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Risk assessment of invasive alien plant species in Pangandaran nature reserve, West Java, Indonesia

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ABSTRACT

As a member of Convention on Biological Diversity (CBD), Indonesia has confirmed to prevent, control and eradicate invasive alien species (IAS) in order to maintain biodiversity. Pangandaran Nature Reserve (PNR) is one of conservation areas that have been invaded by IAS plants. However, ineffective control method and strategy of IAS plants lead to persistence of these species in this area. Therefore, this study is conducted to assess risk of IAS plants and propose recommendation strategy to manage them. IAS plants are assessed through two indices, risk index and feasibility index, of which each is calculated based on risk assessment protocol by Virtue (2008), to determine their strategy of control. There are 10 IAS plants in PNR. Five species with high important value index are selected to be assessed. Risk and feasibility indices and recommendation strategy to manage IAS plants are respectively *Tectona grandis* (169.2; 169.6; manage species), *Chromolaena odorata* (149.5; 105.6; manage species), *Cynodon dactylon* (100.8; 120.45; manage location), *Melastoma malabathricum* (76.8; 47.52; manage location), *Chrysopogon aciculatus* (42.88; 49.89; manage location), *Fimbristylis monostachya* (15.04; 20.19; monitoring). *T. grandis* has the highest risk of invasiveness, but it has low feasibility of control. Thus, *T. grandis*, *C. odorata* and *C. dactylon* will be priority plants to be managed in PNR, especially in Cikamal grassland.

***Key words**: Cikamal, Invasive alien plant species, Pangandaran nature reserve, Risk assessment.*

Introduction

Invasive alien plant species (IAS plants) are non-local plant species that grow uncontrolled and dominate in an area, so that their presence disturbs native plants (Tjitrosemito, 2004). IAS plants can invade an ecosystem because it has several advantages including rapid growth, large number of seeds, effective method of seed dispersion, and rapid reproduction (Tjitrosemito, 2004). In addition, IAS plants also contain secondary metabolites such as allelopathic compounds. These characters make invasive species a threat to biodiversity (Titrosoedirjo *et al*. 2016).

Indonesia as one of the members of the Convention on Biological Diversity (CBD) has agreed to carry out the mandate of article 8h in the conventions which concerning prevention, control and eradication of IAS, including IAS plants (Convention on Biological Diversity). But it turns out that Indonesia is still having difficulties in dealing with IAS plants so that invasion of IAS plants continues to occur. Invasion of IAS plants have even reached conservation area such as national park. Some of the cases are *Passiflora* sp. in Gunung Gede-Pangrango National Park, *Acacia nilotica* in Baluran National Park, and *Chromolaena odorata* in Bromo Tengger Semeru National Park, and Ujung Kulon National Park (Padmanaba *et al*., 2017).

Pangandaran Nature Reserve (PNR) is also a conservation area that needs to be protected. But research conducted by Nakazono (2012) reported the invasion of *Tectona grandis* into grasslands in PNR. Other studies on plants that have been done in PNR were generally only limited to biodiversity or composition and distribution of vegetation (Kurniawan and Parikesit, 2008; Nurjaman *et al*., 2017; Salwanafi, 2018). The presence of these IAS plants, *T. grandis* in particular, and few management activities prompted the changing of community in some regions such as Nanggorak, Badeto, and Batu Meja from grassland into secondary forest (Rosleine and Suzuki, 2012).

Until now, the presence of IAS plants in PNR is still exist because management effort is not regularly applied and when applied does not produce desired result. Therefore, a risk assessment is needed to determine the risk of each IAS plant before being able to propose recommendations for appropriate IAS plants management in PNR.

Materials and Methods

This research was carried out in January 2018 and November 2018 in 6 study sites (Pasir putih, Cirengganis, Cikamal, Nanggorak, and Badeto) within PNR area (108°39'18" – 108°39'52" BT and 7°42'16" – 7°42'35" LS). Plant specimens were identified in School of Life Sciences and Technology (SITH) ITB.

