherodactylus planirostris	MN	Low	MC	Medium
Hyla meridionalis	MC	Low	MO	Low
Osteopilus septentrionalis	MN	Low	MO	Low

SEICAT, socio-economic impact classification of alien taxa; EICAT, environmental impact classification for alien taxa; MR, major; MO, moderate; MN, minor; MC, minimal concern.

Assessing impacts





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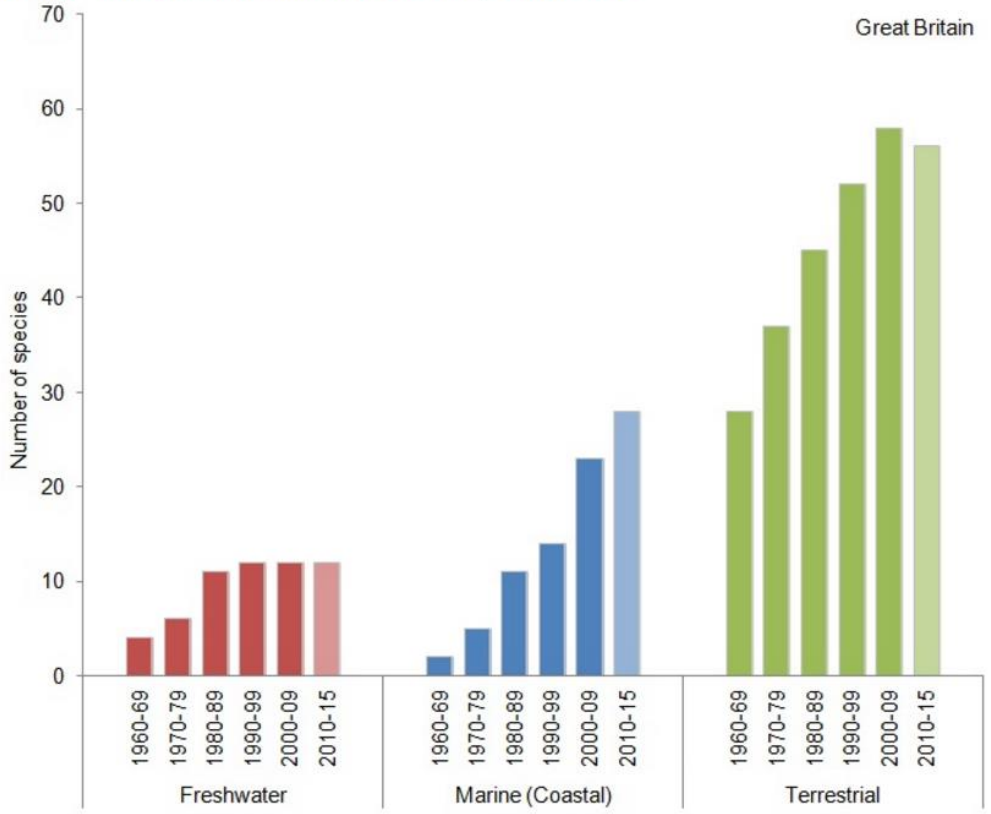
Understanding impacts to inform indicators

Figure B6i. Number of non-native invasive species established in or along more than 10 per cent of Great Britain's land area or coastline, 1960 to 2015.



Notes: The last time period covers a shorter period than the other bars (2010–2015).

Source: Botanical Society of Britain & Ireland, British Trust for Ornithology, Centre for Ecology & Hydrology, Marine Biological Association, National Biodiversity Network Gateway.

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Time to think about pathogens…

