

EVALUATING THE INVASIVE STATUS OF *MIMOSA PIGRA* L., *EUPATORIUM ODORATUM* L. AND *EICHHORNIA CRASSIPES* (MART.) SOLMS IN TRAM CHIM NATIONAL PARK IN DONG THAP PROVINCE

Nguyen Thi Cam Nhung¹ and Dang Minh Quan^{2*}

¹Graduate School of Ecology, Can Tho University, Vietnam

²School of Education, Can Tho University, Vietnam

*Corresponding author: Dang Minh Quan, Email: dmquan@ctu.edu.vn

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Abstract

The study assessed the threat level of *Mimosa pigra*, *Eupatorium odoratum* and *Eichhornia crassipes* to flora in Tram Chim National Park by using the tour survey and standard quadrat setting method. Regarding canal and swamp habitats, *Eichhornia crassipes* had a very high threat level (IVI = 155.80% and the level 4 of association), reaching highest point in the rainy season. As regards the inside-dike habitats, *Mimosa pigra* had a high threat level (IVI = 70.79% and the level 4 of association), reaching the highest point in the dry season. *Eupatorium odoratum* had a moderate threat level (IVI = 49.99% and the level 3 of association). National Park managers enacted some effective controlling and management for *Mimosa pigra* and *Eichhornia crassipes*, but not for *Eupatorium odoratum* due to its low level of encroachment in the wild.

Keywords: *Eichhornia crassipes*, *Eupatorium odoratum*, invasive alien plant, *Mimosa pigra*, Tram Chim National Park.

ĐÁNH GIÁ THỰC TRẠNG XÂM LẤN CỦA MAI DƯƠNG (*MIMOSA PIGRA* L.), CỎ LÀO (*EUPATORIUM ODORATUM* L.) VÀ LỤC BÌNH (*EICHHORNIA CRASSIPES* (MART.) SOLMS) Ở VƯỜN QUỐC GIA TRÀM CHIM TỈNH ĐÔNG THÁP

Nguyễn Thị Cẩm Nhung¹ và Đặng Minh Quân^{2*}

¹Học viên cao học, Trường Đại học Cần Thơ, Việt Nam

²Khoa Sư phạm, Trường Đại học Cần Thơ, Việt Nam

*Tác giả liên hệ: Đặng Minh Quân, Email: dmquan@ctu.edu.vn

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Tóm tắt

Nghiên cứu đánh giá mức độ đe dọa của Mai dương, Cỏ lào và Lục bình đối với hệ thực vật ở Vườn Quốc gia Tràm Chim thông qua việc điều tra theo tuyến và lập ô tiêu chuẩn. Ở kênh và lung, Lục bình có mức độ đe dọa rất cao (IVI = 155,80% và quần hợp cấp 4), nhất là vào mùa mưa. Trong đê bao, Mai dương có mức độ đe dọa cao (IVI = 70,79% và quần hợp cấp 4), nhất là vào mùa khô. Cỏ lào có mức độ đe dọa ở mức trung bình (IVI = 49,99% và quần hợp cấp 3). Vườn Quốc gia đã có những biện pháp quản lý và kiểm soát hiệu quả đối với Mai dương và Lục bình, nhưng chưa có biện pháp kiểm soát Cỏ lào do mức độ xâm lấn của nó trong tự nhiên chưa cao.

Từ khóa: Cỏ lào, Mai dương, Lục bình, thực vật ngoại lai xâm hại, Vườn Quốc gia Tràm Chim.

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1. Introduction

Invasive alien plant (IAP) is one of the species alien groups that caused the extremely damage because of their ability to spread rapidly and invade, destroying native species and biodiversity, imbalances natural ecosystems and causes economic loss (Tran, 2000). *Mimosa pigra*, *Eupatorium odoratum* and *Eichhornia crassipes* are three invasive alien species that have popularly appeared in Vietnam (Ministry of Natural Resources and Environment, 2018). They caused serious harm and threaten the biodiversity of wetlands, especially, some protected areas such as Tram Chim National Park, U Minh Ha National Park and many areas in the South West. However, in recent times, there are still not many studies focusing on this issue (Nguyen, 2015).

