Faculty of Science

New invasive species, which may arrive in the European Union: Horizon scan and risk analysis

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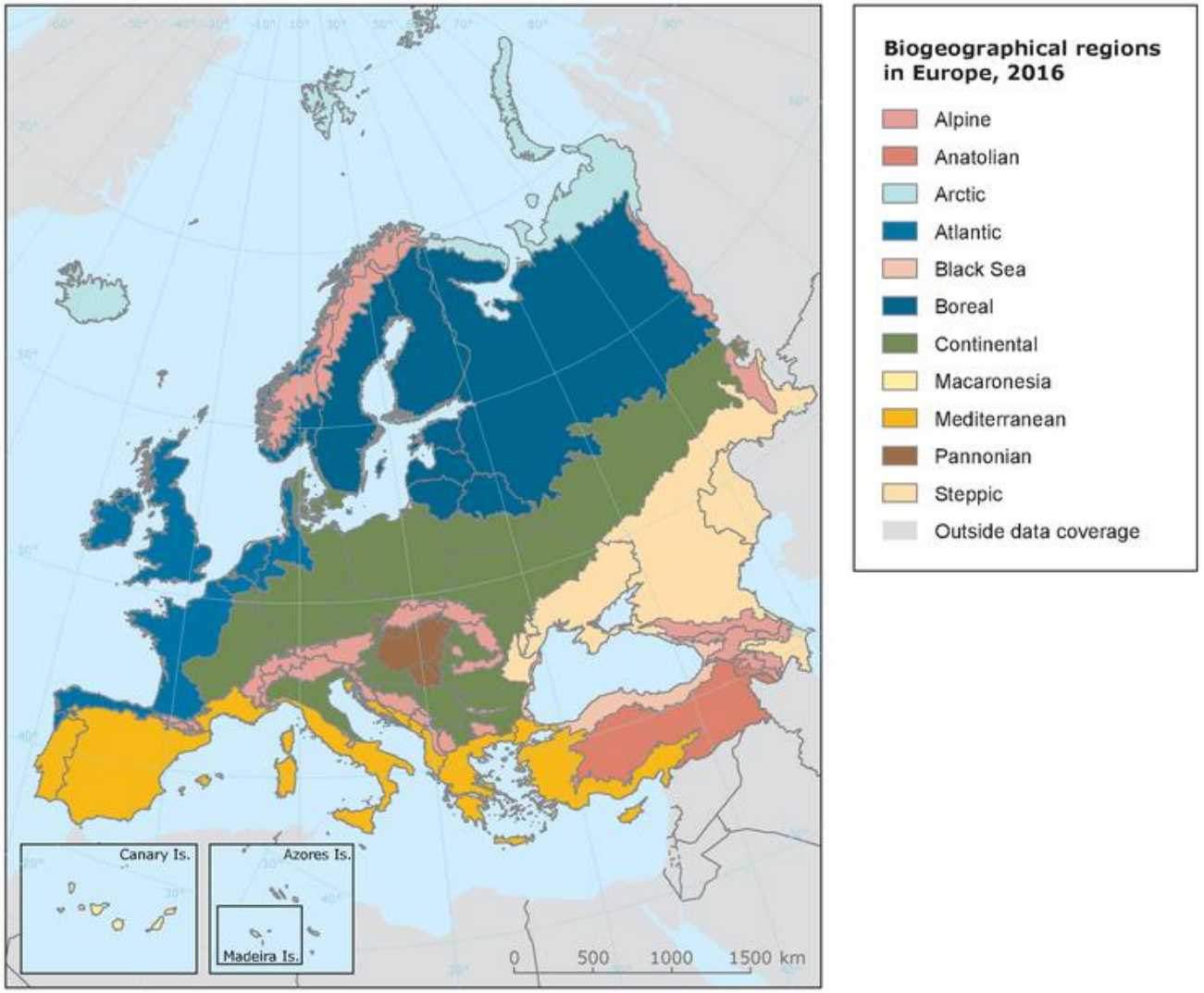
Project leader: Professor Helen Roy,
CEH, United Kingdom

The biological reality



Project leader: Professor Helen Roy, CEH, United Kingdom

Simplified bioregion	EEA bioregions	Köppen-Geiger correspondence
MAC	Macaronesia (Canary Islands + Madeira + Azores)	Warm oceanic or subtropical climate (Cfa) + hot desert climate (Bwh)
MED	Mediterranean + Black Sea	Mediterranean climate with hot (Csa) and warm (Csb) summer + cold semi-arid climate (Bsk)
ATL	Atlantic	Cool (Cfb) + temperate (Cfc) oceanic climates
CON	Continental + Pannonian	Continental climate with warm summer (Dfb)
STE	Steppic	Continental climate with hot summer (Dfa)
BOR	Boreal + Arctic + Alpine	Subarctic (Dfc) and Arctic (ET) climates

