Plant invasion: what can the science tell to nature conservation practice?

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Invasion biology has knowledge on:

- invasiveness of species
- invasibility (vulnerability) of habitats
- factors influencing the effectiveness of control

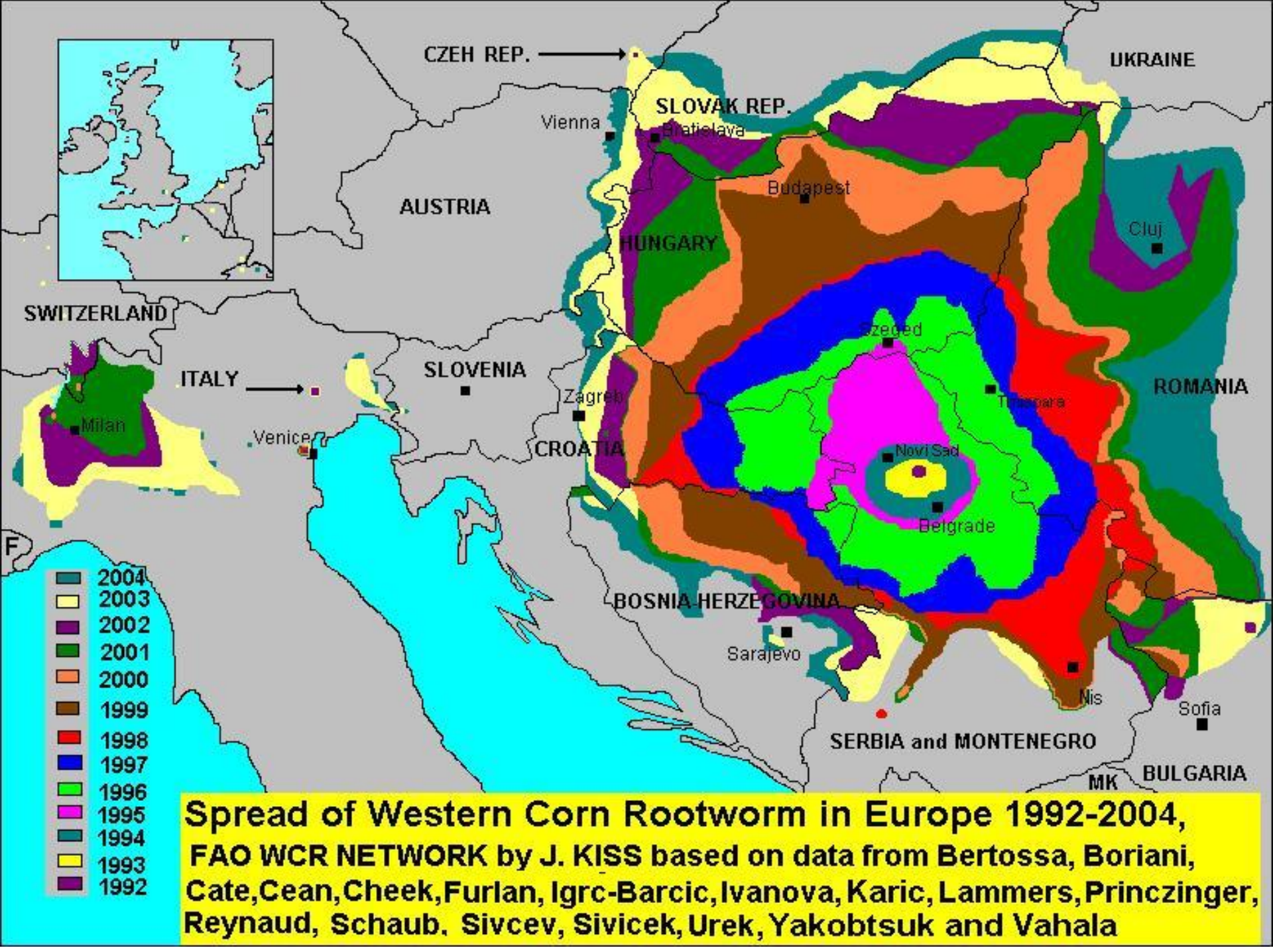
Communication between science and practice may be hindered by …

- Different terms are used in the two fields, or same words with different meaning
- Different aims: general understanding vs local forecasting of processes

Scientific definition of biological invasion

- Quick spread of a
- non-native species

- Effect on the native biota is not considered!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BULGARIA
Spread of Western Corn Rootworm in Europe 1992-2004,
FAO WCR NETWORK by J. KISS based on data from Bertossa, Boriani, Cate,Cean,Cheek,Furlan, Igrc-Barcic,Ivanova,Karic, Lammers,Princzinger, Reynaud, Schaub. Sivcev, Sivicek,Urek,Yakobtsuk and Vahala

Examples of observed speed of spread

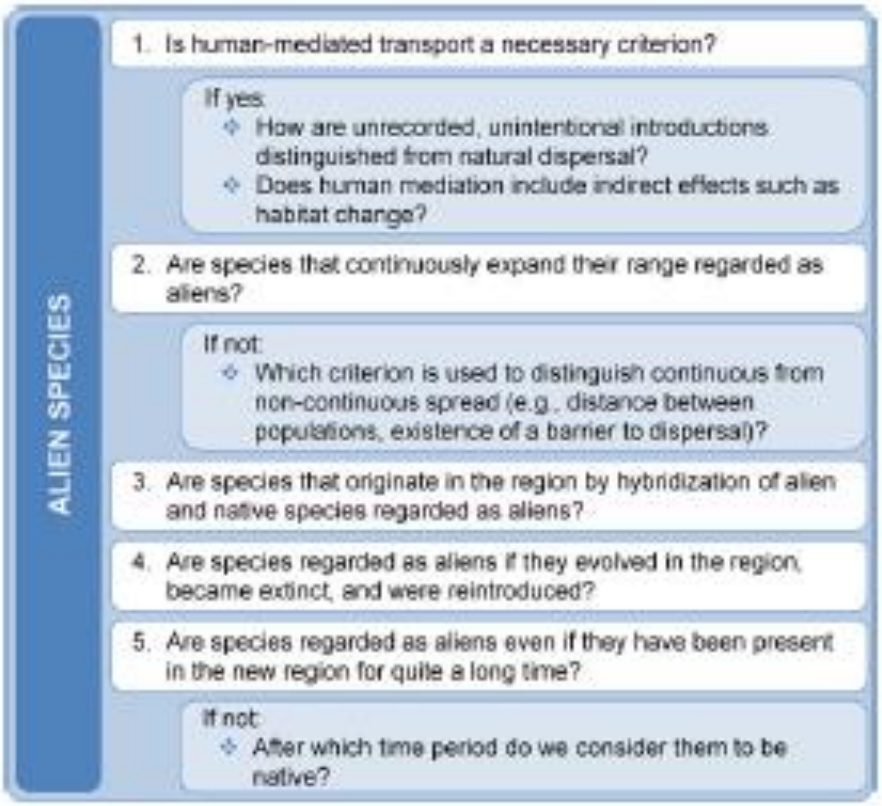
Species	Observed speed (km/year)
Himalayan balsam (*Impatiens glandulifera*)	9.4 – 32.9
gypsy moth (*Lymantria dyspar*)	9.6
guskrat (*Ondatra zibethica*)	0.9 – 25.4
cereal leaf beetle (*Oulema melanopus*)	26.5 – 89.5
small white (*Pieris rapae*)	14.7 – 170
rabies virus of foxes (*Rabies lyssa*)	30 – 60
grey squirrel (*Sciurus carolinensis*)	7.66
Eurasian collared dove (*Streptopelia decaocto*)	43.7
starling (*Sturnus vulgaris*)	200
Yersinia pestis	400

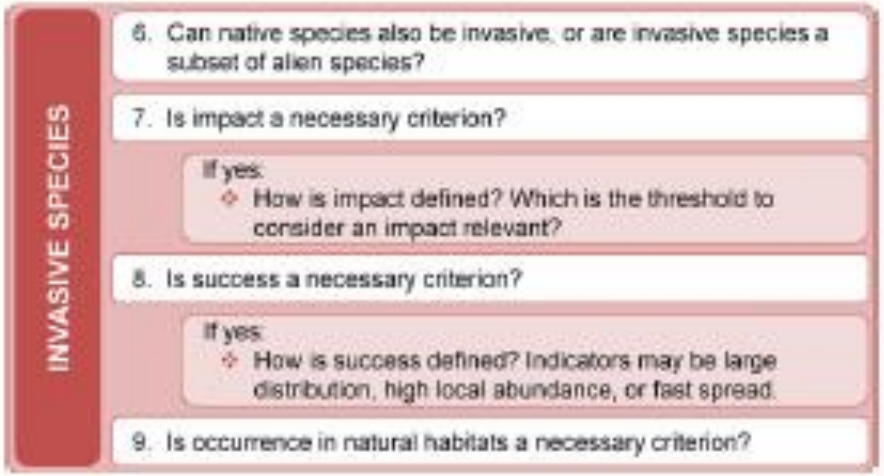
IUCN definitions

- "**Alien species" (non-native, non-indigenous, foreign, exotic)** means a species, subspecies, or lower taxon occurring outside of its natural range (past or present) and dispersal potential (i.e. outside the range it occupies naturally or could not occupy without direct or indirect introduction or care by humans) and includes any part, gametes or propagule of such species that might survive and subsequently reproduce.
- "**Alien invasive species"** means an alien species which becomes established in natural or semi-natural ecosystems or habitat, is an agent of change, and threatens native biological diversity.