Research Implementation

1. Vegetation analysis

Vegetation analysis to detect IAS plants in PNR was carried out in six regions (Pasir Putih, Cirengganis, Cikamal, Nanggorak, Badeto, and Batu Meja) using the 50m belt transect method by taking the observation area 10m each to the right and to the left. The plants observed were divided into two groups, trees and herbs (Rosleine, 2013). Frequency, dominance, and density of trees were estimated in 10m x 10m plots and 5m x 5m subplots placed at the corner of the 10m x 10m plot, while frequency and dominance of herbs were calculated in 1m x 1m subplots. The parameters measured in the field for trees were diameter at breast height (DBH), number of individuals per species, and frequency, while parameters measured for shrubs and herbs were frequency and percentage of dominance. Frequency is also used to calculate the percentage of actual distribution.

2. Specimen identification and validation of Invasive Alien Species (IAS) plants

The specimens were identified based on Flora of Java book volume I-III by Backer and van den Brink (1963, 1965, 1968). Specimens not available in the book were identified based on local name references from PNR officials and from other references. Alien invasive species were classified by checking into online databases such as CABI, GISD, KMTB BIOTROP, and PIER. If a species was not listed as an IAS plant in the database but recorded as an alien species in other references and showed significant abundance in the field, then it would be considered as an IAS plant.

3. Risk assessment of IAS Plants

Risk assessment of IAS plants was done by using The South Australia's Weed Risk Management System protocol by Virtue (2008) modified by Tjitrosoedirdjo *et al*. (2016) which consisted of two sets of questions. The first set of questions was to assess the risk of IAS plants symbolized in risk index (R). The value of R was determined by calculating scores from three parameters: invasiveness (Iv), impact (I), and potential distribution (DP). The second set of questions was to assess the feasibility of IAS plants management symbolized in feasibility index (F). The value of F was determined by calculating scores from three parameters: control costs (CC), actual distribution (AD), and persistence (P).

Data analyses

Important value (IV) was used to describe plants dominance towards other plants in a community. Sutisna (1981) stated that an understory species was considered dominant if its IV was ≥ 10%, while it required IV ≥15% for tree species to be considered dominant. IV was calculated from equation below (Wiryani *et al*., 2018):

$$IV = D_r + F_r + Do_r$$

with, D_r (relative density) = $\frac{\text{Species density}}{\text{Density of all species}} \times 100\%$

F_r (relative frequency) = $\frac{\text{Species frequency}}{\text{Frequency of all species}} \times 100\%$

Do_r (relative dominance) = $\frac{\text{Species dominance}}{\text{Dominance of all species}} \times 100\%$

For herbaceous and understory vegetation, IV was obtained from addition of F_r and Do_r (Rosleine and Suzuki, 2012).

Risk index (R) was obtained after all questions from three related parameters were answered. The scores from each parameter were processed by equation as followed (Virtue, 2008):

$$R = Iv \times I \times DP$$

with, Iv (invasiveness) = $\frac{\text{Total score}}{15} \times 10$, rounded by one decimal

I (impact) = $\frac{\text{Total score}}{19} \times 10$, rounded by one decimal

DP (distribution potential) = Total score

One of parameters to obtain F (feasibility index) is the actual distribution (AD) of IAS plants. The AD value was determined in percentage units using the following formula (Rahayu, 2017):

Percentage of AD = $\frac{\sum_j^i FiAj}{A\ CIK} \times 100\%$

with, F_i = Frequency of species i

A_j = Area of ecosystem where species found (ha)

A CIK = Area of Cikamal (3 ha)

F was obtained after answering all questions from three related parameters using formula as followed (Virtue, 2008):

$$F = CC \times AD \times P$$

with, CC (control cost) = $\frac{\text{Total Score}}{15} \times 10$, rounded by one decimal

AD (actual distribution) = $\frac{\text{Total Score}}{12} \times 10$, rounded by one decimal

P (persistence) = $\frac{\text{Total Score}}{11} \times 10$, rounded by one decimal

The R and F score obtained were classified into the following categories (Virtue, 2008):

The higher the value of R showed higher risk of IAS plants, while the higher the value of F showed lower feasibility to manage IAS plants.