Tram Chim National Park belongs to the typical wetland ecosystem of the Dong Thap Muoi region in the lower Mekong region. This diversity ecosystem were more than 130 species of native plants, 120 species of freshwater fish, nearly 40 species of amphibians, reptiles and more than 200 species of birds, of which 16 were rare birds, especially the red-headed crane (Nguyen, 2009). The current state of the flora in Tram Chim National Park is increasingly degraded due to the impact of tourism and the invasion of IAP species. Previous research mainly studied plant species composition (Luu et al., 2019), the invasion of *Mimosa pigra* (Nguyen, 2000), and some ecological characteristics of exotic plant species (Le, 2014) in this park. However, the level of invasion of the typical IAP species in the Circular 35/2018 of Tram Chim National Park has not been announced, especially in the climate change condition. Therefore, this study was carried out to provide the latest data on the distribution and invasion *Mimosa pigra*, *Eupatorium odoratum* and *Eichhornia crassipes* in this park. The results will be the scientific basis for effective management and control of invasive species in the context of climate change.

2. Research methods

2.1. Research method in the field

The study was conducted from September 2019 to April 2020, and samples were collected twice a year, once in the rainy season (September to October, 2019) and once in the dry season (March to April, 2020). The method of sampling transect, setting up standard plots and sampling trees was based on the method of Nguyen (2007). From the map of habitat status of Tram Chim National Park and from actual observations, the study surveyed and collected samples at 10 transects, through 05 areas (namely A1, A2, A3, A4, and A5) and set up 45 quadrats of 30 quadrats in terrestrial habitats for survey *Mimosa pigra* and *Eupatorium odoratum*, and 15 quadrats in canal and lake habitats for *Eichhornia crassipes* survey. Each quadrat size was 100 m² (10 m x 10 m). Within each of the 100 m² quadrat, there were five sub-squares (1 m x 1 m) of sample collection at four corners and center of the quadrat to determine the frequency of occurrence, density, and coverage of these three species in the park (Figure 1).

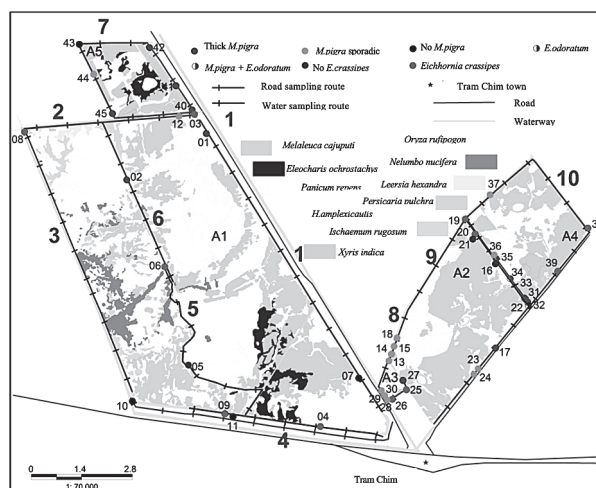


Figure 1. Diagram of transects and sampling quadrats in Tram Chim National Park
(Luu Hong Truong et al., 2019)

2.2. Threat assessment method

Association level: Association level of plants is an index showing the structure of the population of plant species to be surveyed. This

index was determined by five levels (Nguyen Nghia Thin, 2007): level 1 (grows sporadically), level 2 (grows into dust), level 3 (grows into small groups), level 4 (grows into large groups) and level 5 (grows into a thicket).

Occurrence frequency and relative occurrence frequency: The frequency of occurrence is the equation $F(\%) = \frac{P_i}{P} \times 100$ (Sharma, 2003), in which p_i is the number of quadrats that these invasive species present, and P is the total of surveying quadrats.