- Source: IUCN Guidelines for the prevention of biodiversity loss caused by alien invasive species http://intranet.iucn.org/webfiles/doc/SSC/SSCwebsite/Policy_statements/IUCN_Guidelines_for_the_Prevention_of_Biodiversity_Loss_caused_by_Alien_Invasive_Species.pdf

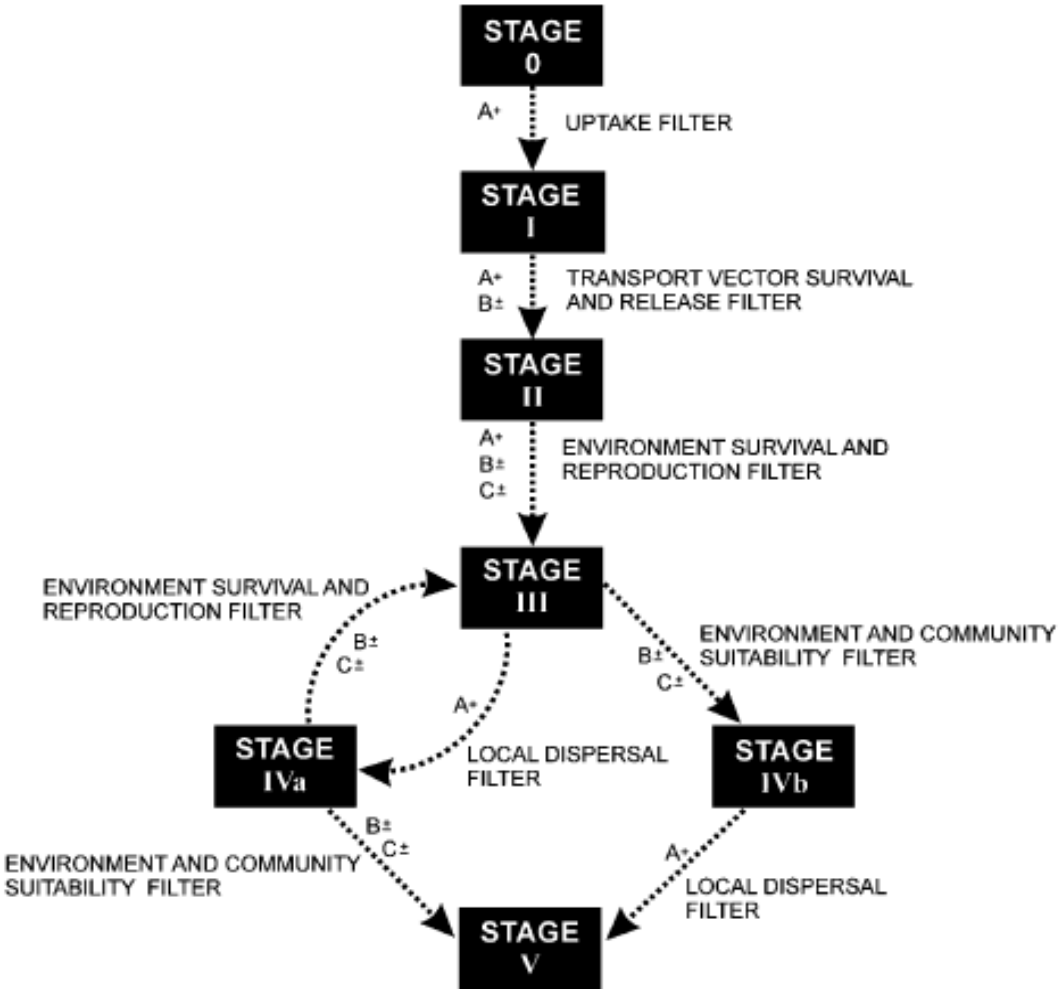
Solution: clear definitions in each work





Heger, T. et al. 2013. Conceptual Frameworks and Methods for Advancing Invasion Ecology. *Ambio* **42**:527-540.

Stages of the invasion process



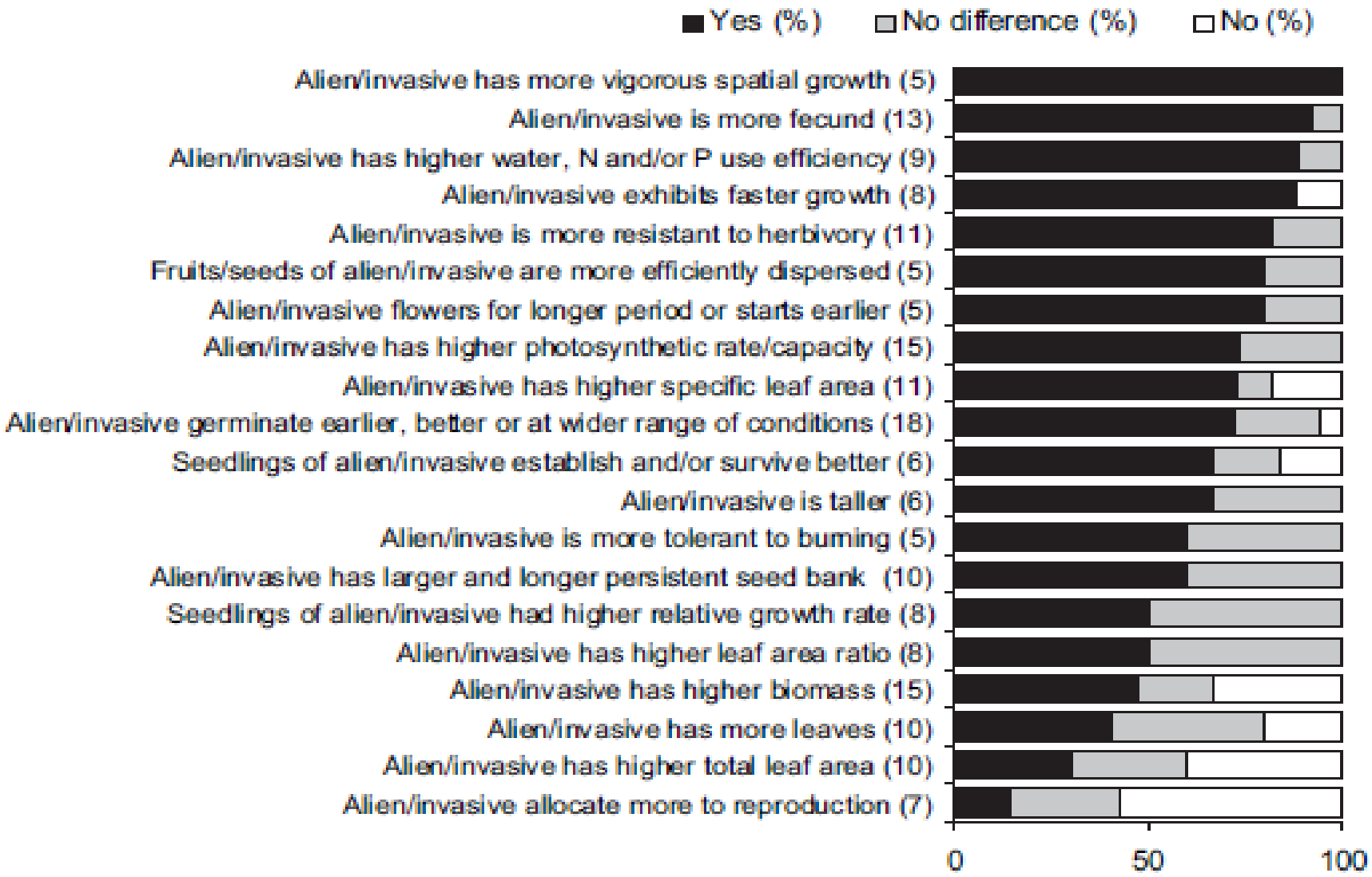
Colautti, R. I. and MacIsaac, H. J. 2004. A neutral terminology to define 'invasive' species *Diversity and Distributions* **10**:135-141.