Recommended strategy of IAS plants management was determined based on matrix of score and category of R and F, as showed in Table 2 (Virtue, 2008):

Table 1. Classification of risk and feasibility indices

R	Category	F	Category
>192	Very high	>113	Negligible
<192	High	<113	Low
<101	Medum	<56	Medum
<39	Low	<31	High
<13	Negligible	<14	Very high

Results and Discussion

IAS Plants in PNR

Result of vegetation analysis showed that there were 11 invasive alien plant species (IAS plants) recorded throughout Pangandaran Nature Reserve (PNR), most of which were found in Cikamal (9 out of 11 IAS plants) with high abundance (Table 1). Meanwhile, other IAS plants in the rest of regions were not significant enough to be considered dominant. This is probably due to Cikamal grassland as the only remaining and most extensive open area in PNR that offers high and constant light intensity which favored by most IAS plants (Solfiyeni 2016). Therefore, the likelihood of IAS plants colonization and spread in Cikamal is high. While in other regions, with all of them being forest community, IAS plants are outcompeted by other species higher in abundance. Similar notion is also stated by Booth *et al*. (2003) that the invasion of a species may fail due to the IAS plant being outgrown by already established species in a more established community.

Risk Assessment of IAS Plants

Six IAS plants with IV e"10% (*Tectona grandis*, *Cynodon dactylon*, *Chromolaena odorata*, *Melastoma malabathricum*, *Chrysopogon aciculatus*, and *Fimbristylis miliacea*) were selected to be run through risk assessment protocol by Virtue (2008) modified by Tjitrosoedirdjo *et al*. (2016) because they are considered dominant in their respective area (Rosalia 2008). But the risk assessment was only done based on IAS plants found in Cikamal region, since Cikamal was the region with the highest number of IAS plants. The following is only an example of assessment to *T. grandis* after being run with risk assessment protocol.

1. Risk of IAS plants

In order to assess risk of IAS plants, a set of questions need to be answered. This set of questions are divided into three main parameters; invasiveness, impacts, and potential distribution. Invasiveness looks at the IAS plants ability to spread. Impacts examine the effect if IAS on environment, economy, and social. While potential distribution indicates the total area IAS plants could spread into. Scores obtained from each of these parameters are multiplied to get a risk index score.

Based on the calculation of the three parameters above, it is known that all IAS plants in Cikamal have potential to invade (high-low risk category) (Table 2). *T. grandis* has the highest risk index (169.2), which means that its ability to invade is also high. Until now, there has been no research data that states *T. grandis* has a high risk of invasive except Nakazono (2012). Either with its status as invasive in databases used, that none of them classified *T. grandis* as an IAS plant. This is explained by Tjitrosoedirdjo *et al*. (2016) that the invasive ability of a species can be different in a different land use system. This is because each land use system has different conditions related to the history of disturbance, time since the invasion, and the distribution of invasive alien species and their impact on the structure and function of the ecosystem (Glass, 2004).

Some prominent traits of *T. grandis* that supports its potential as a high risk IAS plant in PNR are; resistance to general management actions, wide potential distributions, deliberate introduction, and superior competition ability. *T. grandis* has up to 95% resistance towards management actions applied in PNR (PNR officials 2018, pers. comm.). This is due to its stature as a big woody tree species that made it hard to cut down until its root parts. The absence of follow-up actions afterwards also plays its role, which allows *T. grandis* to regenerate easily through shoots from logged stumps.

T. grandis also has been widely spread in PNR as it can be found in four regions from out of total six regions (Table 1). The mass planting of *T. grandis* in the past could also promote this species wide distribution throughout PNR area without ignoring its potential to spread through natural dispersal by birds, insects, and water (WUR). The presence of frugivorous birds such as *Aegithina tipia* and *Antrachoceros albirostris* (Safanah *et al*., 2017) could help fruits and seeds of *T. grandis* to spread to all parts of PNR.

In terms of competition with other species, field observation showed that even saplings of *T. grandis* has monopolized light source with its broad leaves blocking penetration of light from reaching soil surface and other lower species. Reports by Healey and Gaara (2003) also states that *T. grandis* produces allelopathic compounds in the form of phenolic acid that can impede growth of other species. The impact of *T. grandis* was clearly seen in Cikamal grassland, where many saplings of *T. grandis* were started to invade the edge area of grassland with several other IAS plants such as *C. odorata*, reducing grass growing area. This can lead to community change like what happened in Nanggorak, Badeto, and Batu Meja regions, which were once grassland community but now turns into secondary forest community. This could also be bad for ungulates populations such as *Cervus timorensis* and *Bos javanicus*, as Cikamal grassland is the only grazing site remaining in PNR.