The political reality

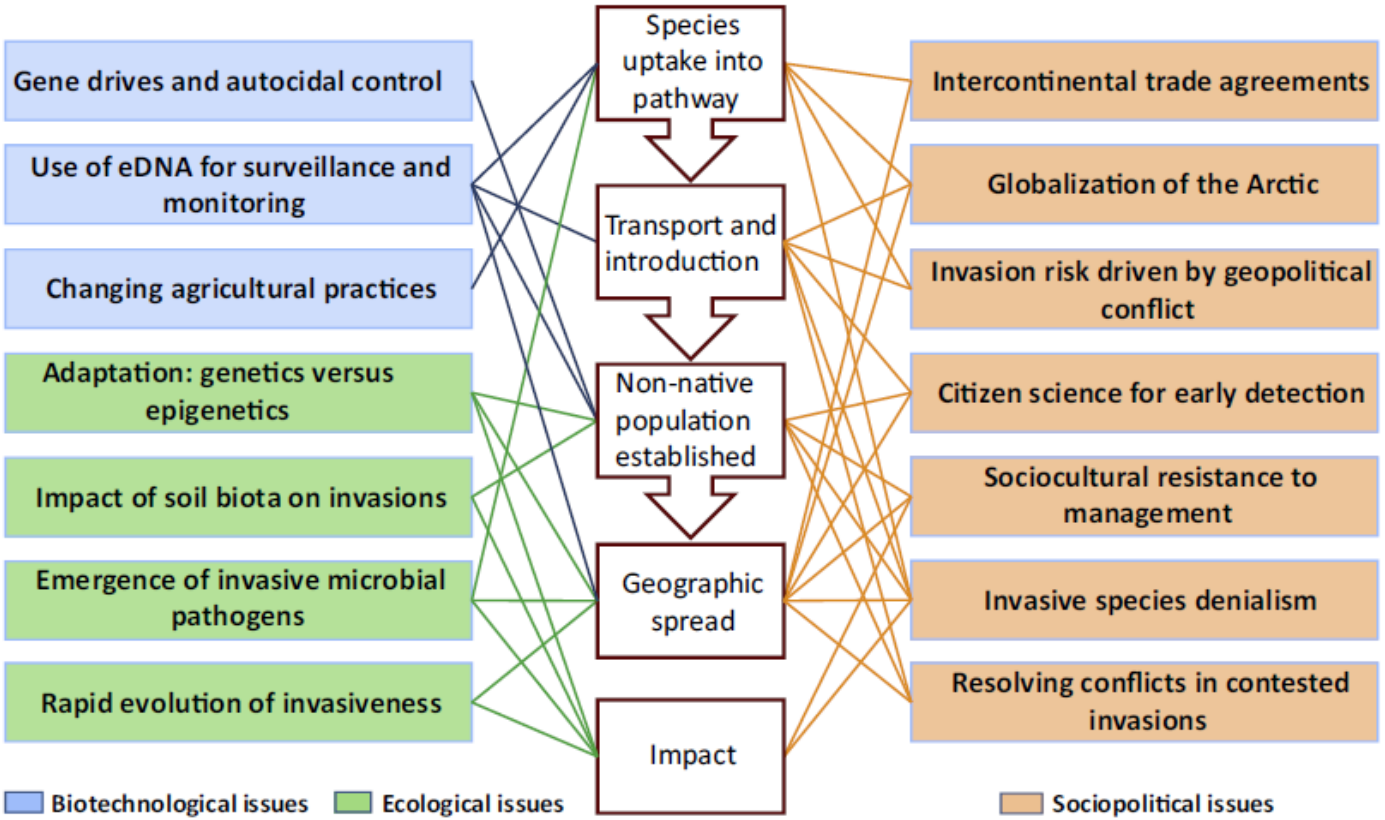


Figure 2. Horizon Scanning Topics and their Relevance to the Invasion Process and Impact. Each of the biotechnological, ecological, and sociopolitical issues identified here has a direct influence on multiple stages of the invasion process: uptake of the species into a vector-pathway system, survival during transport, introduction to a new region, establishment of a reproducing population, and subsequent spread within the region. Several issues also directly challenge our understanding of, and capacity to manage, the ecological impacts of invasions. These links are not meant to be comprehensive, but rather to illustrate the breadth of relevance of these issues.

Ricciardi et al 2017

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Open Access

POLICY PERSPECTIVES

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

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PRIMARY RESEARCH ARTICLE

WILEY Global Change Biology

Developing a list of invasive alien species likely to threaten biodiversity and ecosystems in the European Union

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A multi-authored effort

Threats to **ecosystems**

Species (mostly) not yet in the EU

Box moth *Cydalima perspectalis*

Threatens severely the few pockets of natural box tree (*Buxus*) populations in Southern Europe

https://en.wikipedia.org/wiki/Cydalima_perspectalis

Invasive Alien Species - Prioritising prevention efforts through horizon scanning