Invasiveness of species

Two possible questions

- Which traits make possible survive and spread of species in a new area?
  - the aim is understanding the process
  - searching for general trends
  - Only traits functionally related to success of invasion are considered
- How could we forecast the invasive species of the future?
  - Predictive power, not functional role is the selection criteria
  - Local forecast

Alien vs native comparisons within genera



Pyšek, P. & Richardson, D. M. 2007. **Traits Associated with Invasiveness in Alien Plants: Where Do we Stand? In:** W.Nentwig (Ed.) *Biological Invasions*, Springer-Verlag Berlin Heidelberg

Approaches of forecasting

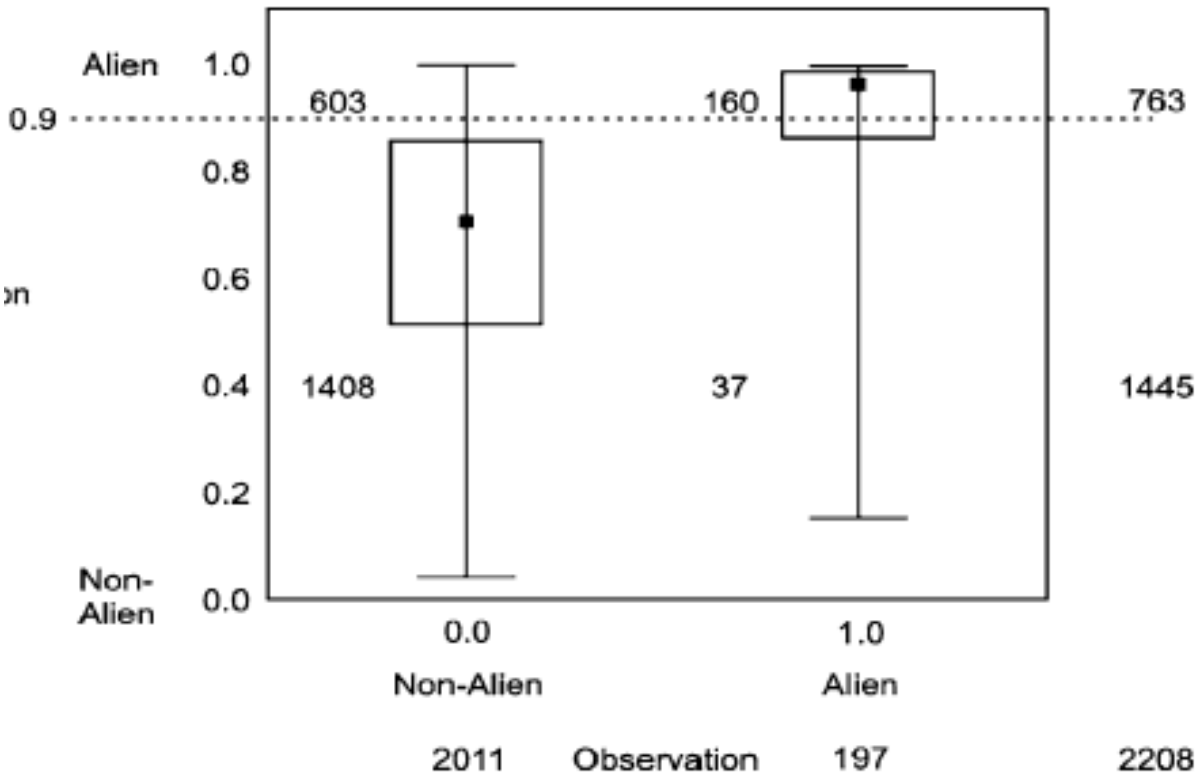
- Statistical modelling
  - The output is probability that may be converted to binary value
  - Quality of the prediction is in the focus, not significance of the predictor
  - Small effect may be significant in large samples, but does not lead to good prediction
- Scoring
- Detailed evaluation by expert (e.g. EPPO)

Quality of the prediction

- sensitivity = # true positive/# positive
- specificity = # true negative/# negative
- accuracy = (# true positive + # true negative)/ # species

- If the predicted case is rare, relative number of false negatives may be high. Therefore someone rather doubt that it is possible to predict invasions.

An example: invasion of plant species native in Germany to Argentina

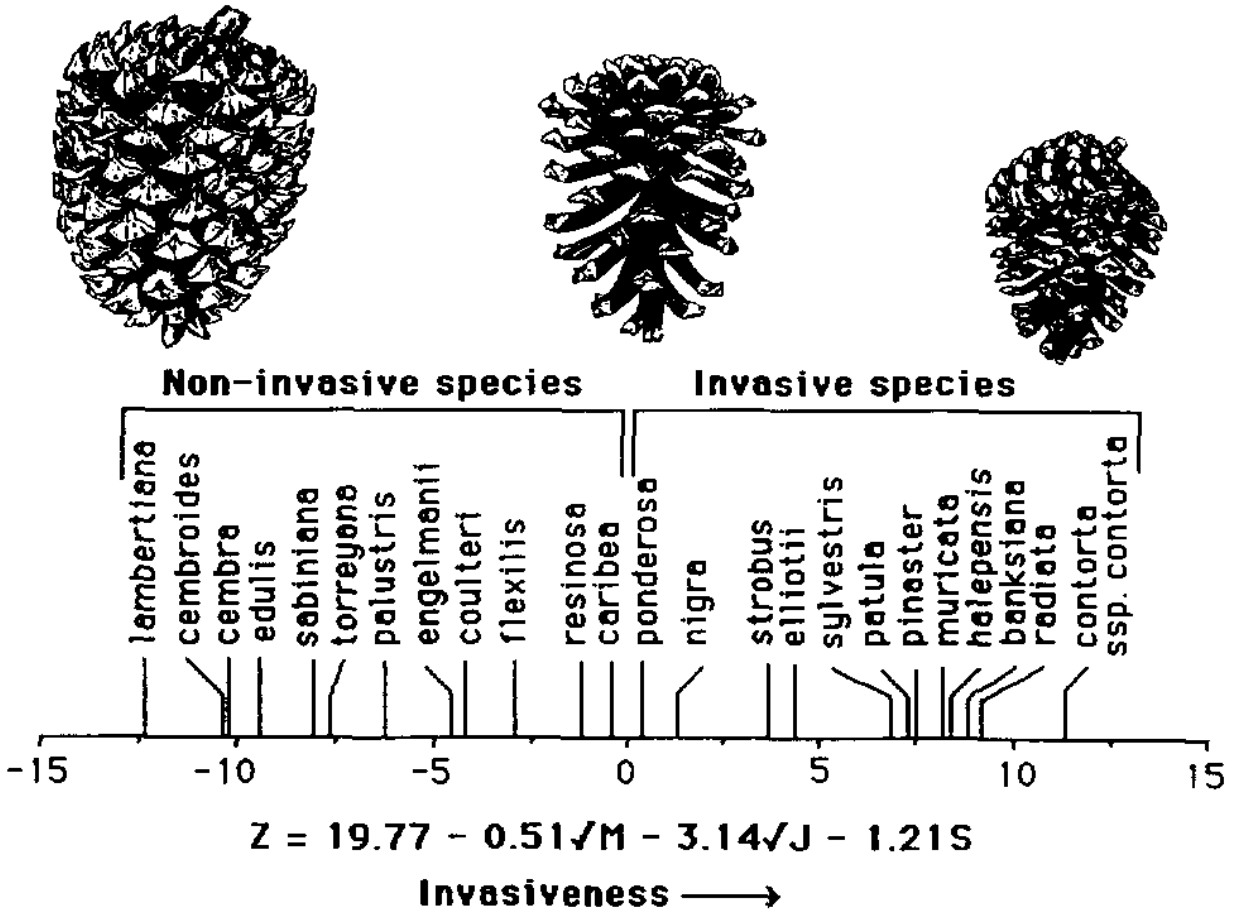


sensitivity = 160/197 = 81%
specificity = 70%
accuracy = 71%

precision = 21%
(only 160 of 763 species)

Prinzing A, Durka W,Klotz S and Brandl R(2002) Which species become aliens? *Evolutionary Ecology Research* 4: 385–405