2. Feasibility of IAS plants management

Another set of questions need to be answered to assess IAS plants feasibility of management. This set of questions is consisted of three parameters; control

Table 2. Matrix of IAS plants recommendations of management

Risk Index (R)	Feasibility Index (F)					
	Negligible > 113	Low < 113	Medium < 56	High < 31	Very High < 14	
Negligible < 14	LIMITED ACTION	LIMITED ACTION	LIMITED ACTION	LIMITED ACTION	MONITORING	
Low < 39	LIMITED ACTION	LIMITED ACTION	LIMITED ACTION	MONITORING	MONITORING	
Medium < 101	MANAGE LOCATION	MANAGE LOCATION	MANAGE LOCATION	PROTECT LOCATION	CONTAIN SPREAD	ALERT
High < 192	MANAGE SPECIES	MANAGE SPECIES	PROTECT LOCATION	CONTAIN SPREAD	DESTROY INFESTATION	
Very High > 192	MANAGE SPECIES	PROTECT LOCATION AND MANAGE SPECIES	CONTAIN SPREAD	DESTROY INFESTATION	ERADICATE	

cost, actual distribution, and persistence. Control cost estimates the amount of cost required to detect, on-ground control, and enforcement/education needs. Actual distribution considers how widespread the IAS plant is in the field. While persistence refers to the expected duration of control works. The calculation of feasibility index is also similar to that of risk index by multiplying each of the score from each parameter, except that when feasibility index has higher value, it indicates low feasibility.

The calculation of the three parameters above showed that the feasibility category of IAS plants management in PNR varies considerably from high to negligible (Table 3). *T. grandis* has the lowest feasibility (negligible), shown by its feasibility index being the highest (192) among other IAS plants (Table 3). This means that the management of *T. grandis*in PNR is difficult to do. This is could be related to *T. grandis* widespread actual distribution, as a report from Rahayu (2017) also suggests that IAS plant with low management feasibility has tendency to be widespread. Table 3 also showed that IAS plants with lower distribution would be easier to manage.

According to this research, key features of *T. grandis* that lead to its low feasibility are; expensive control costs, widespread actual distribution, and high persistence. Tjitrosoedirdjo *et al*. (2016) made several adjustments in calculating control costs. First, cost category/currency used for estimating control cost in this research was converted from Australian dollar (AUD) to Indonesian rupiah (IDR). Second, cost categories are differentiated based on the island where the land is being evaluated. The assumption approach was also used in this research to cover lack of secondary data related to management costs in PNR. These assumptions take into account labor wages of IDR 80,000/day with an average number of workers of six people. Therefore, the estimated cost needed to manage IAS plants is IDR 480,000/day without including the cost of chemicals and special equipment because the management method applied at PNR still uses the conventional method (clearing and burning). The use of chemicals is not recommended in conservation areas because of their adverse impact on the environment may threaten the biodiversity in the area. This rate assumed to applies to all IAS plants, hence score of control costs for all species, except *T. grandis*, are quite similar (Table 3). Management of *T. grandis*, especially in mature plants, requires a longer processing time so that the amount of money spent to pay workers are higher.

The actual distribution score of *T. grandis* was identical to that of *C. dactylon* and *C. odorata* (Table 3). All three were distributed in large to small distribution patterns in 20%-40% of the Cikamal region, where. *T. grandis* was spread from inside of the secondary forest to the edge of the grassland. *C. aciculatus* and *M. malabathricum* also have an actual percentage distribution of 20% - 40% but their distribution was more scattered and smaller, hence resulted in smaller actual distribution score. *T. grandis* found in pasture areas were thought to originate from forest area and new shoots regenerated from logged stumps of mature *T. grandis* because most of them were saplings. Meanwhile, C. *dactylon* were only found in Cikamal grassland area, occupying most of the middle area of the grassland by forming