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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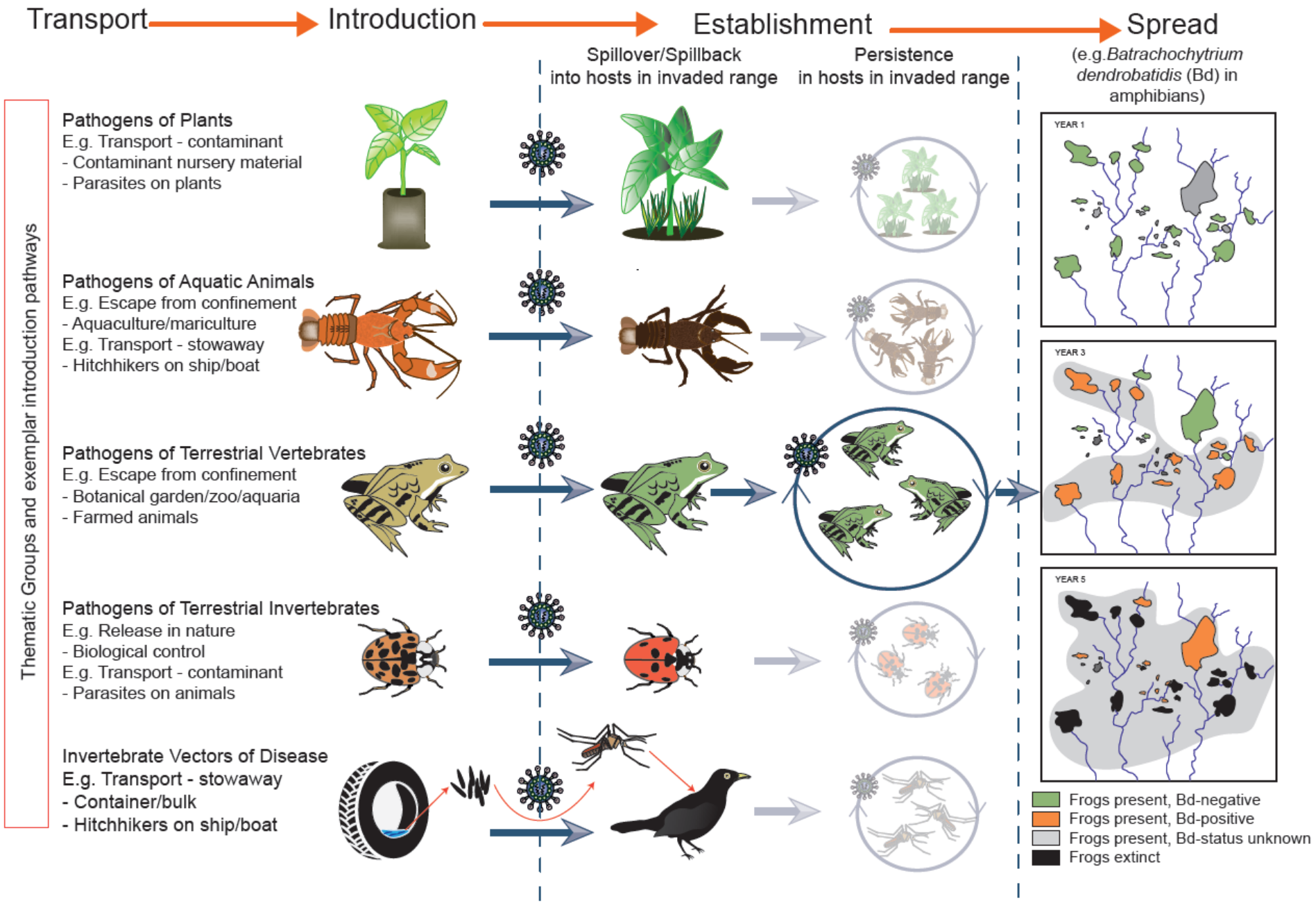
Invasions and wildlife disease



Conservation Letters

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POLICY PERSPECTIVES

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

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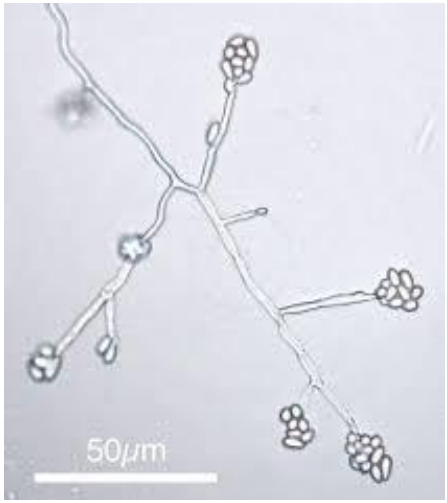

Prioritising pathways for prevention

Aesculapian snake *Zamenis longissimus*

UNEP

CBD

Convention on Biological Diversity

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Eighteenth meeting
Montreal, 23-28 June 2014
Item 5.2 of the provisional agenda*

