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# Assessing Ecological Risk of Invasive Alien Plants in South Korea[1]

JI-HYON KIL, KEW-CHEOL SHIM, and HO-JOON LEE[2]

**Abstract:** Invasive alien plant species represent an ecological risk to indigenous plants and ecosystems. In this study, the dichotomous system is suggested to assess the ecological risk of invasive plant species. Case studies of noxious alien plants in South Korea were used to develop the system based on environmental risk factors. Assessing ecological risk of invasive alien plants was considered with the following factors: harmful effects to animals or humans, ecological characteristics, invasion time, present state after invasion (dispersion), and availability of resources. Invasive plant risk assessment was based on the methodology for predictive risk assessment used to manage and monitor invasive alien plants in South Korea. Our system enabled us to classify invasive plants in Korea into four grades: (1) noxious species (three categories), (2) monitoring species (five categories), (3) harmless species (innocuous species), and (4) beneficial species. Our assessment system can help land managers monitor invasive alien plant species.

**Additional index words:** Dichotomous system, ranking system.

## INTRODUCTION

The threats to the natural environment by invasive species are a global issue (De Poorter 2002; Vitousek et al. 1996). Invasive species threaten to affect other plant species and communities as they expand their ranges and invade new areas. The invasion of exotic plants into ecosystems is detrimental on an ecological level because it can potentially alter the balance between the native species (Coblentz 1990; OTA 1993; Vitousek et al. 1996). Invasive alien plants also are harmful to humans and domestic livestock (Harper et al. 1996). Because invasive species are increasing, we recognize the need for a classification system to help management planning with invaded ecosystems (Heffernan et al. 2001; Koh et al. 2002).

Many countries attempting to solve the problems of invasive plants want to develop a system of invasive plant management in an ecological, environmentally

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[2] Researcher, Division of Plant Ecology, National Institute of Environmental Research, Environmental Research Complex, Gyungseo-dong, Seogu, Incheon 404-170, Republic of Korea; Assistant Professor, Department of Biology Education, Kongju National University, Shinkwan-dong, Gongju, Chungnam 314-701, Republic of Korea; Professor, Department of Biological Sciences, Konkuk University, Hwayang-dong, Gwangjin-gu, Seoul 143-701, Republic of Korea. Corresponding author's E-mail: skcshim@kongju.ac.kr.

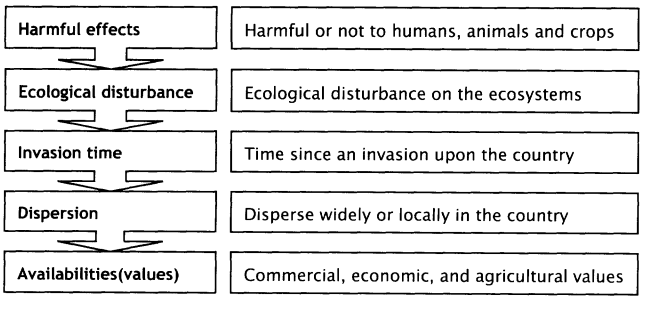


*Figure 1.* Priority factors to assess an ecological risk of invasive plants in South Korea.

A1. harmful to human, animals, and crop plants
B1. harmful to human, animals and crop plants in the country ---------- Noxious species I
B2. harmful to human, animals and crop plants out of country, but never reported to be harmful to human, animals and crop plants in the country
C1. disturbed ecologically in the country ---------- Noxious species II
C2. disturbed ecologically out of the country, but never reported to disturbed ecologically in the country
D1. less than 20 years since invasion
E1. dispersed widely ---------- Monitoring species I
E2. dispersed locally ---------- Monitoring species III
D2. more than 20 years since invasion
E3. dispersed widely ---------- Monitoring species II
E4. dispersed locally ---------- Monitoring species IV
A2. never reported to be harmful to human, animals, and crop plants in or out of country
B3. disturbed ecologically
C3. disturbed ecologically in the country ---------- Noxious species III
C4. disturbed ecologically out of the country, but never disturbed ecologically in the country
D3. less than 20 years since invasion in the country
E5. dispersed widely ---------- Monitoring species I
E6. dispersed locally ---------- Monitoring species III
D4. more than 20 years since invasion in the country
E7. dispersed widely ---------- Monitoring species II
E8. dispersed locally ---------- Monitoring species IV
B4. never disturbed ecologically in or out of the country
C5. never valuable in commerce, agriculture and economy
D5. less than 20 years since invasion in the country, and dispersed widely ---------- Monitoring species V
D6. more than 20 years since invasion in the country ---------- Innocuous species
C6. valuable in commerce, agriculture and economy ---------- Beneficial species

*Figure 2.* Dichotomous key to selected grades and categories of invasive alien plant species by ecological risk in South Korea.

*Table 1.* Grades, categories, and characteristics of ecological risk, and examples of invasive alien plants in South Korea.