ENV.B.2/ETU/2014/0016

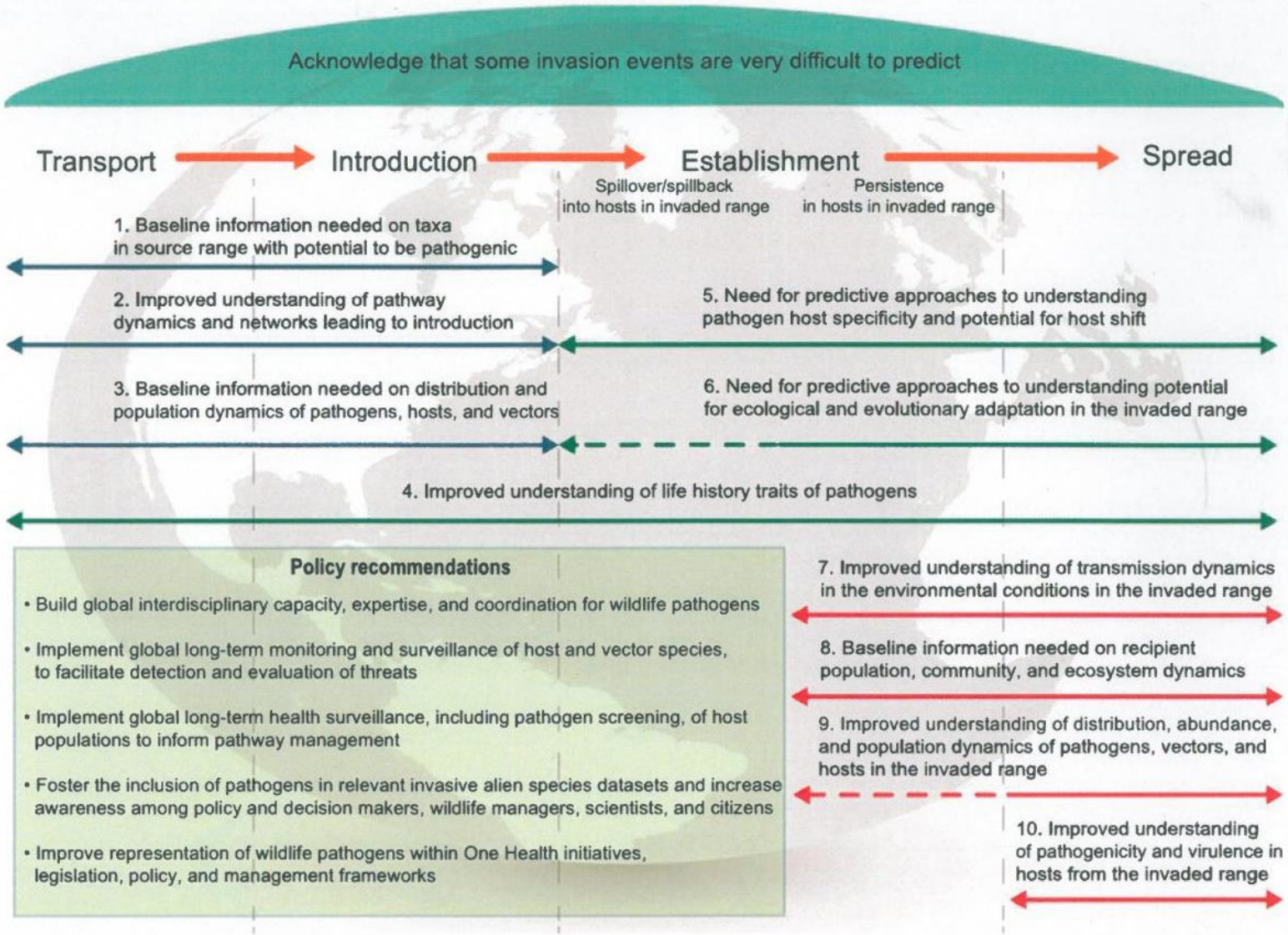
Final report

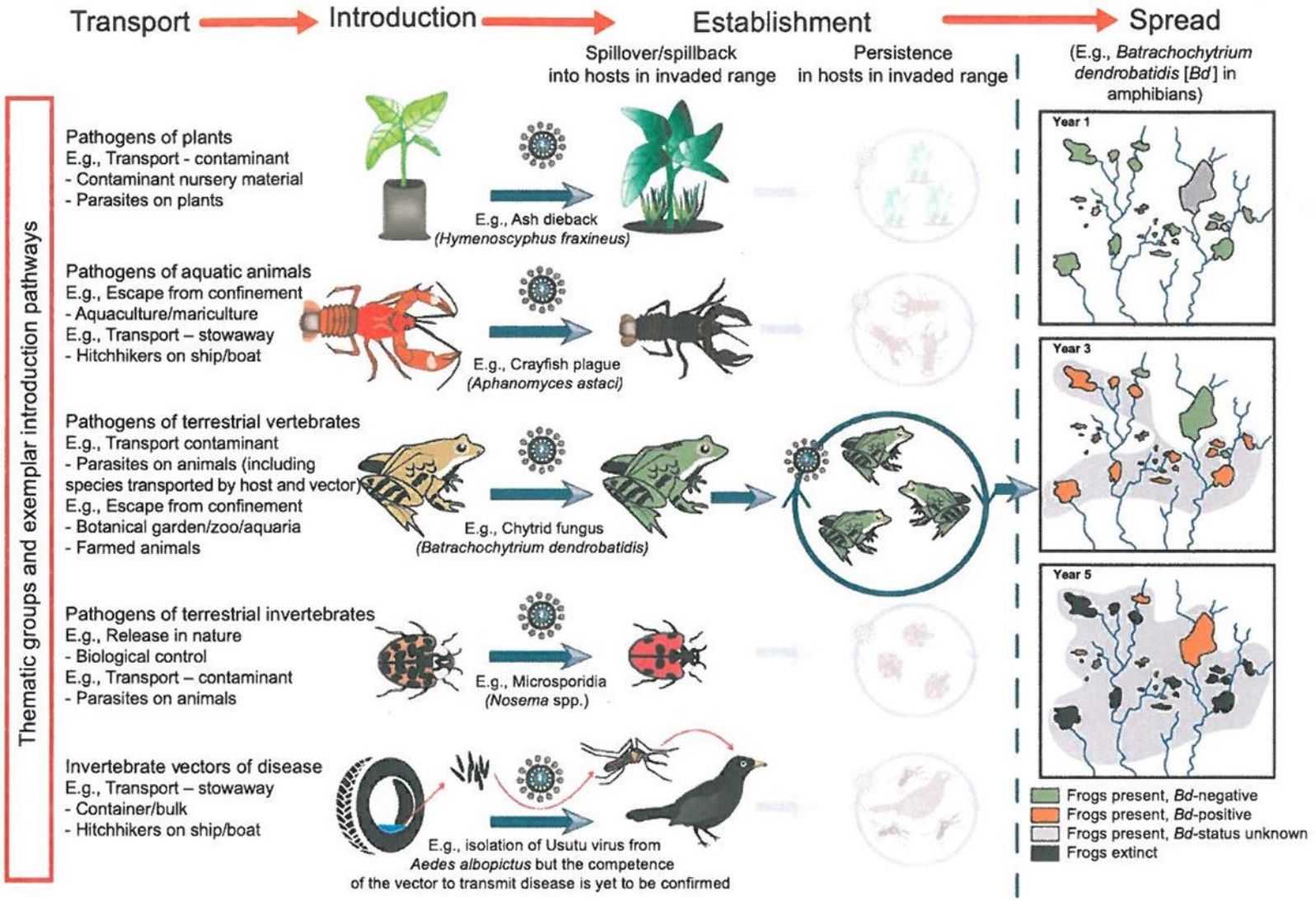
Study on Invasive Alien Species – Development of risk assessments to tackle priority species and enhance prevention