PATHWAYS OF INTRODUCTION OF INVASIVE SPECIES, THEIR PRIORITIZATION AND MANAGEMENT

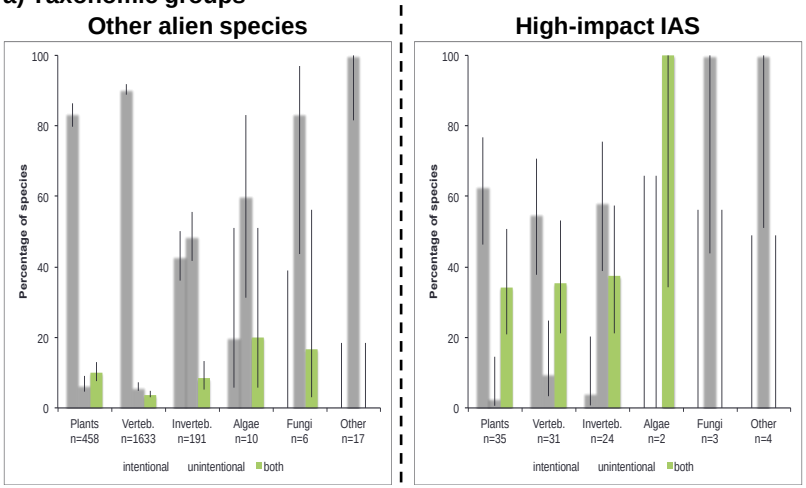
Note by the Executive Secretary

I. INTRODUCTION

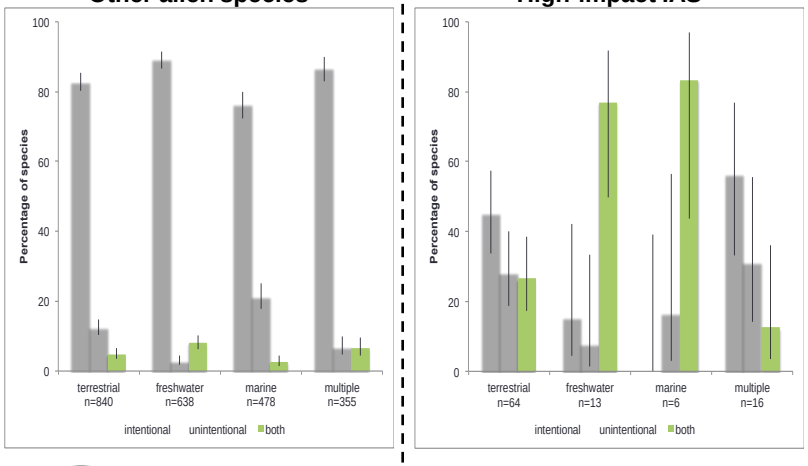
1. The Guiding Principles for the Prevention, Introduction and Mitigation of Impacts of Alien Species that threaten Ecosystems, Habitats and Species (the Guiding Principles) annexed to decision VI/23** provide all Governments and organizations with guidance for developing effective strategies to minimize the spread and impact of invasive alien species. In particular, the Guiding Principles highlight the importance of identifying pathways of introduction of invasive species in order to minimize such introductions, and call to assess the risks associated with such pathways.