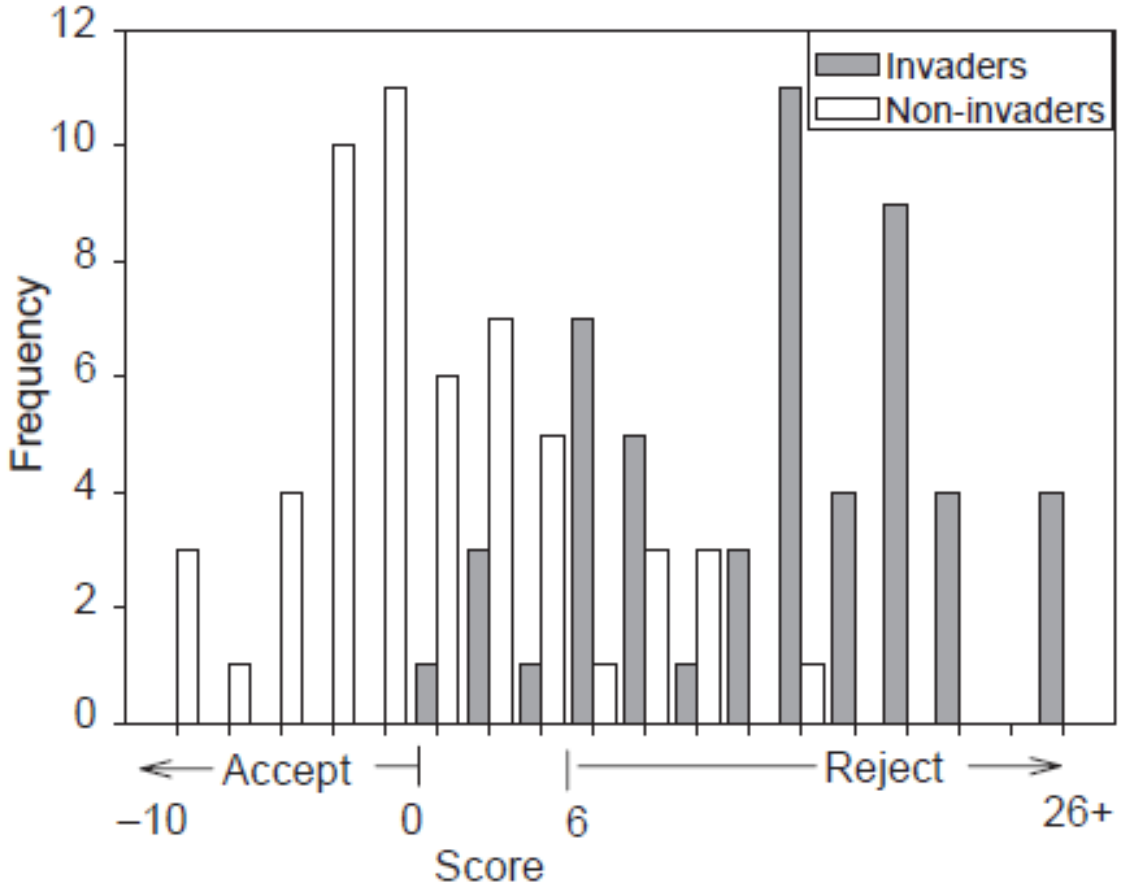
Successful application of a statistical model: pines in the Southern Hemisphere



M = seed mass (mg); S = mean interval between large seed crops (year); J = minimum length of juvenile period (year)

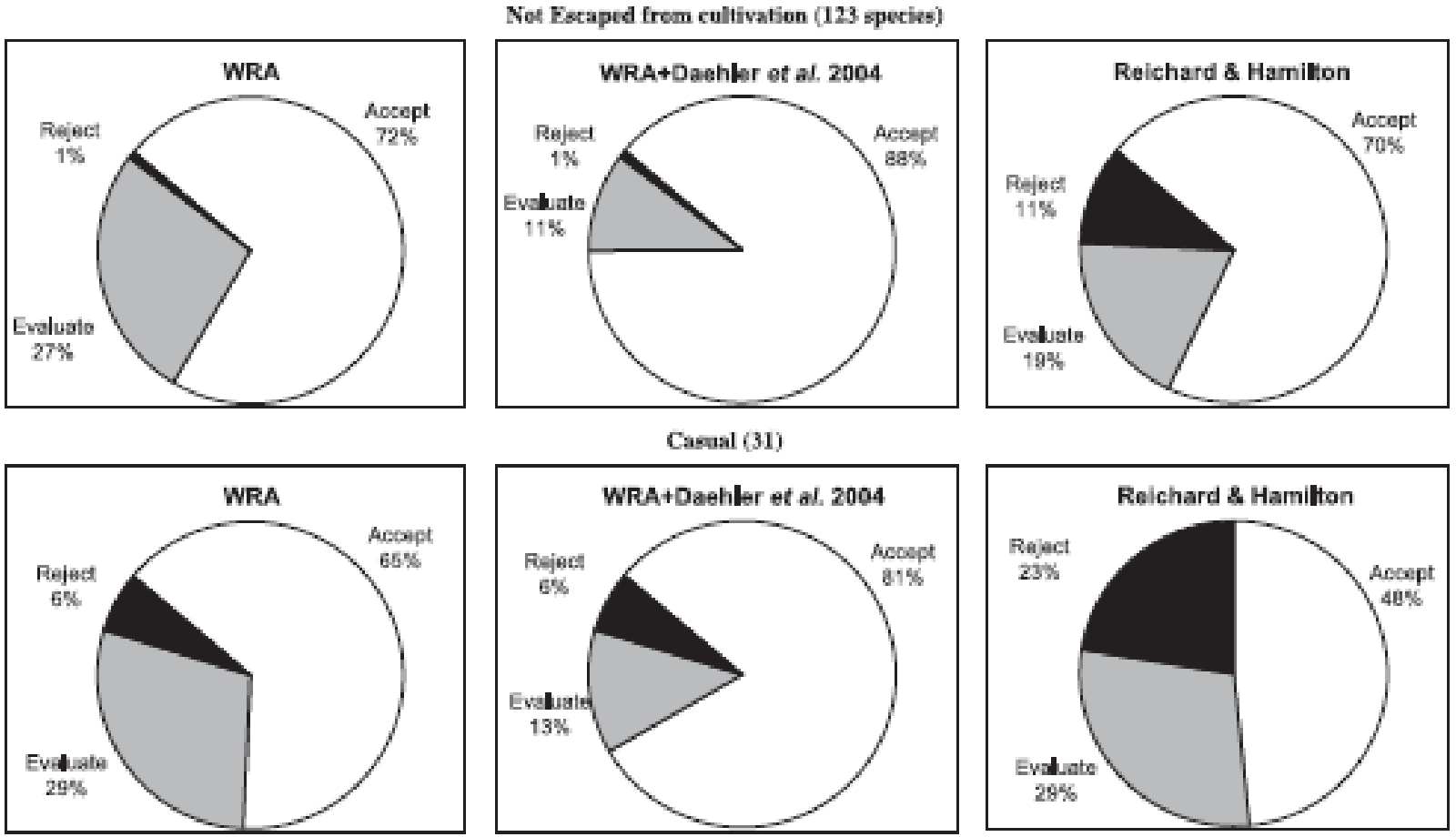
Rejmánek, M. 1996. A theory of seed plant invasiveness: the first sketch. *Biological Conservation* 78:171-181.

WRA scoring developed for Australia, tested in Hawaii



Daehler, C. C. and Carino, D. A. 2000. Predicting invasive plants prospects for a general screening system based on current regional models *Biological Invasions* 2:93–102.

Testing of scoring systems on alien trees in Czech Republic



Křivánek, M. & Pyšek, P. 2006. Predicting invasions by woody species in a temperate zone: a test of three risk assessment schemes in the Czech Republic (Central Europe) *Diversity and Distributions* 12: 319–327