Contract No 07.0202/2016/740982/ETU/ENV.D2

Final Report

Horizon-scanning can be defined as a systematic examination of potential threats and opportunities, within a given context, and likely future developments which are at the margin of current thinking and planning. Horizon scanning may explore novel and unexpected issues, as well as persistent problems and trends.


Acknowledge that some invasion events are very difficult to predict
Transport
Introduction
Establishment
Spread
Spillover/spillback into hosts in invaded range
Persistence in hosts in invaded range
1. Baseline information needed on taxa in source range with potential to be pathogenic
2. Improved understanding of pathway dynamics and networks leading to introduction
5. Need for predictive approaches to understanding pathogen host specificity and potential for host shift
3. Baseline information needed on distribution and population dynamics of pathogens, hosts, and vectors
6. Need for predictive approaches to understanding potential for ecological and evolutionary adaptation in the invaded range
4. Improved understanding of life history traits of pathogens
Policy recommendations
• Build global interdisciplinary capacity, expertise, and coordination for wildlife pathogens
• Implement global long-term monitoring and surveillance of host and 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 and increase awareness among policy and decision makers, wildlife managers, scientists, and citizens
• Improve representation of wildlife pathogens within One Health initiatives, legislation, policy, and management frameworks
7. Improved understanding of transmission dynamics in the environmental conditions in the invaded range
8. Baseline information needed on recipient population, community, and ecosystem dynamics
9. Improved understanding of distribution, abundance, and population dynamics of pathogens, vectors, and hosts in the invaded range
10. Improved understanding of pathogenicity and virulence in hosts from the invaded range


Transport
Introduction
Establishment
Spillover/spillback into hosts in invaded range
Persistence in hosts in invaded range
Spread
(E.g., Batrachochytrium dendrobatidis [Bd] in amphibians)
Thematic groups and exemplar introduction pathways
Pathogens of plants
E.g., Transport - contaminant
- Contaminant nursery material
- Parasites on plants
E.g., Ash dieback
(Hymenoscyphus fraxineus)
Pathogens of aquatic animals
E.g., Escape from confinement
- Aquaculture/mariculture
E.g., Transport – stowaway
- Hitchhikers on ship/boat
E.g., Crayfish plague
(Aphanomyces astaci)
Pathogens of terrestrial vertebrates
E.g., Transport contaminant
- Parasites on animals (including species transported by host and vector)
E.g., Escape from confinement
- Botanical garden/zoo/aquaria
- Farmed animals
E.g., Chytrid fungus
(Batrachochytrium dendrobatidis)
Pathogens of terrestrial invertebrates
E.g., Release in nature
- Biological control
E.g., Transport – contaminant
- Parasites on animals
E.g., Microsporidia
(Nosema spp.)
Invertebrate vectors of disease
E.g., Transport – stowaway
- Container/bulk
- Hitchhikers on ship/boat
E.g., isolation of Usutu virus from Aedes albopictus but the competence of the vector to transmit disease is yet to be confirmed
Year 1
Year 3
Year 5
Frogs present, Bd-negative
Frogs present, Bd-positive
Frogs present, Bd-status unknown
Frogs extinct