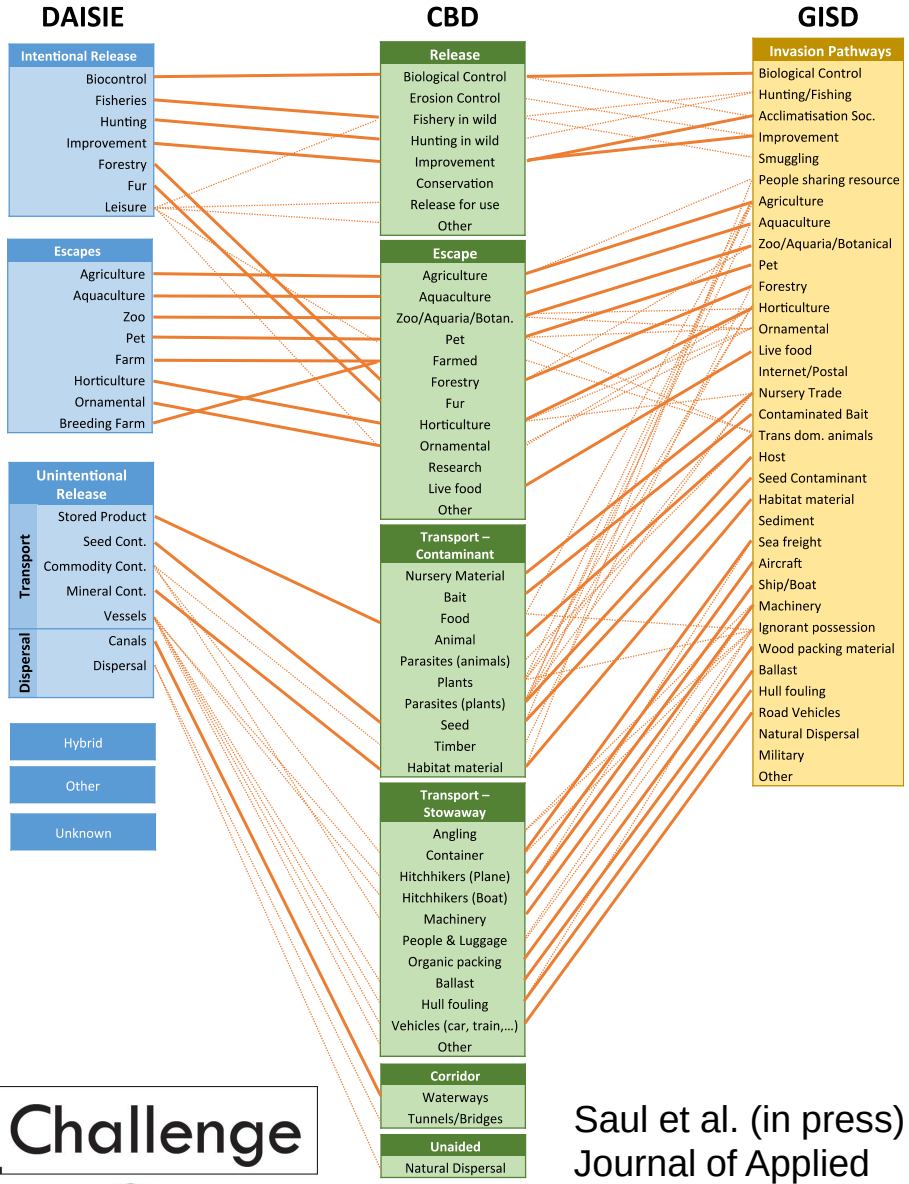
Mapping pathways

a) Taxonomic groups



b) Environments





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ALIEN Challenge

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Saul et al. (in press) Journal of Applied Ecology

Variation in the importance of pathways

Overview Articles

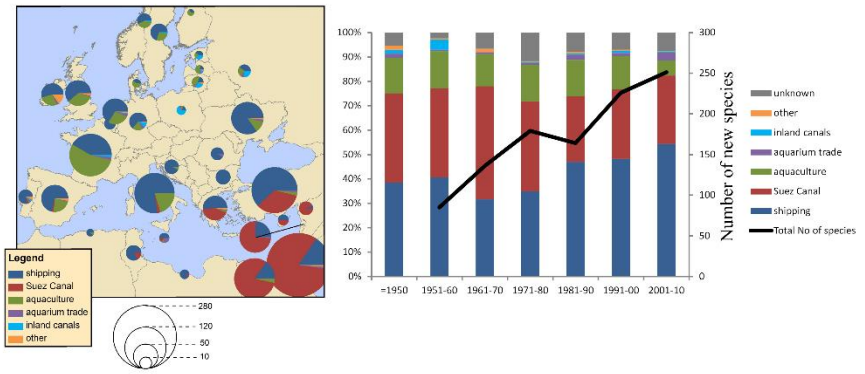
Crossing Frontiers in Tackling Pathways of Biological Invasions

FRANZ ESSL, SVEN BACHER, TIM M. BLACKBURN, OLAF BOOY, GIUSEPPE BRUNDU, SARAH BRUNEL, ANA-CRISTINA CARDOSO, RENÉ ESCHEN, BELINDA GALLARDO, BELLA GALIL, EMILI GARCÍA-BERTHOU, PIERO GENOVESI, QUENTIN GROOM, COLIN HARROWER, PHILIP E. HULME, STELIOS KATSANEVAKIS, MARC KENIS, INGOLF KÜHN, SABRINA KUMSCHICK, ANGELIKI F. MARTINOU, WOLFGANG NENTWIG, COLETTE O'FLYNN, SHYAMA PAGAD, JAN PERGL, PETR PYŠEK, WOLFGANG RABITSCH, DAVID M. RICHARDSON, ALAIN ROQUES, HELEN E. ROY, RICCARDO SCALERA, STEFAN SCHINDLER, HANNO SEEBENS, SONIA VANDERHOEVEN, MONTSERRAT VILÀ, JOHN R. U. WILSON, ARGYRO ZENETOS, AND JONATHAN M. JESCHKE

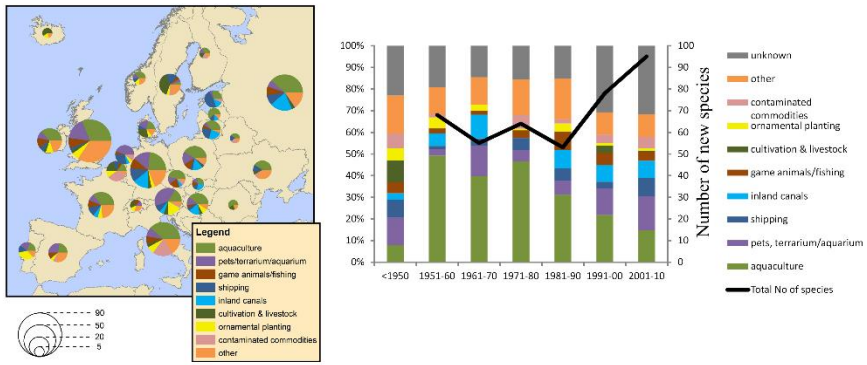
Substantial progress has been made in understanding how pathways underlie and mediate biological invasions. However, key features of their role in invasions remain poorly understood, available knowledge is widely scattered, and major frontiers in research and management are insufficiently characterized. We review the state of the art, highlight recent advances, identify pitfalls and constraints, and discuss major challenges in four broad fields of pathway research and management: pathway classification, application of pathway information, management response, and management impact. We present approaches to describe and quantify pathway attributes (e.g., spatiotemporal changes, proxies of introduction effort, environmental and socioeconomic contexts) and how they interact with species traits and regional characteristics. We also provide recommendations for a research agenda with particular focus on emerging (or neglected) research questions and present new analytical tools in the context of pathway research and management.

