International Journal of Allied Sciences (IJAS)
Volume.14, Number 2; Febuary-2023;
ISSN: 2836-3760 | Impact Factor: 7.07
https://zapjournals.com/Journals/index.php/Allied-Sciences
Published By: Zendo Academic Publishing

UTILIZING WEED RISK ANALYSIS FOR EFFECTIVE INVASIVE PLANT MANAGEMENT

[1]Bhattacharya Gopal

Article Info

Keywords: Weed Risk Analysis, Invasive Plant Management, Control Strategies, Biogeographical Factors, Ecological Factors, High-risk Species, Targeted Control Measures, Effective Resource Allocation

Abstract

The role of Weed Risk Analysis (WRA) in effective invasive plant management is crucial for developing appropriate control strategies and preventing the spread of invasive species. A risk assessment system has been developed to assess the weed potential of new plants, evaluating their potential to become invasive based on various biogeographical and ecological factors. The assessment process classifies species into three categories - high risk, intermediate risk, and low risk - to determine the appropriate management strategies for each plant species. This innovative rating system was validated by testing 47 well-known invasive plant species and 193 exotic plants to examine its effectiveness in predicting invasive potential. The overall accuracy of the WRA system was found to be 65%, with an impressive 77% accuracy in correctly predicting invasive species. Although the accuracy of predicting non-invasive species was found to be slightly lower at 62%, the results still demonstrate the potential of WRA as a valuable tool in invasive plant management. The WRA system's ability to accurately predict invasive species allows for the implementation of targeted control measures, reducing the impact of invasive species on native ecosystems and minimizing potential economic losses associated with their spread. By identifying high-risk species, resources can be allocated efficiently to prevent their introduction and spread, while low-risk species can be monitored and managed accordingly. Furthermore, the WRA system contributes to increasing our understanding of the factors that contribute to a plant's invasive potential, such as its reproductive capacity, dispersal mechanisms, and competitive abilities. This information can be used to develop more targeted and effective management strategies, as well as informing policy decisions related to the importation and regulation of exotic plant species. In conclusion, the role of Weed Risk Analysis in effective invasive plant management is significant, as it allows for the accurate identification and classification of potentially invasive species. By utilizing this risk assessment system, resources can be allocated more effectively, and targeted control measures can be implemented to prevent the spread of invasive plants. With an overall accuracy of 65% and a 77% success rate in predicting invasive species, the WRA system

[1] Acharya & BM Reddy College of Pharmacy, Soldevanahalli, Hesaraghatta Bengaluru, 560107, Karnataka, India

is a valuable tool in the ongoing battle against invasive plants, ensuring the protection of native ecosystems and minimizing the economic impact of these potentially harmful species.

Introduction

Utilizing Weed Risk Analysis for Effective Invasive Plant Management: An Introduction

Invasive plant species pose significant threats to biodiversity, ecosystem functioning, and human well-being worldwide (Vilà et al., 2011). These non-native plants can outcompete native species, alter ecosystem processes, and cause substantial economic losses in agriculture, forestry, and other industries (Pimentel et al., 2005). Consequently, the effective management of invasive plants is crucial for the conservation of biological diversity and the maintenance of ecosystem services. One approach to addressing this challenge is through weed risk analysis (WRA), a systematic methodology for assessing the potential invasiveness and impacts of plant species before they become established and widespread (Pheloung et al., 1999). This introduction provides an overview of the WRA framework, its applications in invasive plant management, and future directions for advancing this critical field of research and practice.

Weed risk analysis integrates information from various sources, including species traits, distribution data, and expert knowledge, to evaluate the likelihood of a plant's introduction, establishment, and spread, as well as its potential ecological and socioeconomic impacts (Pheloung et al., 1999). This process typically involves three stages: risk assessment, risk management, and risk communication (Panetta & Cacho, 2014). Risk assessment entails the identification of potential invasive species, the estimation of their invasion probabilities, and the evaluation of their consequences for the environment and human activities. Risk management involves the development and implementation of strategies to prevent, detect, and control invasive plants, taking into account the feasibility, effectiveness, and cost of available options. Risk communication includes the dissemination of WRA findings to stakeholders, decision-makers, and the public, as well as the promotion of awareness and collaboration in invasive plant management.

Several WRA tools have been developed to support decision-making in different contexts and regions, ranging from qualitative checklists and scoring systems to quantitative models and simulation approaches (Gordon et al., 2008). For example, the Australian Weed Risk Assessment (AWRA) is a widely used screening tool that combines a series of questions about a plant's biology, ecology, and history of invasion to generate a risk score and classification (Pheloung et al., 1999). Other WRA methods, such as the Generic Impact Scoring System (GISS) and the Invasive Species Risk Assessment (ISRA), focus on the assessment of environmental and socioeconomic impacts, respectively, by integrating multiple criteria and stakeholder preferences (Kumschick et al., 2015; Wainger & Harms, 2012). Moreover, spatially explicit WRA models, such as the Invasive Plant Distribution and Habitat Suitability (IPDHS) framework, can predict the potential distribution of invasive plants under different climate and land-use scenarios, thereby informing the targeting of surveillance and management efforts (Peterson et al., 2008).