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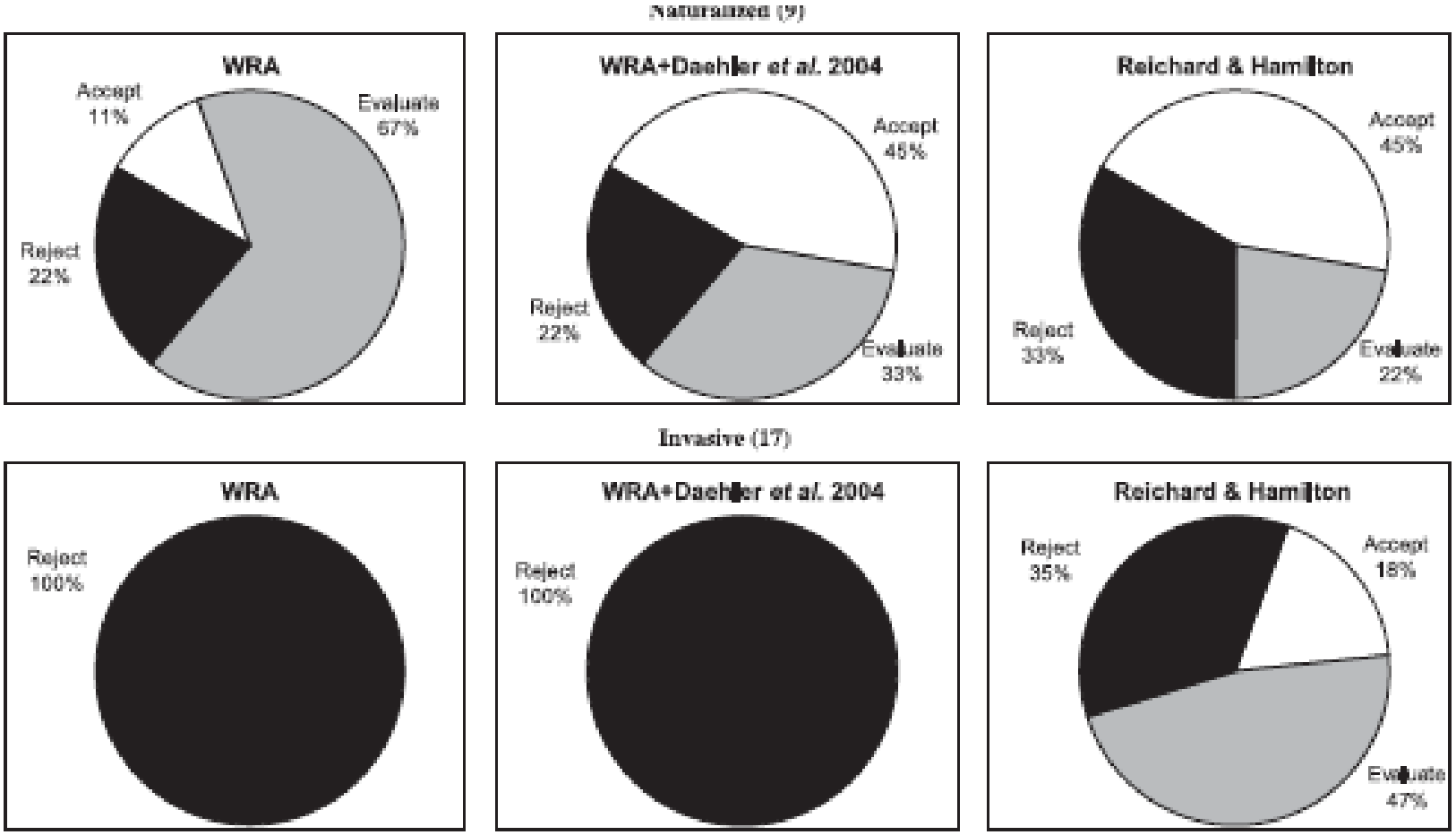
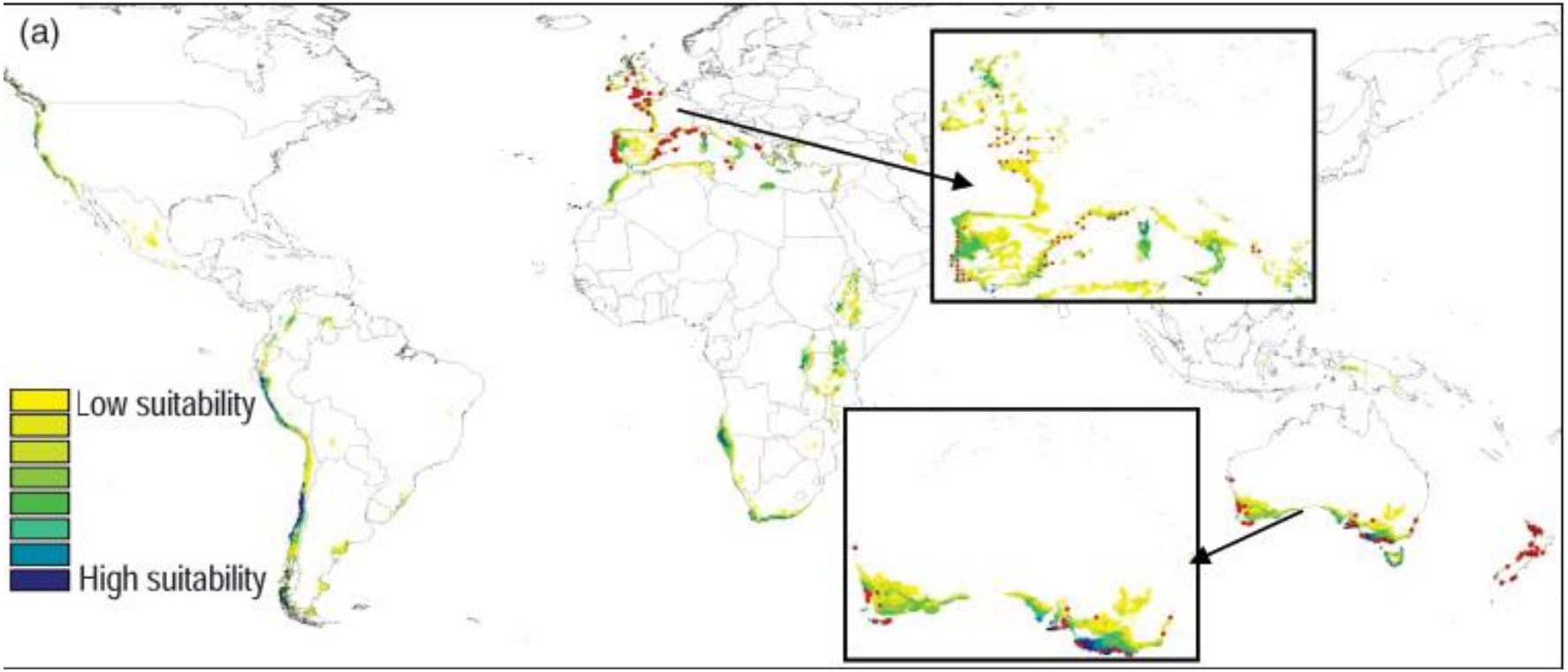


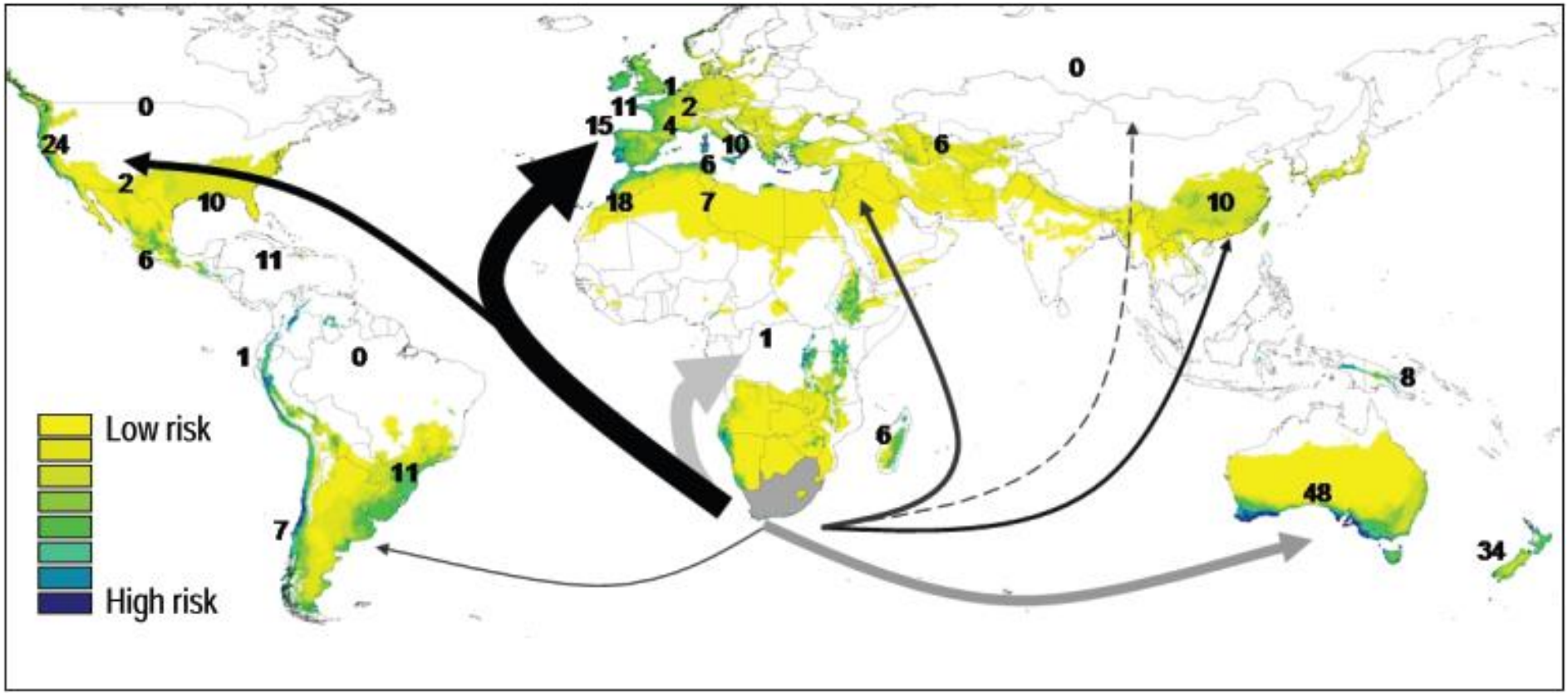
Křivánek, M. & Pyšek, P. 2006. Predicting invasions by woody species in a temperate zone: a test of three risk assessment schemes in the Czech Republic (Central Europe) *Diversity and Distributions* 12: 319–327