Keywords: alien species, impact, management, propagule pressure, temporal trends

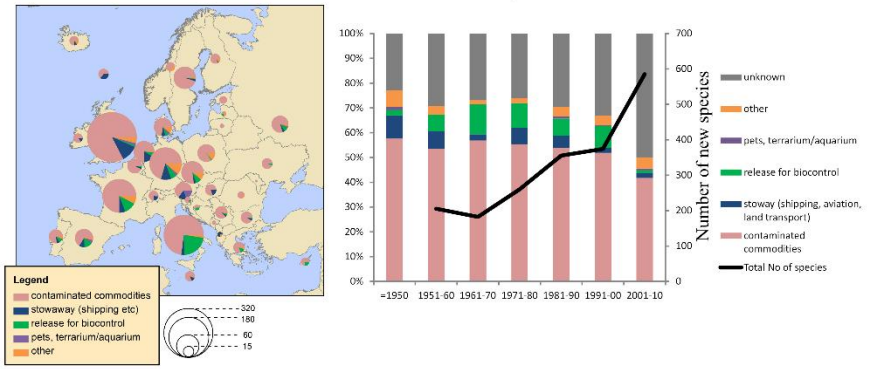
A. Marine species



B. Freshwater species



C. Terrestrial arthropods



Essl et al. (2015) Crossing frontiers in tackling pathways of biological invasions. *Bioscience:* biv082

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Surveillance and monitoring invasions

Harmonia axyridis

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Department for Environment Food & Rural Affairs

JNCC
Joint Nature Conservation Committee

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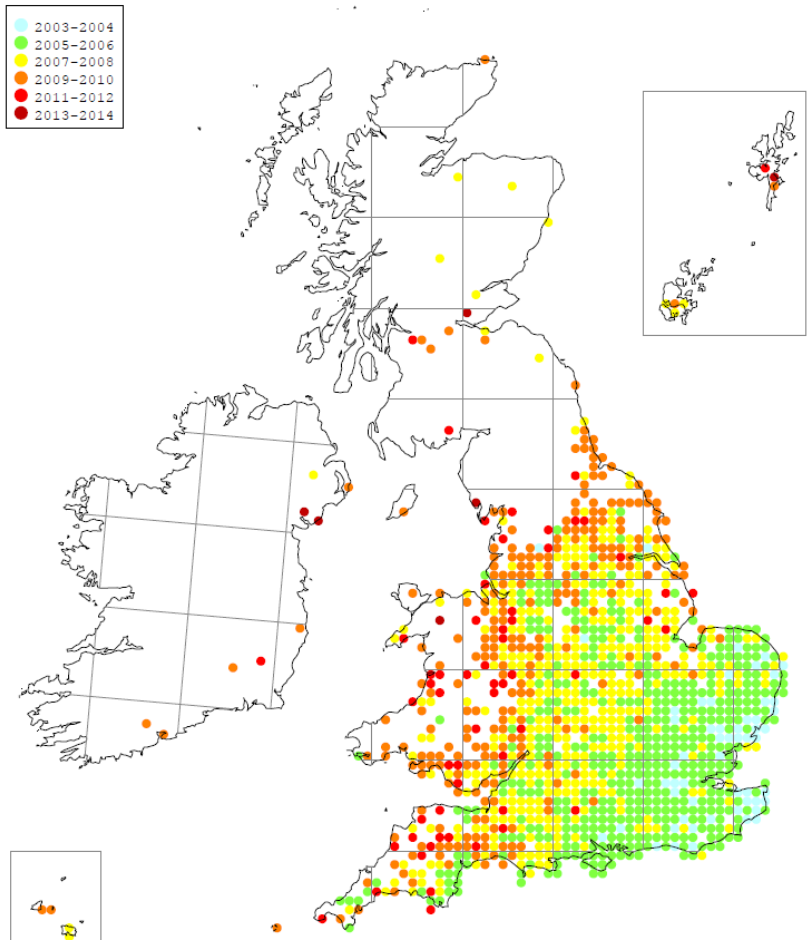
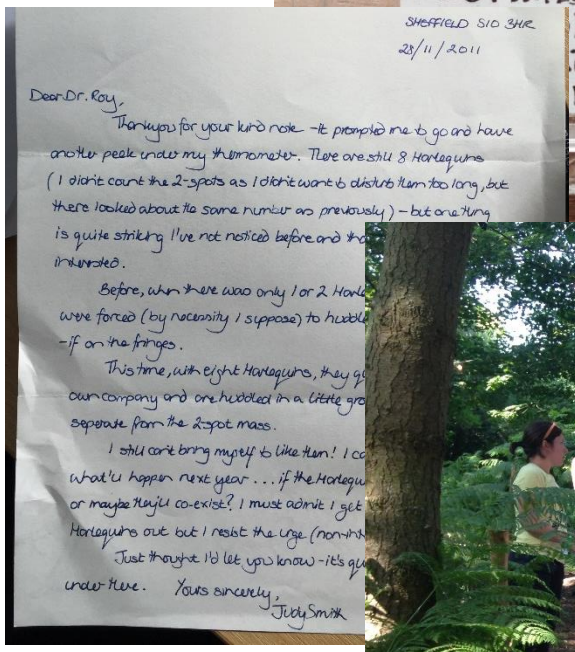
Engaging people in surveillance and monitoring