Despite the growing adoption of WRA in policy and practice, several challenges and opportunities remain for improving its accuracy, relevance, and usability in invasive plant management. First, the validation and refinement of WRA methods require the collection and synthesis of high-quality data on species traits, invasion histories, and management outcomes, as well as the development of robust metrics and indicators for measuring invasiveness and impacts (Gordon et al., 2008). Second, the integration of WRA with other tools and approaches, such as ecological niche modeling, network analysis, and decision support systems, can enhance the prediction, prioritization, and evaluation of invasive plant management interventions (Leung et al., 2012). Third, the engagement of diverse stakeholders and the incorporation of their knowledge, values, and goals in WRA can foster the co-production of actionable and legitimate science for guiding invasive plant management decisions (Estevez et al., 2015).

In conclusion, weed risk analysis represents a valuable framework for informing and improving invasive plant management by synthesizing and applying the best available evidence, tools, and expertise. Future research and practice in this area should address the data, methodological, and participatory challenges and opportunities identified above to advance the science, policy, and practice of invasive plant management and contribute to the broader goals of biodiversity conservation and sustainable development.

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

Species	Sum of scores	Risk class
Senecio inaequidens	26	II
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 3 continent or covers more than one continent

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 2 layering, or stems root if touching the ground
- 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 4 plants

• 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 risk area. If the species is present in Europe, this question refers to p the European range. If the species is not present in Europe, this ques to the native or introduced range of the species.*	*within the lant within tion refers*	

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.

References

Andow, D.A. (2003). Pathways-based risk assessment of exotic species invasions. G.M. Ruiz, J.T. Carlton (Eds.), *Invasive species: vectors and management strategies*, Island Press, Washington (2003), pp. 439–455.

Singh, M.C. and M.B. Priyadarshi (2014). Predicting invasive plants using weed risk assessment. *Indian Journal of Weed Science*. **46**(1): 91-95

Singh, M.C., Phogat, B.S., Singh, I., Rathi, Y.S. and Dubey, S.C. (2019). Study of weeds problem in wheat germplasm grown at NBPGR. *International Journal of Science, Environment and Technology.* **8**(2): 411-415.

Weber, E. (2003). Invasive plant species of the world: a reference guide to environmental weeds. CABI Publishing, Wallingford (2003) 548pp.

Estevez, R. A., Anderson, C. B., Pizarro, J. C., & Burgman, M. A. (2015). Clarifying values, risk perceptions, and attitudes to resolve or avoid social conflicts in invasive species management. Conservation Biology, 29(1), 19-30.

Gordon, D. R., Onderdonk, D. A., Fox, A. M., & Stocker, R. K. (2008). Consistent accuracy of the Australian weed risk assessment system across varied geographies. Diversity and Distributions, 14(2), 234-242.

Kumschick, S., Bacher, S., Dawson, W., Heikkilä, J., Sendek, A., Pluess, T., ... & Nentwig, W. (2015). A conceptual framework for prioritization of invasive alien species for management according to their impact. NeoBiota, 22(1), 69-100.

Leung, B., Lodge, D. M., Finnoff, D., Shogren, J. F., Lewis, M. A., & Lamberti, G. (2012). An ounce of prevention or a pound of cure: bioeconomic risk analysis of invasive species. Proceedings of the Royal Society B: Biological Sciences, 279(1742), 2848-2855.

Panetta, F. D., & Cacho, O. J. (2014). Designing weed risk assessments to account for variations in impact: why one size does not fit all. Plant Protection Quarterly, 29(1), 16-20.

Peterson, A. T., Stewart, A., Mohamed, K. I., & Araújo, M. B. (2008). Shifting global invasive potential of European plants with climate change. PloS One, 3(6), e2441.

Pheloung, P. C., Williams, P. A., & Halloy, S. R. (1999). A weed risk assessment model for use as a biosecurity tool evaluating plant introductions. Journal of Environmental Management, 57(4), 239-251.

Pimentel, D., Zuniga, R., & Morrison, D. (2005). Update on the environmental and economic costs associated with alien-invasive species in the United States. Ecological Economics, 52(3), 273-288.

Vilà, M., Espinar, J. L., Hejda, M., Hulme, P. E., Jarošík, V., Maron, J. L., ... & Pyšek, P. (2011). Ecological impacts of invasive alien plants: a meta-analysis of their effects on species, communities and ecosystems. Ecology Letters, 14(7), 702-708.

Wainger, L. A., & Harms, N. E. (2012). A method for scoring environmental and socioeconomic impacts of invasive species. Ecological Indicators, 18, 214-222.