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PREVENTING EXOTIC NOXIOUS WEEDS THROUGH WEED RISK ANALYSIS

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Abstract: A risk assessment system was developed to assess the weed potential of new plants. Species eligible for risk assessment are classified into three categories (high risk, intermediate risk, low risk) by rating them according to various biogeographical and ecological aspects. The rating system was validated by testing 47 well-known invasive plant species and 193 exotic plants. The overall accuracy was 65%. Accuracy of correctly predicting invasive species was 77%, while accuracy of correctly predicting non-invasive species was 62%.
Keywords: Biological invasion, Plant invasiveness, Plant quarantine, Weed risk assessment.

Introduction

The spread of exotic species into natural communities is threatening native biological diversity and the functioning of ecosystems, and is occurring at an alarming rate (Weber, 2003). The significance of invasive species as a global environmental problem is widely recognized, and article 8(h) of the Biodiversity Convention asks for measures "to prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species". As more and more exotic (alien, nonnative) plant, species are introduced and become naturalized in most regions of the world, the likelihood of new invasion events with subsequent negative ecological impacts on the native communities increases rapidly. To prevent new plant invasions, there is an urgent need for the development of early warning systems to determine the likelihood of a given species becoming invasive and of methods to conduct rapid assessments of the status of invaders (Andow, 2003). Preventive measures would ideally consist of the prevention of entry of a species, and the restriction of spread once the species is present (Singh *et al*., 2019). It is possible to avoid damage to native ecosystems by exotic species and the associated costs if such harmful species are not used and planted in the first place. However, this step requires knowledge as to whether a particular species will become invasive where it has been introduced but is not yet widespread, or where it is intended for introduction. It is possible to recognize potential harmful species to at least some extent.

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In fact, sound models that could be applied to predict invasiveness are needed urgently, including quick and easy-to-perform assessment protocols to screen exotic plant species for their potential invasiveness.

Material and Methods

Risk assessment protocol

Plant species considered suitable for risk assessment include any exotic species that is not yet present, has a restricted distribution in the risk area, and is planned to be introduced and commercially used on a large scale. The rating system allocates scores to the species for biogeographical, ecological, and experience-linked aspects (Singh and Priyadarshi, 2014). The scores of the 12 questions are summed up, and species are classified into “high risk”, “intermediate risk”, and “low risk”.

Result and Discussion

Validation

The risk assessment system was validated by testing a set of well-known invasive plant species. Out of the 47 invasive plant species tested, 36 were recognized as being invasive in the risk assessment, giving an accuracy of 76.6% (Table 1). The species with the highest scores were *Ailanthus altissima*, *Helianthus tuberosus* and *Reynoutria japonica* (Table 2).

Table 1. Accuracy and likelihood ratio of the risk assessment

Identified as	Invasive plant species	Non-invasive plant species
Low risk	0 (0%)	119 (61.6%)
Intermediate	11 (23.4%)	64 (33.2%)
High risk	36 (76.6%)	10 (5.2%)
Total number of species	47 (100%)	193 (100%)
Accuracy for identifying invasive species: A_i=76.6%		
Accuracy for identifying non-invasive species: A_n=61.6%		
Overall accuracy: A_o=64.6%		
Likelihood ratio: LR=14.8		

Table 2. Invasive plant species and their rating as obtained by the risk assessment

Species	Sum of scores	Risk class
Ailanthus altissima	39	III (High risk)
Helianthus tuberosus	39	III
Reynoutria japonica	39	III

Species	Sum of scores	Risk class
Reynoutria sachalinensis	39	III
Solidago canadensis	39	III
S. gigantea	39	III
Arundo donax	37	III
Epilobium adenocaulon	36	III
Robinia pseudacacia	36	III
Bidens frondosa	35	III
Cornus sericea	35	III
Heracleum mantegazzianum	35	III
Rudbeckia laciniata	35	III
Crassula helmsii	34	III
Ludwigia grandiflora	34	III
Acer negundo	33	III
Elodea canadensis	33	III
E. densa	33	III
Ludwigia peploides	33	III
Lupinus polyphyllus	33	III
Pinus strobes	33	III
Prunus serotina	33	III
Myriophyllum brasiliense	32	III
Parthenocissus quinquefolia	32	III
Paspalum distichum	32	III
Rubus laciniatus	32	III
Erigeron annuus	31	III
Impatiens glandulifera	31	III
Rhus typhina	31	III
Rumex longifolius	31	III
Oenothera biennis	29	III
Rosa rugosa	29	III
Veronica filiformis	29	III
Lonicera japonica	28	III
Rumex confertus	28	III
Spiraea douglasii	28	III
Amorpha fruticosa	27	II (further evaluation)
Rhododendron ponticum	27	II
Galinsoga ciliata	26	II
Gunnera tinctoria	26	II
Senecio inaequidens	26	II

Species	Sum of scores	Risk class
Vaccinium macrocarpon	26	II
Cyperus eragrostis	25	II
Impatiens parviflora	25	II
Physocarpus opulifolius	25	II
Aster squamatus	24	II
Lysichiton americanum	23	II

The accuracy of correctly predicting non-invasive species (61.6%) was less than the accuracy of correctly predicting invasive species (76.6%). The overall accuracy was closer to 50% than to 100% (Table 1). However, the likelihood-ratio was high (14.8), indicating that the risk assessment has some predictive character.