A team selected species for consideration

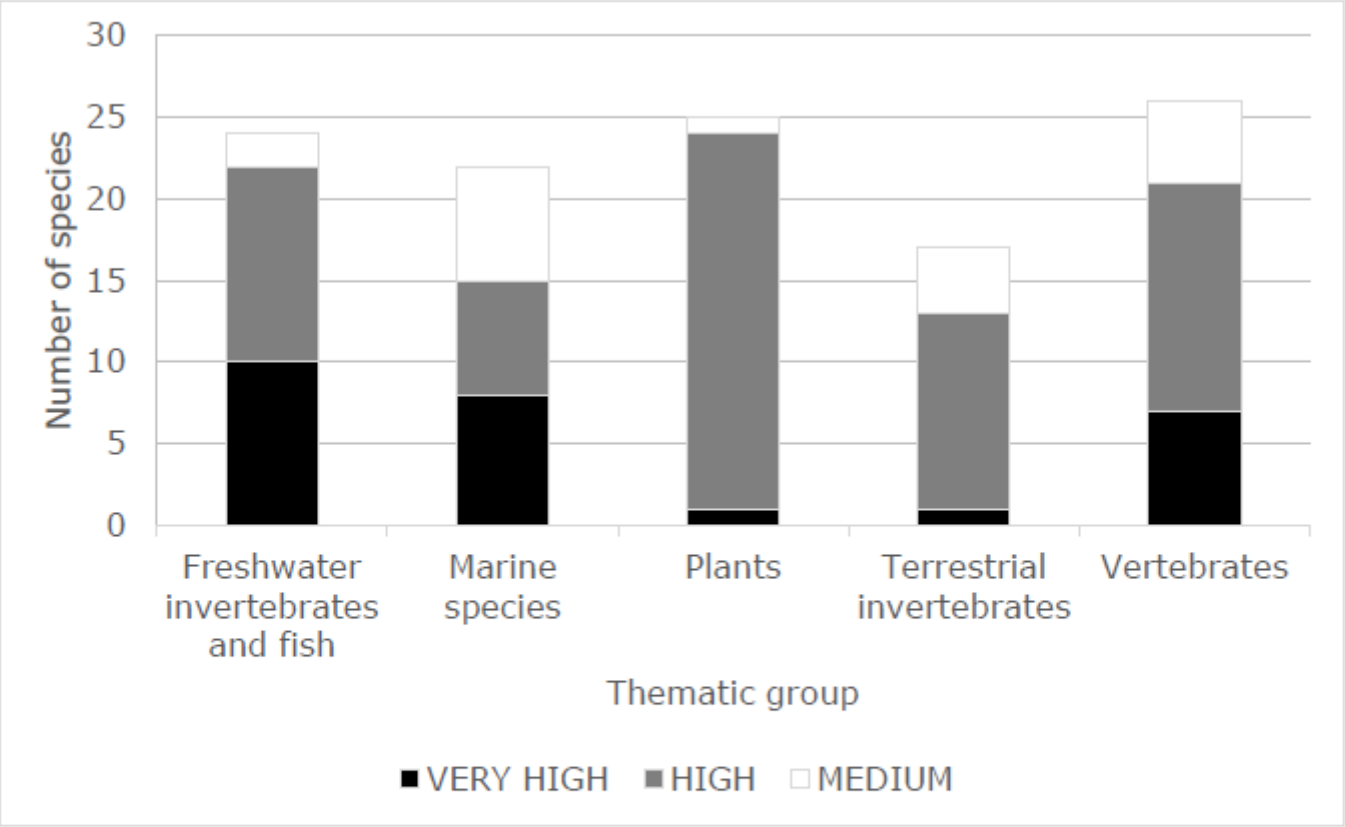


Figure 5.2 Number of species agreed by consensus for each thematic group (Freshwater invertebrates and fish, Marine species, Plants, Terrestrial invertebrates, Vertebrates) to represent very high, high or medium probability of arrival, establishment, spread and threat to biodiversity and associated ecosystem services across the EU within the next ten years.