Climatic matching – *Carpobrotus edulis*



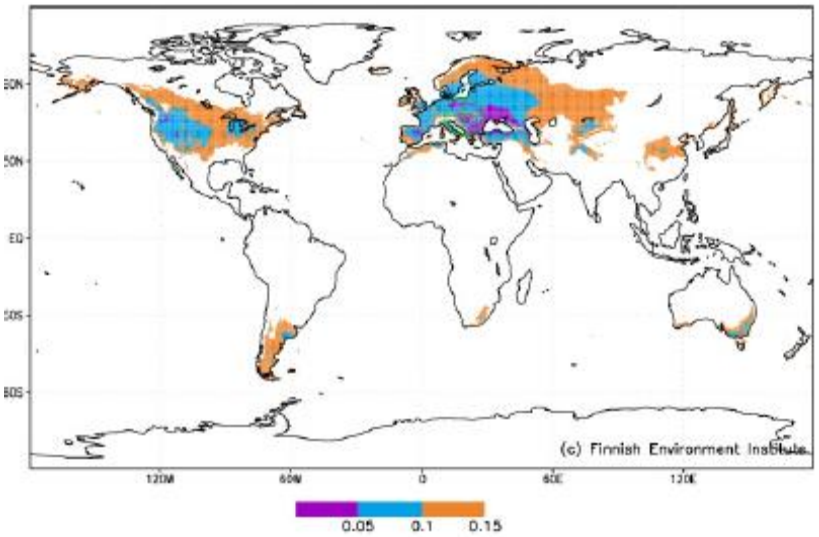
Thuiller, W., Richardson, D. M. , Pyšek, P. , Midgley, G. F., Hughes, G. O. & Rouget, M. 2005 Niche-based modelling as a tool for predicting the risk of alien plant invasions at a global scale. *Global Change Biology* 11:2234–2250

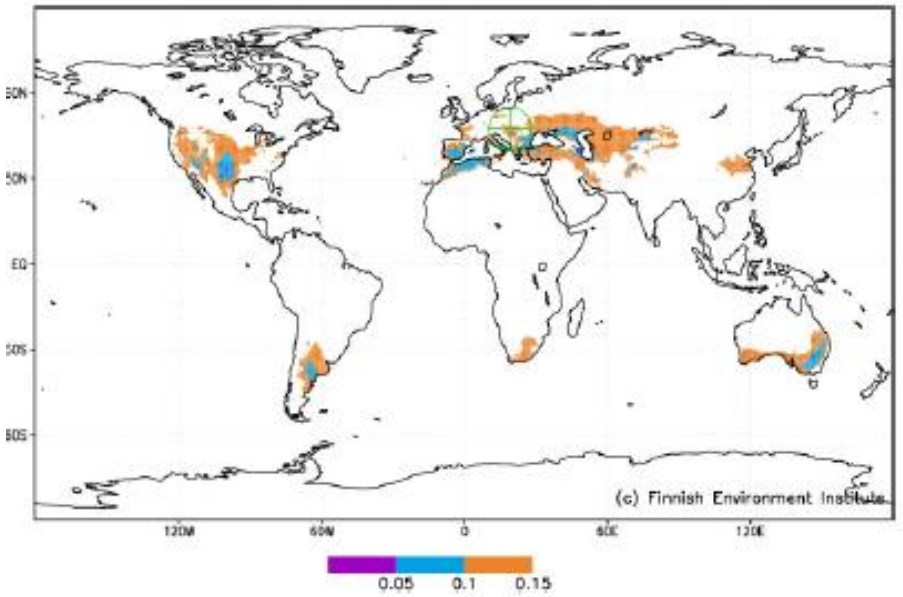
Probability of introduction



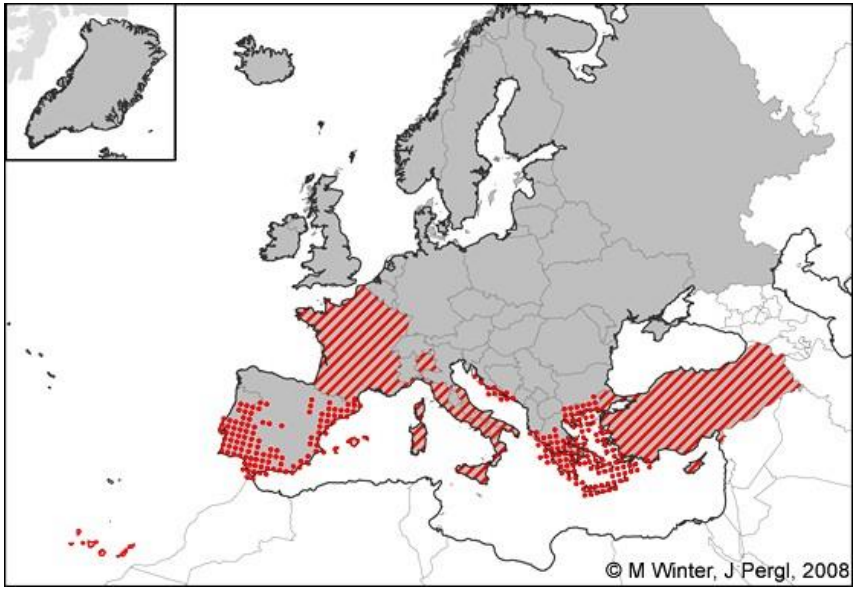
Thuiller, W., Richardson, D. M. , Pyšek, P. , Midgley, G. F., Hughes, G. O. & Rouget, M. 2005 Niche-based modelling as a tool for predicting the risk of alien plant invasions at a global scale. *Global Change Biology* 11:2234–2250

Areas with climate similar to Budapest's recent climate and climate predicted to 2100