The objective of a risk assessment for invasive weeds is to decide which species should be listed on quarantine weed lists and to decide which new species infestations should be controlled or removed in order to prevent their spread. Predicting plant invasiveness is, however, limited due to three facts: (1) the high ecological and taxonomic diversity of invasive plants, (2) the lack of ecological data for most plant species, and (3) the variation in invasiveness within the range of a species.

Risk assessment

Answer the following questions and sum up the scores given on the right side. If not otherwise indicated, only one answer applies.

1. Climatic match	
Does the known geographical distribution of the species include ecoclimatic zones similar with those of the risk area?	
• No	0
• Yes	2

2. Status of species in India	
Is the species native to India?	
• Yes	0
• No	2

3. Geographic distribution in India	
In how many countries does the species occur?	
• Species occurs in 0 or 1 country	1

• Species occurs in 2–5 countries	2
• Species occurs in >5 countries	3

4. Range size of global distribution	
How is the size of the global range (native and introduced)?	
• Range is small, species is restricted to a small area within one continent	0
• Range is large, extending over more than 15° latitude or longitude in one continent or covers more than one continent	3

5. History as an agricultural weed elsewhere	
Is the species reported as a weed from somewhere else?	
• No	0
• Yes	3

6. Taxonomy	
Does the species have weedy congeners?	
• No	0
• Yes	3

7. Seed viability and reproduction	
How many seeds do the species approximately produce?	
• Few seeds or no viable seeds	1
• Many seeds	3
• Do not know	2

If the species is present in the risk area, this question refers to plants within the risk area. If the species is present in Europe, this question refers to plants within the European range. If the species is not present in Europe, this question refers to the native or introduced range of the species.	
8. Vegetative growth	
Allocate species to one of the following. If more than one statement applies, take the one with the highest score.	
• Species has no vegetative growth that leads to lateral spread	0
• If a tree or shrub, species has the ability to resprout from stumps or stem layering, or stems root if touching the ground	2
• Species has bulbs or corms	1
• Species has well developed rhizomes and/or stolons for lateral spread	4
• Species fragments easily, fragments can be dispersed and produce new plants	4

• Other or do not know	2

9. Dispersal mode	
Allocate species to one of the following. If more than one statement applies, take the one with the highest score.	
• Fruits are fleshy and smaller than 5 cm in diameter	2
• Fruits are fleshy and larger than 10 cm in length or diameter	0
• Fruits are dry and seeds have well developed structures for long-distance dispersal by wind (pappus, hairs, wings)	4
• Fruits are dry and seeds have well-developed structures for long-distance dispersal by animals (spikes, thorns)	4
• Species has mechanisms for self-dispersing	1
• Other or do not know	2

10. Lifeform	
What is the lifeform of the species?	
• Species is a small annual (< 80 cm)	0
• Species is a large annual (>80 cm)	2
• Species is a woody perennial	4
• Species is a small herbaceous perennial (< 80 cm)	2
• Species is a large herbaceous perennial (>80 cm)	4
• Species is a free floating aquatic	4
• Other	2

11. Habitats of species	
Allocate species to one of the following. If more than one statement applies, take the one with the highest score.	
• Riparian habitats	3
• Bogs/swamps	3
• Wet grasslands	3
• Dry (xeromorphic) grasslands	3
• Closed forests	3
• Lakes, lakeshores, and rivers	3
• Other	0

12. Population density	
What is the local abundance of the species?	
• Species occurs as widely scattered individuals	0
• Species forms occasionally patches of high density	2

• Species forms large and dense monocultures	4
• Total score *If the species is present in the risk area, this question refers to plants within the risk area. If the species is present in Europe, this question refers to plant within the European range. If the species is not present in Europe, this question refers to the native or introduced range of the species.*	

Identify risk class Score	
3–20	Low risk — Species is unlikely to pose a threat to agriculture/environment
21–27	Intermediate risk — Species requires further evaluation.
28–39	High risk — Species is likely to become a threat to agriculture/environment if naturalized.

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