Horizon scan

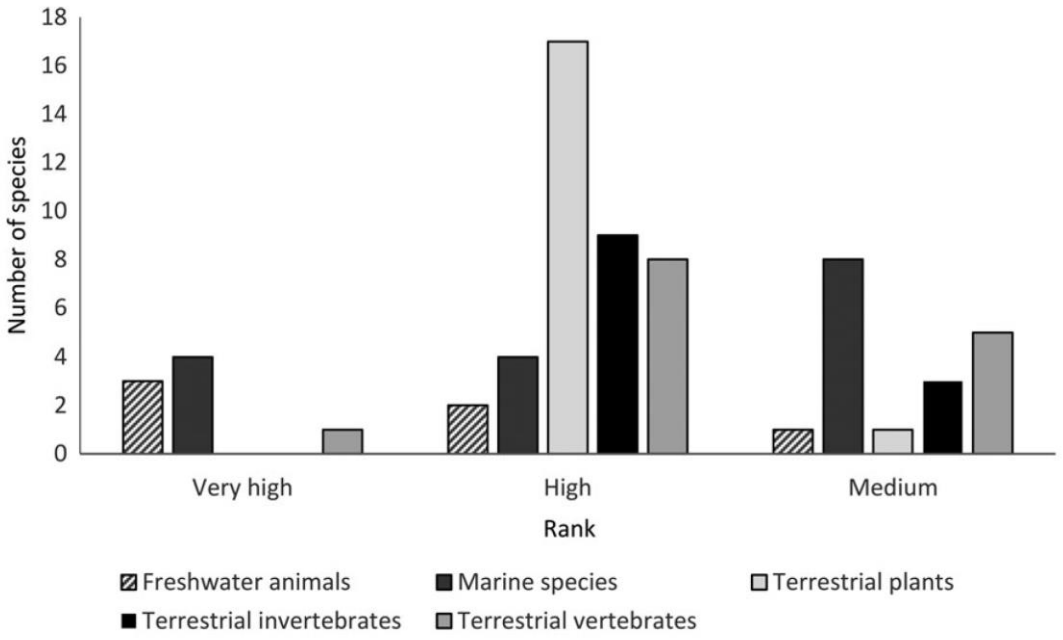


FIGURE 2 Number of species absent from Europe (n = 66) that were considered to have a very high, high or medium probability of arrival, establishment, spread and magnitude of impact on biodiversity and ecosystem services across thematic groups

Roy et al 2018

Horizon scan

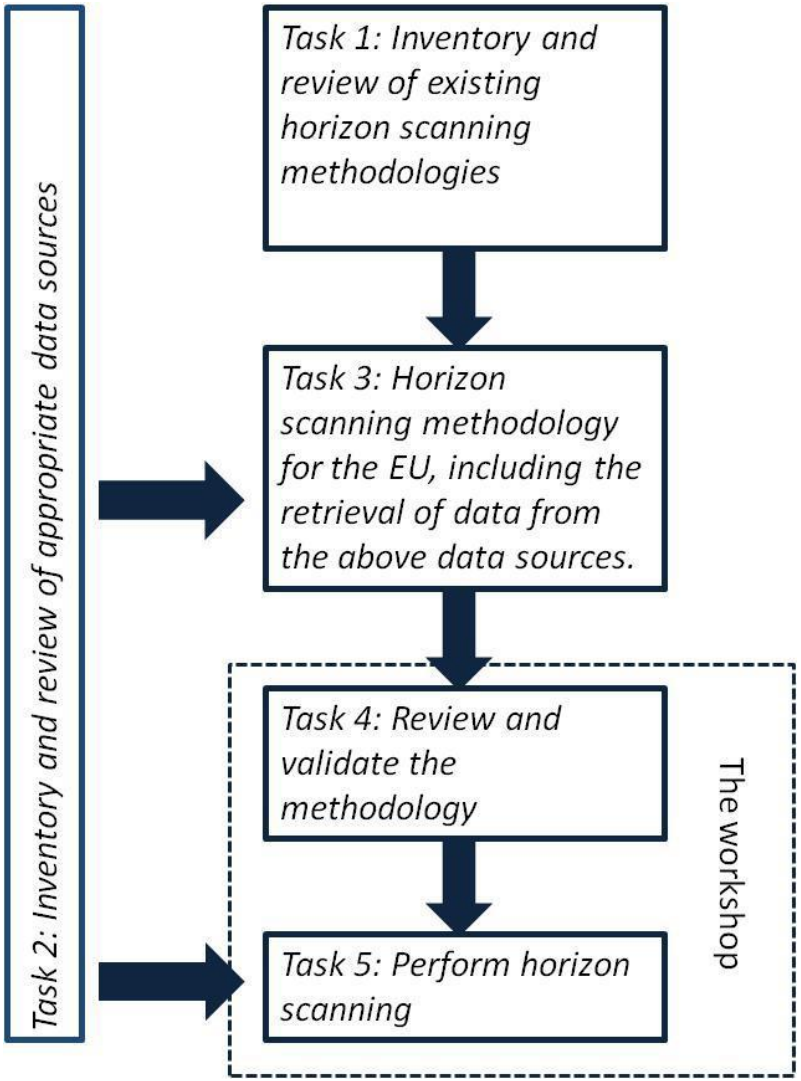


Table 3.7 Descriptors of the five point impact scoring system circulated to the thematic groups for implementation during the preliminary scoring phase of the horizon scanning (Minimal concern =1; Minor =2; Moderate = 3; Major = 4; Massive = 5)

Target of impact	Impact score	Definition
Impact on common species and habitats	Minimal concern	Localised and moderate (or regional and minor) losses, easy to reverse
	Minor	Regional and moderate losses, difficult to reverse
	Moderate	Regional and major (or widespread and moderate) losses, difficult to reverse
	Major	Widespread and major losses, irreversible
	Massive	Not achievable for common species and habitats
Impact on species and habitats of conservation importance	Minimal concern	Localised and minor losses, easy to reverse
	Minor	Localised and moderate (or regional minor) losses, difficult to reverse
	Moderate	Regional and moderate losses, difficult to reverse
	Major	Regional and major (or widespread moderate) losses, difficult to reverse
	Massive	Widespread and major losses, irreversible
Impact on ecosystem function	Minimal concern	Minimal change of function
	Minor	Minor change of function
	Moderate	Moderate change of function
	Major	Major change of function
	Massive	Massive change of all important ecosystem function