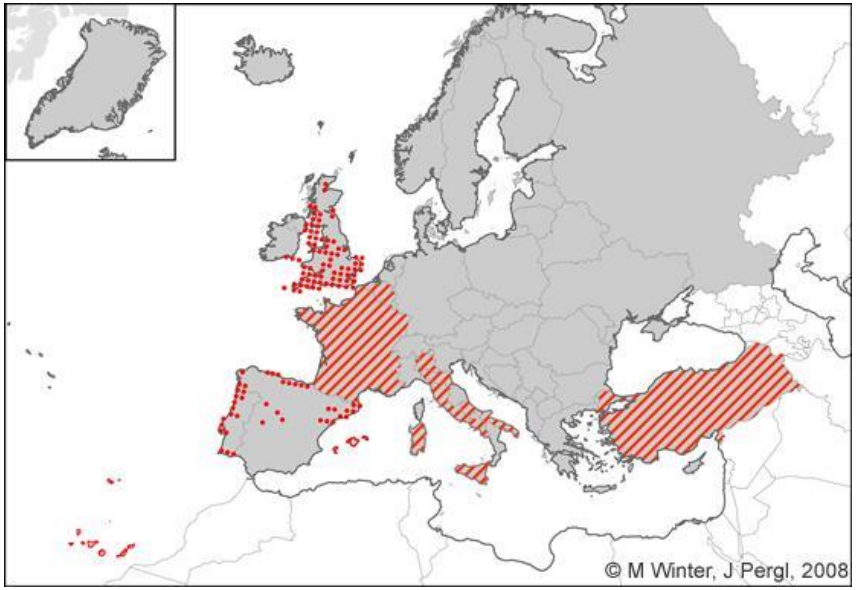




Opuntia ficus-indica



Cortaderia selloana

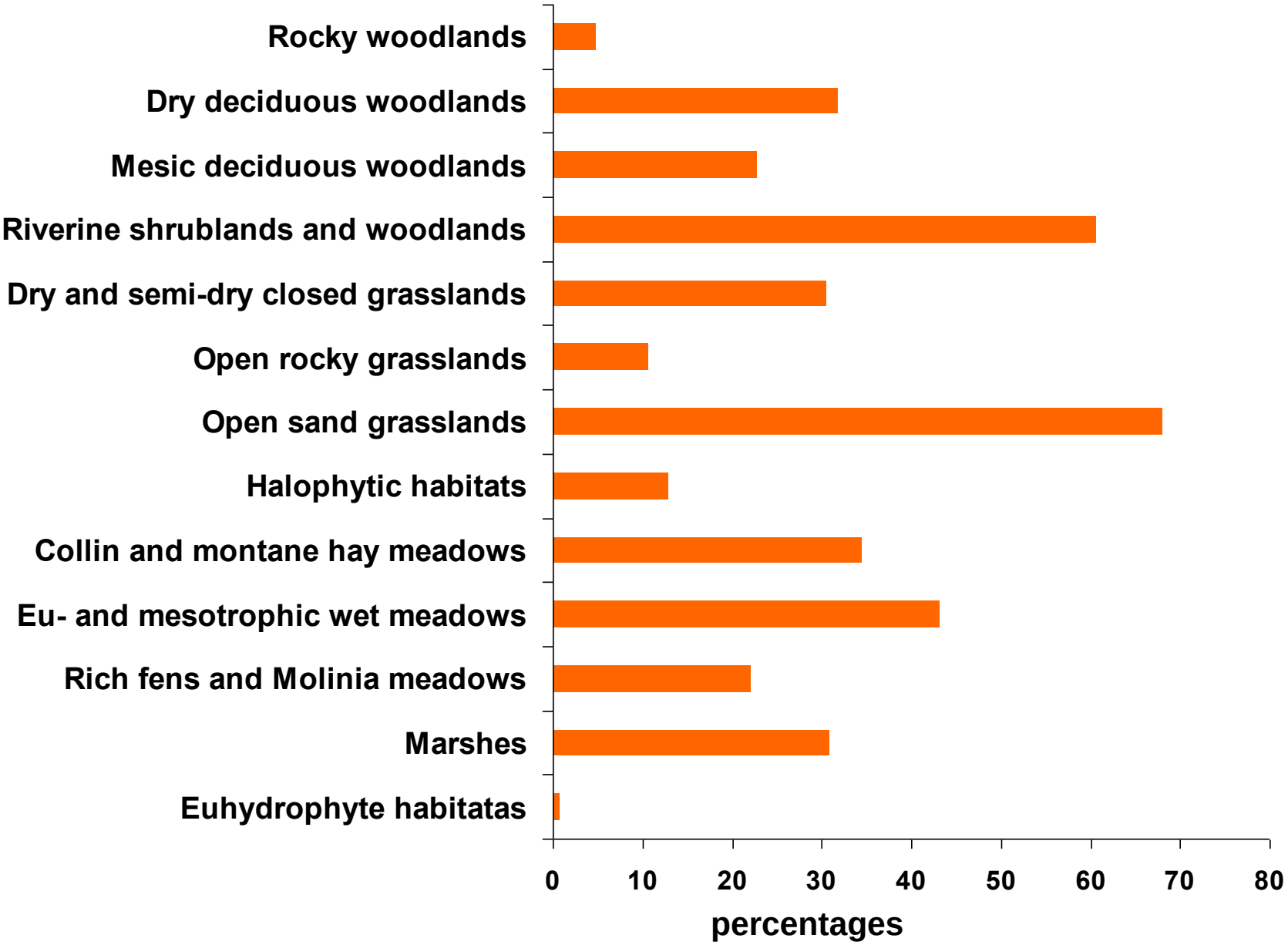


Invasibility of habitats

Both scientists and practioners needs actual data…

- For planning actions (practitioners)
- For doing analysis (scientists) to understand the processes