The relative occurrence frequency is calculated by the formula: $RF(\%) = \frac{\text{Frequency of occurrence of a research species}}{\text{Total frequency of occurrence for all species}} \times 100$

Density and relative density: The density of the species is calculated by the formula (Sharma, 2003): $D_i (\text{individual}/\text{m}^2) = \frac{n_i}{N}$, in which, D_i is species density of i th species; n_i is total number of individuals of species i ; N is the total number of sampling quadrats. Relative density of the species is determined by the formula: $RD(\%) = \frac{D_i}{\sum D} \times 100$, in which, RD is relative density of species i ; D is total densities of species.

Canopy area and canopy cover level: Canopy area (m^2) means the area covered by that species on the ground surface or the water surface (for aquatic plants). Canopy cover level (%) is defined as the percentage of the ground area covered by the canopy (for each species) and the total canopy cover of all species at the surveyed sites (Rastogi, 1999). In addition, to determine the canopy area of the three IAP species, the study also used satellite imagery Landsat 8 OLI/TIRS C1, taken on October 18, 2019 and March 10, 2020 with image resolution of 30 m x 30 m and ENVI Classic software combined with field research to interpret images.

Importance value index (IVI): IVI is a reasonable measure to assess the overall significance of a species because it was interpreted by the specific quantitative parameters of the species in the vegetation (density, frequency of occurrence, and dominance). Because of large cover areas of *Mimosa pigra*, *Eupatorium*

odoratum and *Eichhornia crassipes*, the coverage area of the other species living with these three species was very low. Thus, the dominance of each IAP species was represented by the canopy cover level itself. The IVI was calculated through $IVI(\%) = RF(\%) + RD(\%) + \text{Canopy level}(\%)$ (Rastogi, 1999; Sharma, 2003).

Threat level: Based on the IVI of species and the level of the association, the research divided four threat levels of IAP species (Dang & Dinh, 2019) as follows:

Low threat level: $IVI < 20\%$; Association level of plants: Level 1 or 2.

Average threat level: IVI from 20% to 50%; Association level of plants: Level 3 or 4.

High threat level: IVI from 51% to 80%; Association level of plants: Level 4 or 5

Very high threat level: $IVI > 80\%$; Association level of plants: Level 4 or 5.

Statistical analysis: The method of analysis of variance (ANOVA) in SPSS Ver.22 (IBM Corp., 2013) was applied to compare the mean density of the three invasive species.

2.3. Evaluation of solutions for managing and preventing IAP species

Inheriting the data of Tram Chim National Park on measures to manage and control the invasiveness of IAP species implemented from 2015 to 2019, the study analyzed and evaluated the effectiveness of the control measures on IAP species of the park.

3. Research results

3.1. Distribution of three IAP species in Tram Chim National Park

Tram Chim National Park is a wetland ecoregion in the lower Mekong. Every year, from July to November, most of this area is inundated by both the flood from the Mekong River and the local rainfall. This feature affects the growth and distribution of plants that mainly present in habitats of canals, ditches, or along dikes, namely *Eichhornia crassipes*, *Mimosa pigra*, and *Eupatorium odoratum*. Details of the distribution and association level of these three species in the park are shown in Table 1.

Table 1. Distribution of three IAP species in Tram Chim National Park

Species	Season	Association level					Number of quadrats
		Zone A1	A2	A3	A4	A5	
<i>Mimosa pigra</i>	Rainy	1	1	1	1	4	30
	Dry	2	4	2	3	5	30
<i>Eupatorium odoratum</i>	Rainy	0	3	2	3	0	30
	Dry	0	2	1	2	0	30
<i>Eichhornia crassipes</i>	Rainy	2	5	3	4	2	15
	Dry	1	3	2	3	1	15

Notes: 1: grows sporadically; 2: grows into dust; 3: grows into small groups; 4: grows into large groups; 5: grows into a thicket.