Method	Detail	Strength	Weakness
Interview	One-to-one questioning; structured without debate or open	Good at getting key individuals perspectives on the future	No interaction between participants; possible bias due to selection of experts
Open fora	Online platform (Wiki)	Wisdom of the crowd, broadest possible range of contributors	Unstructured without quality control
Questionnaire	Expert consultation through pre-defined questions	Provides an overview of opinion on a specific theme	No interaction; possible bias due to selection of experts and how questions are phrased
Literature review	Extensive review of existing literature	Broad approach underpinned by existing knowledge (if peer-reviewed)	Unavailability of published reports or expert opinion; delay between observation and publication
Modelling approach	Quantitative approach to derive predictions	Available data used to construct models to derive predictions	Depends on detailed life-history datasets which for many species are lacking
Survey and experiment	Surveys of the environment in some cases coupled with experimentation	Realistic data derived	Labour intensive and expensive

Table 3.5 Confidence scores accompanied by examples to provide context based on the proposed unified framework for environmental impacts (Blackburn et al. 2014) and the EPPO Pest Risk Assessment Decision Support Scheme (EPPO 2011).

Confidence Score	Examples
High	There is direct relevant evidence to support the assessment. The situation can easily be predicted. There are reliable/good quality data sources on impacts of the species. The interpretation of data/information is straightforward. Data/information are not controversial, contradictory.
Medium	There is some evidence to support the assessment. Some information is indirect, e.g. data from phylogenetically or functionally similar species have been used as supporting evidence. The interpretation of the data is to some extent ambiguous or contradictory.
Low	There is no direct evidence to support the assessment, e.g. only data from other species have been used as supporting evidence. Evidence is poor and difficult to interpret, e.g. because it is strongly ambiguous. The information sources are considered to be of low quality or contain information that is unreliable.

New Zealand Flatworm
New Zealand fladorm
Arthurdendyus triangulatus

Fire ants
Solenopsis spp.
'Ildmyre'

White-lined silk moth
Dendrolimus superans

Siberian silk moth
Dendrolimus sibiricus

Chital deer
Axis axis
Chital hjort

Common kingsnake
Lampropeltis getula
'Kongesnog'

House crow
Corvus splendens

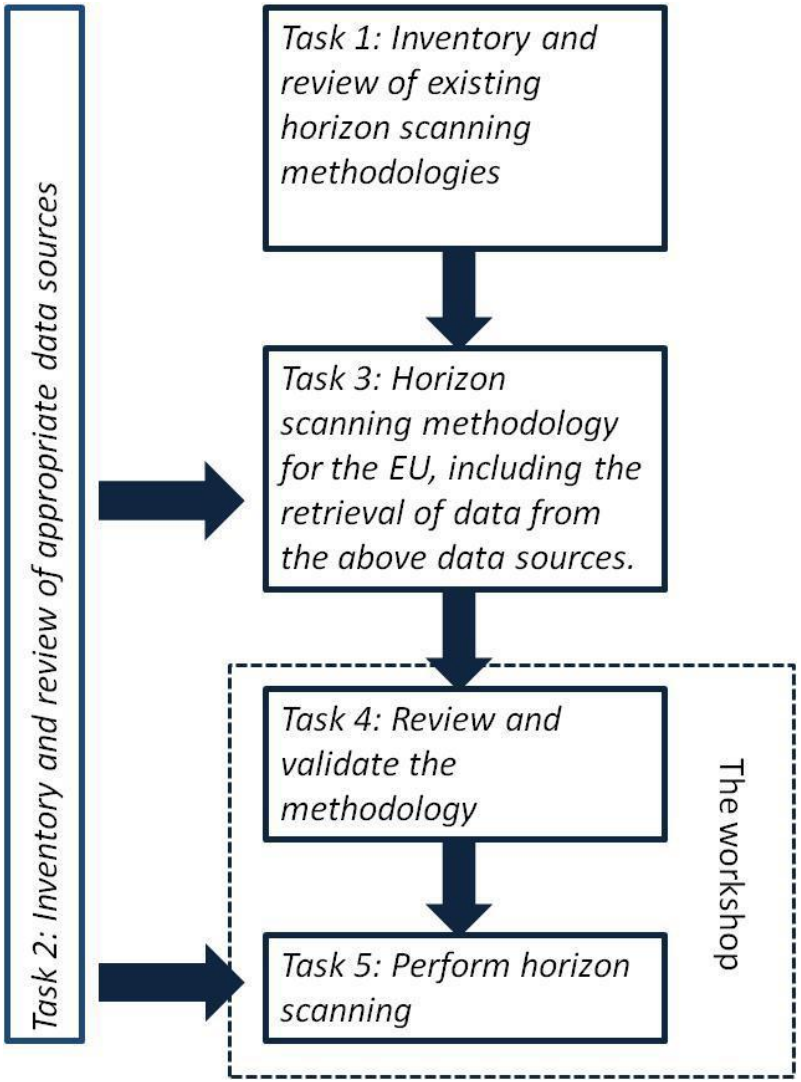
Small Asian mongoose (*Herpestes javanicus*

Step one: ranking species within same group of organisms

Vertebrates

Species	Common name	Taxonomic group	Functional group	Native distribution	Already present in EU?	Initial Overall impact on biodiversity score (A*B*C*D)
Axis axis	Axis deer	Mammals	Herb	As	Yes	625
Castor canadensis	American beaver	Mammals	Herb	NAm	Yes	625
Cervus nippon	Sika deer	Mammals	Herb	As	Yes	625
Corvus splendens	House Crow	Birds	Omni	As	Yes	625
Herpestes	Egyptian	Mammals	Pred	Afr	No	625

Horizon scan



Step 2

Ranking all organisms in one list

Plants, invertebrates, vertebrates, aquatic species

Horizon scan: The species ranking highest

1 Channa argus. The **northern snakehead** is a species of fish native to southern and eastern China but now also widely distributed in Japan within shallow, marshy ponds and wetlands, where it preys on native fish species.