| Grade and category | Characteristics | Plant species |
|---|---|---|
| Noxious species | | |
| I | Found to be harmful to humans, animals (domestics), and crops in and out of the country<br>Potential to induce damages directly by toxic chemicals | *Solanum carolinense* L., *Ambrosia artemisiifolia* L., *Ambrosia trifida* L. |
| II | Found to be harmful to humans, animals (domestics), and crops out of the country but not in the country<br>Predictable to be harmful in the country | *Eupatorium rugosum* Houtt. |
| III | Not found to be harmful to humans, animals (domestics), and crops in and out of the country<br>Found to disturb ecologically on the ecosystem in and out of the country | *Paspalum distichum* L., *Paspalum distichum* L. var. *indutum* Shinners |
| Monitoring species | | |
| I | Less than 20 y since invasion and distributed widely in the country<br>Found to disturb ecologically on the ecosystem out of the country but not in the country<br>Predictable to disturb ecologically in the country | *Coronopus didymus* Smith, *Paspalum dilatatum* Poir. |
| II | More than 20 y since invasion and distributed widely in the country<br>Found to disturb ecologically on the ecosystem out of the country but not in the country | *Senecio vulgaris* L., *Agropyron repens* (L.) Beauv., *Festuca arundinacea* Schreb, *Chenopodium album* L., *Phytolacca americana* L., *Thlaspi arvense* L., *Medicago sativa* L., *Convolvulus arvensis* L., *Datura stramonium* L. |
| III | Less than 20 y since invasion and distributed locally in the country<br>Found to disturb ecologically on the ecosystem out of the country but not in the country | *Cirsium arvense* Scop., *Hordeum murinum* L., *Sorghum halepense* (L.) Pers., *Raphanus raphanistrum* L., *Sinapis arvensis* L., *Conium maculatum* L. |
| IV | More than 20 y since invasion and distributed locally in the country<br>Found to disturb ecologically on the ecosystem out of the country but not in the country | *Lolium temulentum* L. |
| V | Less than 20 y since invasion in the country<br>Not found to disturb ecologically on the ecosystem in or out of the country | *Hordeum jubatum* L., *Papaver dubium* L. |
| Innocuous species | More than 20 y since invasion in the country<br>Not found to disturb ecologically on the ecosystem in or out of the country | *Erechtites hieracifolia* Raf., *Crassocephalum crepidioides* S. Moore, *Veronica persica* Poiret |
| Beneficial species | Valuable in commerce, agriculture, and economy<br>Not found to disturb ecologically on the ecosystem in or out of the country | *Chenopodium ambrosioides* L., *Oenothera biennis* L., *Tagetes minuta* L. |

sound, and cost-effective way (Hobbs and Humphries 1995; Koh et al. 2001, 2002; Suter 1993). By understanding ecological interactions, we suggest that ecological risk of any species can be partially predicted by examining its life history and geographic distribution. Thus, we developed a ranking system based on case studies of invasive alien plants in South Korea and other countries to assess ecological risk.

## METHODOLOGY

The approach used in this investigation was to assemble published data from South Korea, Japan, United States, Canada, United Kingdom, and Australia. A ranking system to assess an ecological risk of invasive alien plants was developed as follows: (1) listing of invasive plant species in South Korea, (2) surveying and assembling the published data on available invasive plants in South Korea and other countries, (3) isolating and identifying ecological risk factors, (4) positioning a hierarchy of ecological risk factors, and (5) developing a ranking system to grade the ecological risk of invasive alien plants.

The factors of ecological risk were selected, and the hierarchical system was developed to assess ecological risk to manage and monitor invasive alien plants. The ranks of invasive alien plant species were classified by dichotomous method. The ranking system was verified by applying to alien plants in South Korea.

## RESULTS AND DISCUSSION

To manage invasive alien plant species effectively, species need to be prioritized based on ecological risk

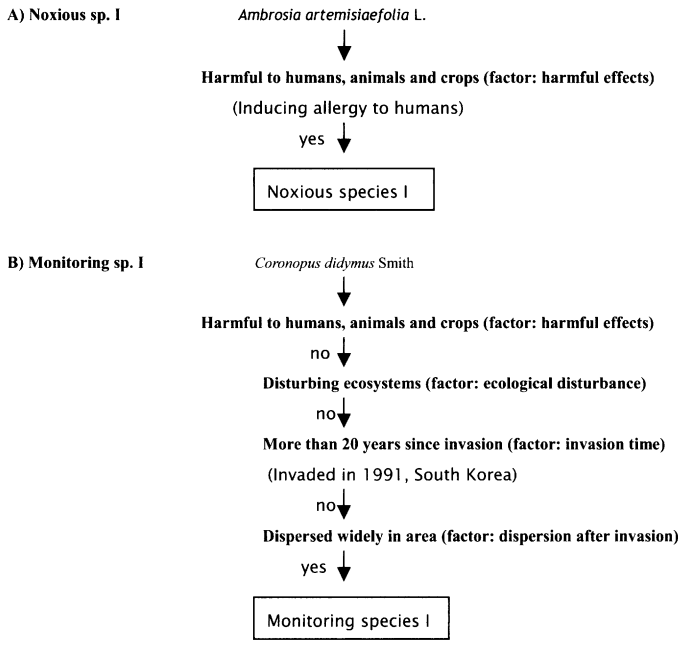


*Figure 3.* Examples of assessing an ecological risk of invasive alien plants.

(Hiebert 1997; Hiebert and Stubbendieck 1993; Koh et al. 2002). But many risk-ranking systems consider few factors and emphasize only management and control aspects of invasive alien plants (Heffernan 1998; Hiebert and Stubbendieck 1993; Holm et al. 1991, 1997; Koh et al. 2001). We suggest that it is important also to examine relative probabilities and magnitudes of harm to human health or animal health (Figure 1). Also, invasion time, present state after invasion (dispersion), and availability (valuable to use commercially, economically, and agriculturally) should be considered when assessing ecological risk. Considering these additional risk factors enabled us to rank invasive alien species by a dichotomous classification method (Figure 2). Four grades of ecological risk were suggested: noxious species, monitoring species, innocuous species, and beneficial species. The examples of assessing an ecological risk of invasive plants are shown in Figure 3.

The ranking system was verified by applying to invasive alien plants in South Korea, and they were classified to grades and categories (Table 1). The ranking system can be used to manage and monitor invasive alien plants. In addition, the ecological risk potential of invaders can be examined by investigating their life-history characteristics as well as geographic and ecological distribution.

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