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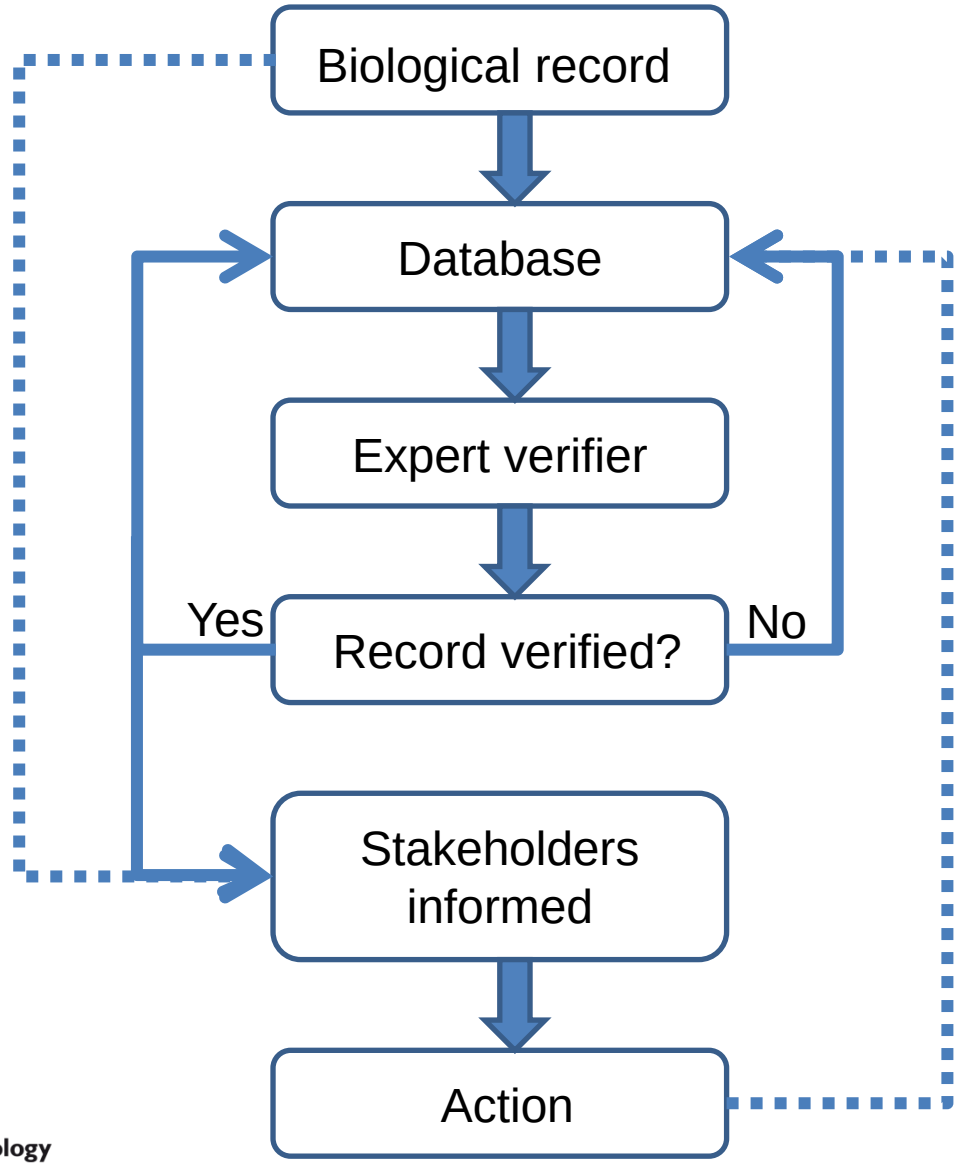
JNCC
Joint Nature Conservation Committee