Table 3. List of invasive alien plants in Pangandaran Nature Reserve

Family	Species	IV (%)											
		Herbs						Trees					
		PP	CIR	CIK	NGR	BDT	BMJ	PP	CIR	CIK	NGR	BDT	BMJ
Aste	*Chromolaena odorata*			21	4.7								
Aste	*Elephantopus scaber*			9.8									
Cype	*Cyperus sp.*			7.5									
Cype	*Fimbristylis monostachya*			12									
Mela	*Melastoma malabathricum*			26	4.6						2.9		
Oxal	*Oxalis corniculata*	2.1											
Poac	*Axonopus compressus*			4.8									
Poac	*Chrysopogon aciculatus*			27									
Poac	*Cynodon dactylon*			38									
Verb	*Tectona grandis*			16	11					125	47	9.6	
Vita	*Cissus sicyoides*				3.6		5.3						

dense monotypic colonies, whereas *C. odorata* occupied the middle and edges of the grassland area in large to small coloniesPersistence of *T. grandis* was actually lower than *C. dactylon* (Table 3) due to *C. dactylon* has shorter reproductive age and longer reproduction period (Horowitz, 1972; Palanisamy *et al.*, 2009), hence *C. dactylon* needs more frequent management actions. But seeds of *T. grandis* can remain viable for more than two years (WUR). As stated by Virtue (2008), viability of seedbank is the primary determinant of how long treatment to IAS plants should be applied. The ability of *T. grandis* to re-invade the same location or to start new invasion is related to its dispersal ability, which is quite high, were as mentioned in discussion of risk above that *T. grandis* was once deliberately planted and has ability for long-distance dispersal through natural vectors.

3. Recommendation of IAS plants management

Based on matrix of recommendation management, risk index, and feasibility index, three recommendations for IAS plants management in PNR were obtained; manage species, manage locations, and monitoring (Table 4). Virtue (2008) has compiled the priority order of management recommendations from the highest; eradication, destroy infestation, contain spread, protect locations, manage species, manage locations, monitoring, and limited actions. Therefore, the sequence of IAS plants priority in PNR are respectively *C. odorata* and *T. grandis* (manage species), *M. malabathricum*, *C. dactylon*, and *C. aciculatus* (manage locations), and *F. monostachya* (monitoring) (Table 4).

Management recommendation of "manage species" aims to reduce environmental, economic, and social impacts as a result of invasion of IAS plants (Tjitrosoedirdjo *et al.*, 2016). In this case, the intended impact is the impact on the environment because the research is carried out in a natural system. IAS plants that are included in the "manage species" recommendations are *T. grandis* and *C. odorata* which is quite widespread, especially in Cikamal region. According to Glass (2004), invasive species with broad range of distribution will be more easily controlled with several steps in a smaller area. In addition, the determination of key locations must be carried out in detail to identify the factors supporting the spread, for instance bird nest, as birds are important dispersal agent. By knowing the location of bird nest, preventive measures can be set up to decrease seed dispersal by birds. In addition, mapping of satellite populations of IAS plants also needs to be done. This is because management that focuses on satellite populations will be more effective than large populations (Sheckelford *et al.*, 2013).

The specific management effort that can be applied to manage *T. grandis* is by continually removing the newly grown teak saplings and shoots that grow from logged stumps immediately after they emerge. This is done because shoots from logged stumps are one of the main sources of *T. grandis* regeneration in the Cikamal grassland. Besides that, this is the easiest way to impede and halt *T. grandis* growth since saplings of *T. grandis* are easy to access and does not need to put too much effort to pull out. Another way is the logging of *T. grandis* saplings in satellite populations around (Sheckelford *et al.*, 2013) the Cikamal area, especially forest areas heading to an already-invaded Nanggorak region, needs to be done to reduce abundance and prevent the further spread of *T. grandis* to Nanggorak.

Similar to *T. grandis*, mapping and control of satellite populations and monotypic colonies of *C. odorata* around Cikamal region also need to be done (Sheckelford *et al.*, 2013). This is related to the broad distribution of *C. odorata* and its seeds can be spread

Table 4. Risk index and category of IAS plants in PNR

Species	Parameters			Risk Index (R)	Risk Category
	Invasiveness (IV)	Impact (I)	Potential Distribution (PD)		
Tectona grandis	6	4.7	6	169.2	High
Chromolaena odorata	5.3	4.7	6	149.5	High
Cynodon dactylon	6	4.2	4	100.8	Medium
Melastoma malabathricum	6	3.2	4	76.8	Medium
Chrysopogon aciculatus	6.7	3.2	2	42.88	Medium
Fimbristylis monostachya	4.7	1.6	2	15.04	Low

through the wind (Witkowski and Wilson, 2001). In young plants, manual control can be done by extraction followed by periodic cleaning every 2-3 months to prevent regeneration (CABI, 2007). In addition, the removal of seeds and flowers as they emerge and clearing in colonization areas can also be done (GISD, 2006). Utilization of biological control agents can be implemented by using *Ceicdochares connexa* as natural enemies of *C. odorata*. This effort has been tested by Widayanti *et al*. (2001) in PNR with good results.