- *Mimosa pigra* has distributed in all zones, from A1 to A5, and occurred during both wet and dry seasons. It has grown and thrived strongly in the dry season. It has grown into dust (zones A1, A3), or into groups (zones A4, A2), or into large and dense clumps (zone A5) along the canals and along the embankments. However, during the rainy season, the association level of *Mimosa pigra* remarkably decreased in some areas along the canals flooded for 4-5 months. Only few individuals have scattered on the dikes and high mounds not flooded in zones A1, A2, A3 and A4. Especially, in zone 5, the survey results showed that the association level of *Mimosa pigra* was the highest. Many individuals have grown in large groups even in the rainy season because along the high dike system in this area, the depth of inundation was lower than the other areas without constructing the dike system. Thus, the control of appropriate flooding depth has formed a favorable habitat for the development of *Mimosa pigra*.

- *Eupatorium odoratum* distributed in zone A2, A3 and A4 during both wet and dry seasons. However, in the rainy season, it appeared more often than in the dry season because this was a suitable condition for the germination of dormant seeds. *Eupatorium odoratum* is a photophilic plant and it often grows in small bushes or small groups along the dike with lots of light, but most often along the road from Ca Dam station to Quyet Thang station in zone A4 and

opposite Ca Dam station in zone A2. These are new dikes to be built in recent years, with lots of bare soil, without the appearance of trees and shrubs, so it is suitable for the growth and development of *Eupatorium odoratum*. In areas A1 and A5, *Eupatorium odoratum* was not found in both rainy and dry seasons because the dike roads in these two areas have been planned to plant many trees and shrubs for building shade and preventing landslips, such as *Eucalyptus camaldulensis*, *Acacia auriculiformis*, *Khaya senegalensis*, *Bambusa bambos*. Thus, these habitats were not suitable for the growth and development of light-loving species, namely *Eupatorium odoratum*.

- *Eichhornia crassipes* distributed in all zones from A1 to A5 in both rainy and dry seasons. They have grown and thrived in the rainy season, especially from July to November (the flood season). In zones A2 and A4, *Eichhornia crassipes* appeared with large clusters and sometimes dominated in many sections of the canals. In the dry season, *Eichhornia crassipes* was dead and degraded seriously. In zones A1, A5, and A3, a few individuals or small dust floated scattered on the water in many canals. Its association level was low due to the low water depth, sunshine lasting long and high temperate. Especially, the high concentration of aluminum in the water caused toxic and limited the growth of *Eichhornia crassipes* (Truong et al., 2019).

3.2. Occurrence frequency, density and canopy area

3.2.1. Occurrence frequency

The occurrence frequency of *Mimosa pigra*, *Eupatorium odoratum* and *Eichhornia crassipes* at 45 sampling quadrats during two seasons in five zones of the park was shown in Table 2.

In the dry season, the occurrence frequency

of *Mimosa pigra* was very high (accounting for 100%), while in the rainy season its occurrence frequency was lower (accounting for 83.33%). Zones A5 and A2 had the highest occurrence frequency of *Mimosa pigra* (100%), followed by zone A1 (94.44%), and lowest in zone A3 (66.67%). In the whole study area, the average frequency of occurrence in both seasons was 91.67%.

Table 2. The occurrence frequency of three IAP species in Tram Chim National Park

No	Species	F (%)								RF (%)
		Rainy season	Dry season	Zone A1	Zone A2	Zone A3	Zone A4	Zone A5	Average season	
1	<i>Mimosa pigra</i>	83.33	100	94.44	100	66.67	83.33	100	91.67	21.25
2	<i>Eupatorium odoratum</i>	60.00	43.33	0.00	100	50.00	83.33	0.00	51.67	11.98
3	<i>Eichhornia crassipes</i>	100	86.67	66.67	100	100	100	100	93.33	51.09

The occurrence frequency of *Eupatorium odoratum* in the rainy season (60.00%) was higher than in the dry season (43.33%). In zone A2, the occurrence frequency of *Eupatorium odoratum* was highest (100%), followed by zone A4 (83.33%) and then zone A3 (50.00%). *Eupatorium odoratum* did not occur in zones A1 and A5. The average frequency of occurrence in both seasons in the whole study area was 51.67%. For the terrestrial IAP group in the park, the occurrence frequency of *Mimosa pigra* was much higher than *Eupatorium odoratum*.