Alien Alerts



iRecord

STOP THE SPREAD
INVASIVE AQUATIC SPECIES
CHECK-CLEAN-DRY

CEH Centre for Ecology & Hydrology
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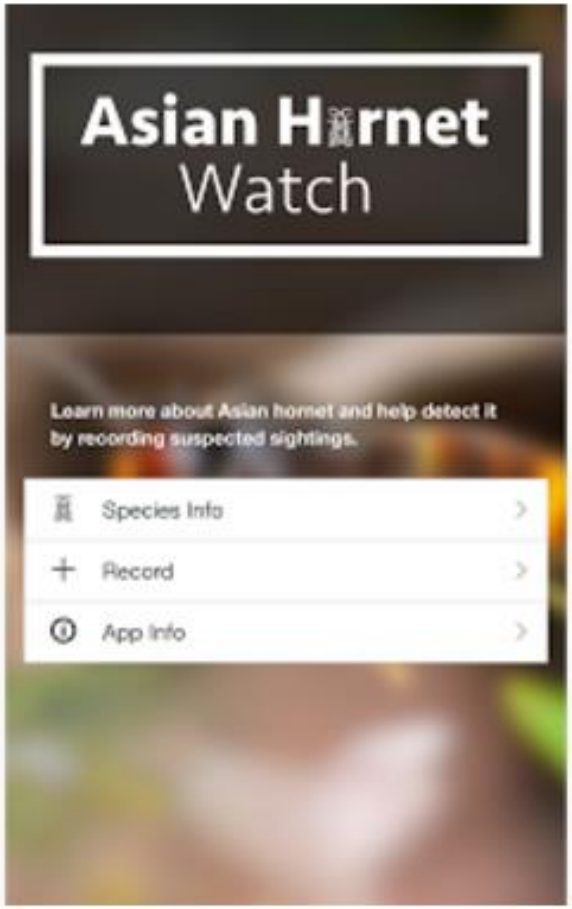
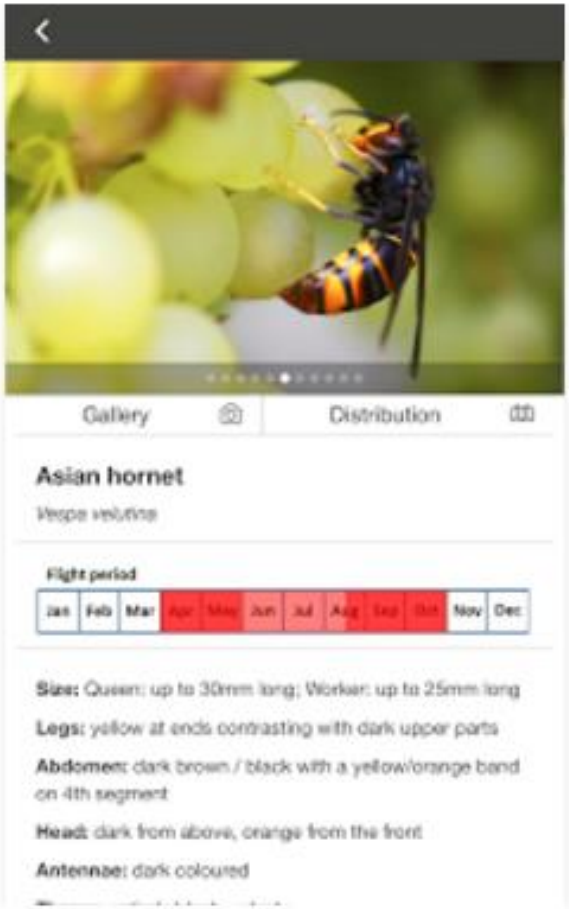
Asian hornet – arrived September 2016

Asian Hornet Watch





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Citizen science and alien species

ARTICLE IN PRESS

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journal homepage: www.elsevier.com/locate/bioc

A vision for global monitoring of biological invasions

Guillaume Latombe [a], Petr Pyšek [b,c], Jonathan M. Jeschke [d,e,f], Tim M. Blackburn [g,h,i], Sven Bacher [j], César Capinha [k], Mark J. Costello [l], Miguel Fernández [m,n], Richard D. Gregory [o], Donald Hobern [p], Cang Hui [q,r,s], Walter Jetz [t], Sabrina Kumschick [u,v], Chris McGrannachan [a], Jan Pergl [b], Helen E. Roy [w], Riccardo Scalera [x], Zoe E. Squires [a], John R.U. Wilson [u,v], Marten Winter [m], Piero Genovesi [y,z], Melodie A. McGeoch [a,*]

For many countries, the efficiency of invasion monitoring can be improved by inclusion into pre-existing biodiversity monitoring schemes. **Countries may capitalize on citizen science, as well as emerging online and remote technologies in data capture to improve records of invasions.** For all countries the goal should be to provide at regular intervals (at least every five years) alien species occurrence data corresponding to their maximum level of resolution, be it for the national inventory, priority sites, spatial extent, or the national distribution of occurrence of a priority set of taxa.