Management recommendation of "manage locations" aims to preserve environmental, economic and social values at key locations through improved management of IAS plants (Tjitrosoedirdjo, *et al*. 2016). This recommendation focuses more on site/location management because it is related to the lower potential distribution of IAS plants. Planting berries around Cikamal grassland can be done as a diversion for *M. malabathricum*-seed-dispersing birds (Starr *et al*. 2003). In addition, the limitation of the Cikamal grassland from human access is also needed to reduce the potential of thorny seeds of *C. aciculatus* being carried by human clothing and footwear to other places. Management can also be done by turning the soil upside down periodically with a hoe to get the rhizomes of *C. dactylon* and *C. aciculatus* exposed to sunlight and drying out (Burton and Hanna, 1985). This is done because their complex rhizome structure and extensive colonization in Cikamal made cutting the top parts alone are ineffective.

Management recommendation of "monitoring" are carried out to detect changes in the risk of IAS plants (Tjitrosoedirdjo *et al*., 2016). Monitoring generally applies to plants that have high management feasibility but low risk so it does not need to be eradicated. IAS plant which is categorized in the "monitoring" recommendation is *F. monostachya*. Monitoring effort can be done by making a permanent sample plot to monitor changes in the impact and abundance of *F. monostachya* colonization (Rahayu, 2017) and reviewing invasiveness change of *F. monostachya* by conducting a risk assessment within a certain period (Glass, 2004).

The recommendations above require continual monitoring efforts to detect threats of IAS plants at the earliest possible time and evaluate any action that has been taken. Considering the results of this research and the capability of stakeholders involved, those recommendations are designed for short-term implementation. The use of herbicides cannot be implemented in PNR to maintain the biodiversity of PNR as high conservation value (HCV) area. Meanwhile, control with biological agents still requires further study and requires ad-

Table 5. Feasibility index and category of IAS plants in PNR

Species	Parameters			Feasibility Index (F)	Feasibility Category
	Control Cost (CC)	Actual Distribution (AD)	Persistence (P)		
Tectona grandis	5.3	5	6.4	192	Negligible
Cynodon dactylon	3.3	5	7.3	120.5	Negligible
Chromolaena odorata	3.3	5	6.4	105.6	Low
Chrysopogon aciculatus	3.3	4.2	3.6	49.9	Medium
Melastoma malabathricum	4	3.3	3.6	47.52	Medium
Fimbristylis monostachya	3.3	1.7	3.6	20.19	High

Table 6. Recommendation of IAS plants management

Species	Risk category	Feasibility category	Recommendation of management
Chromolaena odorata	High	Low	Manage species
Tectona grandis	High	Negligible	Manage species
Cynodon dactylon	Medium	Negligible	Manage location
Melastoma malabathricum	Medium	Medium	Manage location
Chrysopogon aciculatus	Medium	Medium	Manage location
Fimbristylis monostachya	Low	High	Monitoring

equate human resources but is expected to be implemented in PNR in the long-term and become the basis for the more sustainable management of IAS plants.

Management of IAS plants in PNR is an effort to protect conservation areas as well as natural tourism asset in West Java. Therefore, the role and support of various parties such as government agencies, private sector, Non-Governmental Organizations (NGOs), and community are urgently needed. But the role and support of all parties can only be obtained if there is awareness of IAS plants threats. Therefore, dissemination, information exchange, and transfer of knowledge about IAS plants are very important in efforts to prevent the spread of IAS plants in PNR, especially in Cikamal Grassland area.

Conclusion

Cikamal grassland is an area with the highest number of invasive alien species (9 species out of a total of 12 species) in PNR, namely *T. grandis*, *C. odorata*, *C. dactylon*, *M. malabathricum*, *C. aciculatus*, *F. monostachya*, *Cyperus* sp., *E. scaber*, and *A. compressus*. Their risk index, feasibility index, and recommendation of management are respectively as follows: 169.2; 192; manage species, 149.46; 120.45; manage species, 100.8; 101.2; manage species, 76.8; 47.52; manage sites, 42.88; 49.89; manage sites, and 24, 44; 24,48; monitoring.

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