Area threatened by invasion in different habitat groups

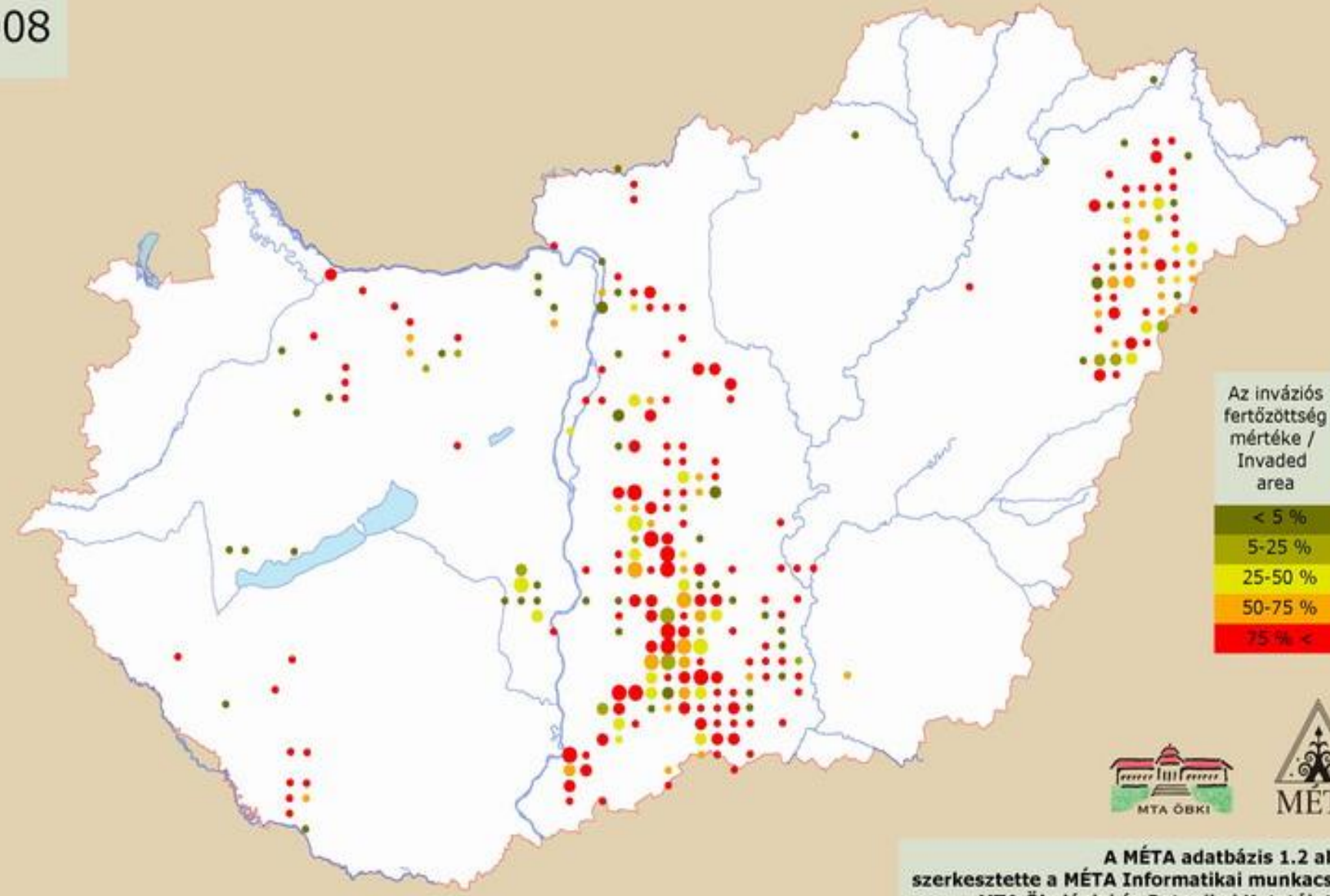


G1

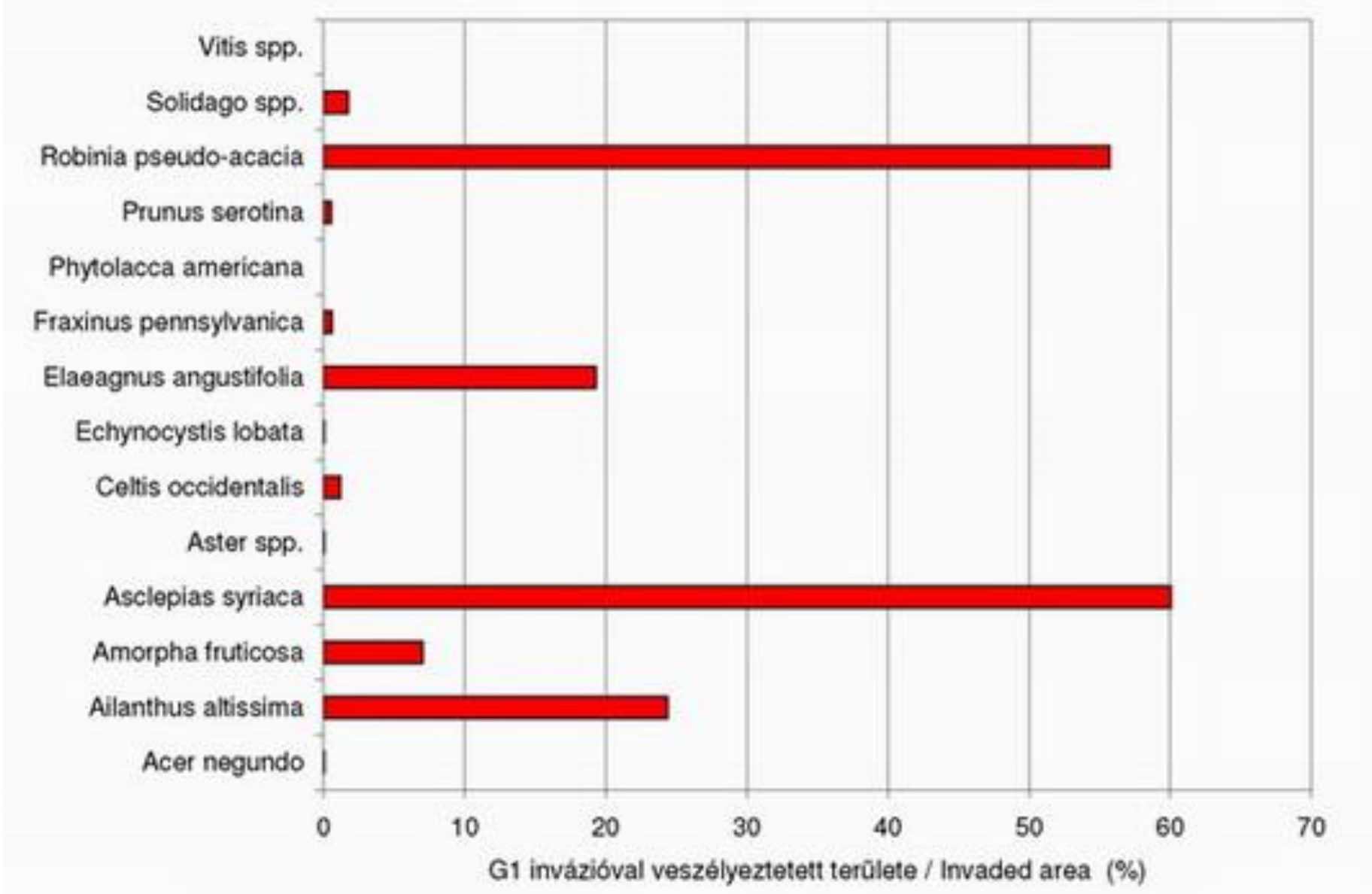
2008

Nyílt homokpusztagyepek inváziós fertőzöttsége

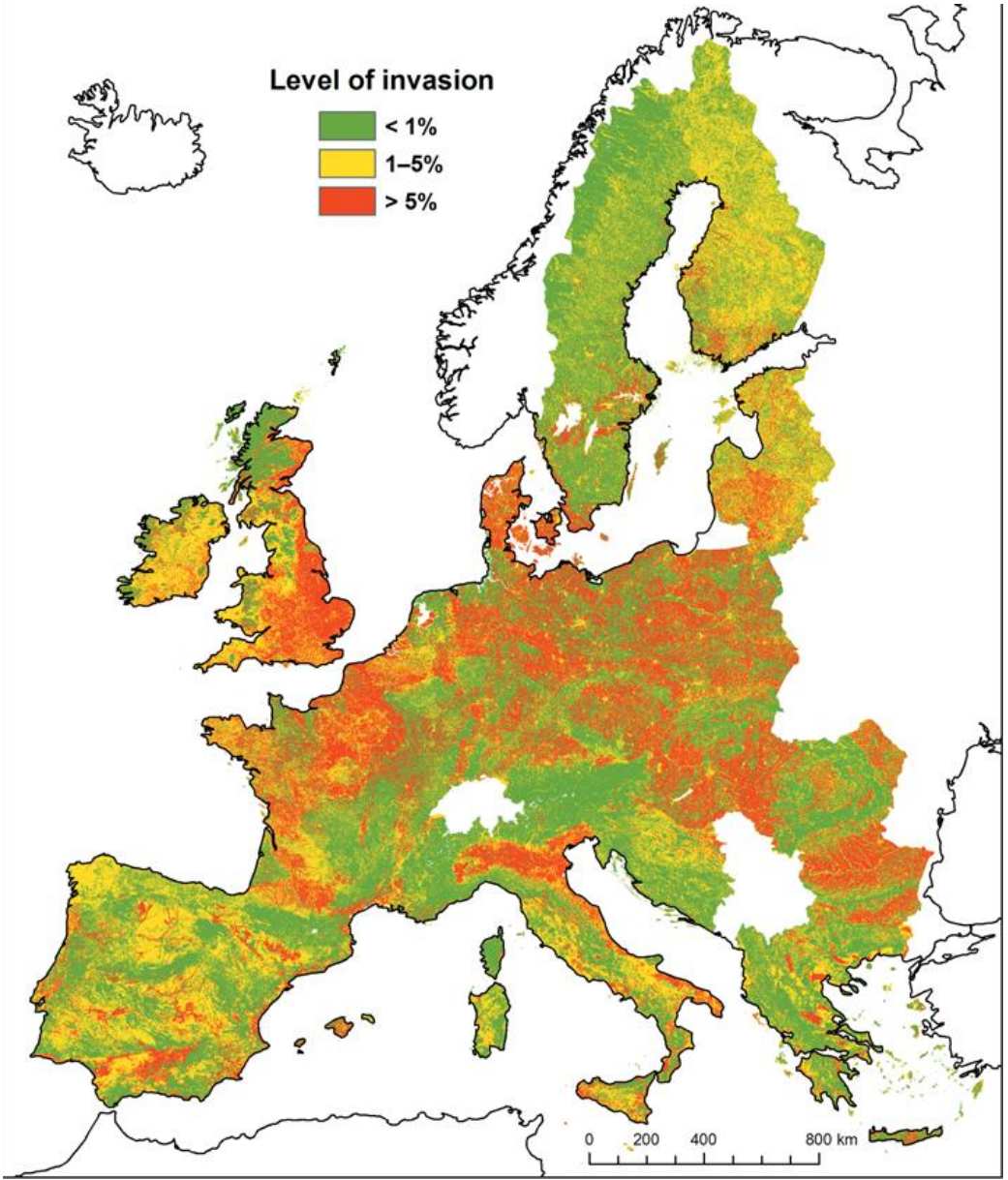
Plant invasion in open sand steppes



A MÉTA adatbázis 1.2 alapján szerkesztette a MÉTA Informatikai munkacsoport MTA Ökológiai és Botanikai Kutatóintézete Vácrátót, 2009. január


Vitis spp.
Solidago spp.
Robinia pseudo-acacia
Prunus serotina
Phytolacca americana
Fraxinus pennsylvanica
Elaeagnus angustifolia
Echynocystis lobata
Celtis occidentalis
Aster spp.
Asclepias syriaca
Amorpha fruticosa
Ailanthus altissima
Acer negundo
0
10
20
30
40
50
60
70
G1 invázióval veszélyeztetett területe / Invaded area (%)

Predictive modelling can fill the gaps



The map was created by extrapolation of existing data in UK, Catalonia, and Czech Republic

Chytry et al. 2009. European map of alien plant invasions based on the quantitative assessment across habitats. *Diversity and Distribution* **15**: 98–107

Some ideas about control of invasion

Three levels of the control

1. Prevention
2. Early detection and rapid response
3. Management of invaded areas

Prevention

- Regulation of intentional introductions
  - black/grey/white lists
  - „black list regulation” – Which species must not be introduced?
  - „white list regulation” – Which species can be introduced?
- Preventing of unintentional introductions
  - Especially species in the black list

Early detection and rapid response

- Much cheaper than management in the later phase of invasion
- Total eradication may be a realistic aim
- No big losses yet → it is hard to explain the problem for the stakeholders

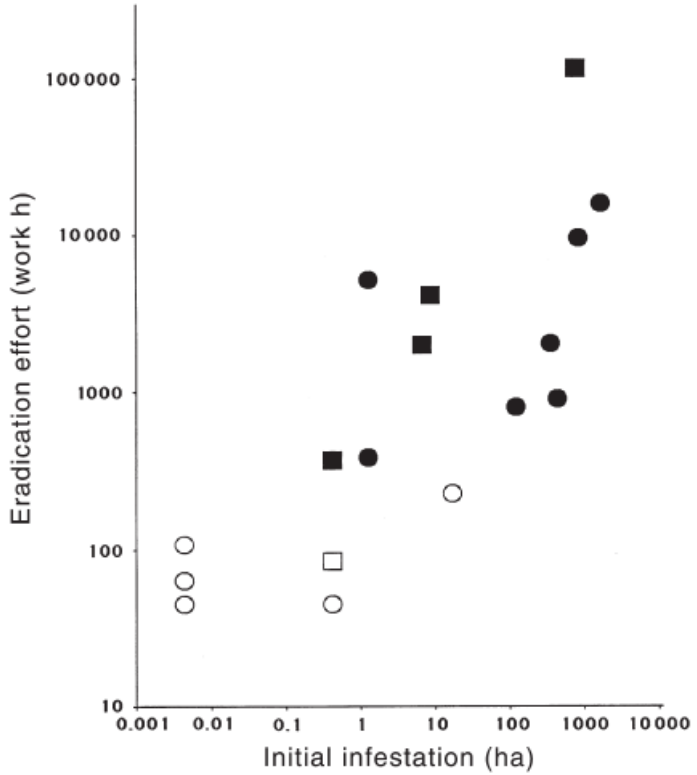


Fig. 2. The dependence of eradication effort (work hours) on the size of initial infestations of two invasive weeds, *Hydrilla verticillata* (eradicated, □; ongoing, ■) and *Onopordum acanthium* (eradicated, ○; ongoing, ●), in

Rejmánek, M. 2000. Invasive plants approaches and predictions. *Austral Ecology* 25:497-506.

Eradication and management programs

- Tested technologies are needed
- After control of the invasive species, the natural vegetation has to be restored
- Spatial planning of management should consider the routes of spread

- All of them are good possibilities for collaboration between research and practice!

Thank you for your attention!