Embedding citizen science in research

DARWIN INITIATIVE

Summary

- Importance of global collaborations
- Sharing information
- Engaging people
- Predicting invasions

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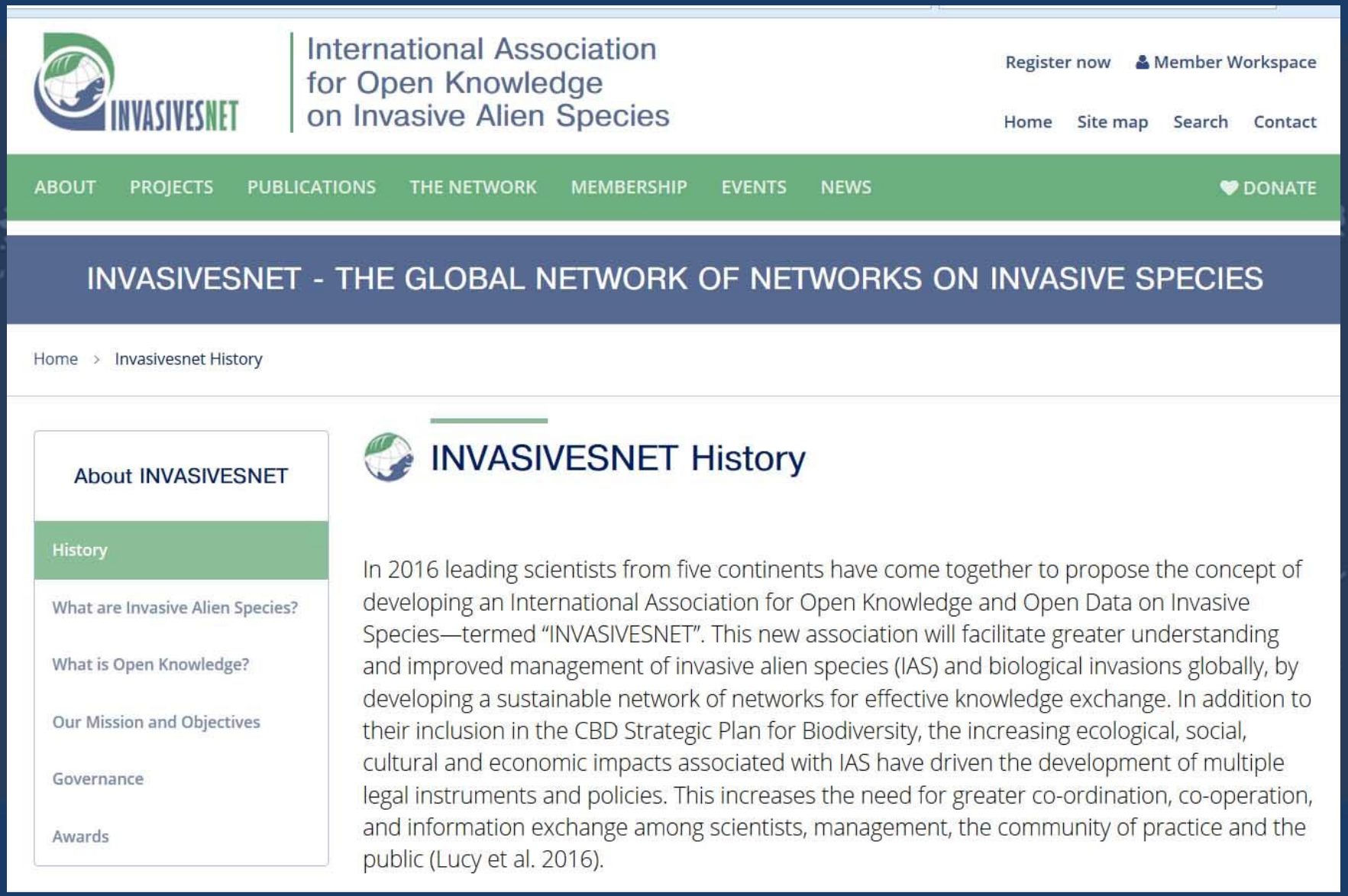
INVASIVESNET Website – *About* page



http://www.invasivesnet.net/about/about_history/

Thank you

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