2 Limnoperna fortunei. The **golden mussel** is native to China and south-eastern Asia but became established in Hong Kong in 1965, and Japan and Taiwan in the 1990s. Subsequently, it invaded the United States and South America. It alters native fauna with an impact on the freshwater food web.

Horizon scan: The species ranking highest

3 Orconectes rusticus. The **rusty crayfish**, native to the United States but now found in Canada, is a large and aggressive species of freshwater crayfish, which is more successful in deterring attack from predators than other crayfish and therefore outcompetes native species.

4 Plotosus lineatus. The **striped eel catfish** is native to the Indian Ocean but was first recorded in the Mediterranean in 2002 and subsequently spread rapidly along the entire Israeli coast. This venomous catfish now inhabits all sandy and muddy substrates contributing to species declines through competition and displacement

Horizon scan: The species ranking highest

5 Codium parvulum. This **green seaweed** native to the Indo-Pacific Ocean and subsequently described from the Red Sea, has since been recorded off the northern shores of Israel in the Mediterranean and along the Lebanese coast. It is considered an ecosystem engineer, altering the structure and functionality of ecosystems.

6 Crepidula onyx. The **onyx slipper snail** is native to the southern coast of California and northern Pacific Coast of Mexico. It is now widespread and considered highly invasive in Asia where it has been reported from Korea, Japan and Hong Kong. Slipper snails are sedentary filter-feeders and change native ecosystems.

Horizon scan: The species ranking highest

7 Mytilopsis sallei. The **black striped mussel** described from the Pacific coast of Panama is a brackish species that invaded the Indo-Pacific Ocean during the 1900s and has reached Fiji, India, Malaysia, Taiwan, Japan, and Australia. In some of these coastal areas the species completely dominates since it can survive extreme environmental conditions.

8 Sciurus niger. The **fox squirrel** native to eastern and central North America, competes for resources with the native western gray (*S. griseus*) and Douglas squirrels (*Tamiasciurus douglasii*).

Horizon scan: The species ranking highest

10 Albizia lebbeck. **Woman's tongue** probably originated in tropical Asia. Its uses include environmental management, forage, medicine and wood. It was introduced for forestry or erosion control in many countries. Fast-growing and reaching 18 to 30m in height, it is now naturalised mainly in dry tropical regions and can invade natural and semi-natural environments, like Florida Keys

Solenopsis ants ranked much lower

Name of organism: *Solenopsis richteri,* Forel, 1909.

S. richetri worker, credits : Alex Wild

Author(s) of the assessment:
Olivier Blight, Dr, Institut Méditerranéen de Biodiversité et d'Ecologie, Avignon University, France

Risk Assessment Area:
The risk assessment area is the territory of the European Union, excluding the outermost regions.

Peer review 1: Wolfgang Rabitsch, Environment Agency Austria, Vienna, Austria
Peer review 2: Jørgen Eilenberg, University of Copenhagen, Denmark
Peer review 3: Richard Shaw, CABI, UK
Peer review 4: Marc Kenis, CABI, Switzerland

	RESPONSE	CONFIDENCE
Summarise Entry	very unlikely unlikely **moderately likely** likely very likely	low **medium** high

Summarise Impact	minimal minor **moderate** major massive	**low** medium high

1.3a. Is introduction along this pathway intentional (e.g. the organism is imported for trade) or unintentional (e.g. the organism is a contaminant of imported goods)? (if intentional, only answer questions 1.4, 1.9, 1.10, 1.11 – delete other rows)	intentional **unintentional**	low medium **high**

Biodiversity and ecosystem impacts		
2.13. How important is impact of the organism on biodiversity at all levels of organisation caused by the organism in its non-native range excluding the risk assessment area?	minimal minor **moderate** major massive	**low** medium high

Conclusion

- Many invasive plants, animals and microorganisms may pose a future problem in the EU
- Horizon scan is a useful method to collect and evaluate data in a systematic way
- It is possible to make a ranking within organismal groups
- It is also possible to make a ranking across organismal groups, although such ranking gives challenges for the scientists involved
- Detailed risk analyses are ongoing for selected species

CA17122 Alien CSI

Chair: Helen Roy

Vice-chair: Quentin Groom

Working Groups

WG1: Engaging people in CS - Elizabete Marchante, Peter Brown

WG2: Approaches to CS - Tim Adriaens, Elena Tricarico

WG3: Data management and standards – Jan Pergl, Lien Reyserhove, Aletta Bonn

WG4: Analysis and visualisation – Franz Essl, Sven Jelaska, Michael Pocock

WG5: Cross-cutting CS initiative(s) for IAS across Europe - Bernat Claramunt, Alan Deidun