Eichhornia crassipes appeared in all surveyed quadrats. Its occurrence frequency was high in both rainy season (100%) and dry season (86.67%). In the whole study area, the average frequency of occurrence of *Eichhornia crassipes* in both seasons was 93.33%. However, occurrence of *Eichhornia crassipes* had the lowest frequency in zone A1 (66.67%).

Eichhornia crassipes is dominant in number of individuals and is very widely distributed in swampy habitats and canals. It forms large clumps, overwhelming the habitat of other aquatic plants, so its relative frequency of appearance is very high (RF = 51.09%) compared to other aquatic plants. In dike habitats, *Mimosa*

pigra predominates with RF = 21.25% and lowest is *Eupatorium odoratum* with RF = 11.98%.

3.2.2. Density

The density of *Mimosa pigra*, *Eupatorium odoratum* and *Eichhornia crassipes* at 45 quadrats in two seasons in the five areas of the park was shown in Table 3.

In the dry season, the average density of *Mimosa pigra* was 3.64 ± 0.5 individual/m², and was higher than in the rainy season (1.05 ± 0.26 individual/m²). In zone A5, the density of *Mimosa pigra* was the highest in both the dry season (5.38 ± 2.42 individual/m²) and the rainy season (3.00 ± 1.34 individual/m²) ($p < 0.05$). However, in the same season its density was of no statistical difference in zones A1, A2, A3 and A4 ($p > 0.05$).

Eupatorium odoratum has been only found in zones A2, A3, A4 in the rainy season with an average density at 2.00 ± 0.49 individual/m². In the dry season, it occurred in zones A2 and A4 with a density of approximately 1.38 ± 0.37 individual/m². However, in both seasons, the density of *Eupatorium odoratum* was not significantly different between the surveyed zones ($p > 0.05$).

Table 3. Density of the three IAP species in Tram Chim National Park

Area	Individual density in rainy season (Individual/m ²)			Individual density in dry season (Individual/m ²)		
	<i>Mimosa pigra</i>	<i>Eupatorium odoratum</i>	<i>Eichhornia crassipes</i>	<i>Mimosa pigra</i>	<i>Eupatorium odoratum</i>	<i>Eichhornia crassipes</i>
A1	0.6±0.22 ^b	-	4.67±0.23 ^c	2.24±0.49 ^b	-	0.4±0.4 ^c
A2	1.06±0.43 ^b	3.64±1.09 ^a	11.67±0.34 ^a	4.4±0.92 ^b	2,43±0,63 ^a	8.47±0.26 ^a
A3	0.03±0.03 ^b	3.93±0.48 ^a	3.27±0.32 ^c	3.1±1.39 ^b	2,02±0,96 ^a	1.47±0.24 ^c
A4	1.02±0.5 ^b	4.58±1.53 ^a	7.27±0.86 ^b	3.71±1.01 ^b	3,67±1,3 ^a	3.23±0.62 ^b
A5	3.00±1.34 ^a	-	3.2±0.53 ^c	5.38±2.42 ^a	-	1.03±0.09 ^c
Average	1.05±0.26	2.00±0.49	6.01±0.87	3.64±0.5	1.38±0.37	2.92±0.8

Note: Values followed by dissimilar letters (a, b, c) under the same column are significantly different at $p < 0.05$ by Duncan's test.

Eichhornia crassipes appeared with the higher average density in the rainy season (6.01±0.87 individual/m²), while the average density in the dry season was 2.92±0.8 individual/m². Zone A2 has the highest density of *Eichhornia crassipes* in both seasons and the difference was statistically significant at 5%. In zone A2, Phu Duc canal has connected to the canal system outside the park, so the exchange of water has improved. The water was less acidic and the toxic concentration (namely aluminum and ferric) was lower than the canals in other areas. Therefore, *Eichhornia crassipes* has grown and developed stronger, even in the dry season.

Based on the total densities of species in surveyed 45 quadrats, the relative densities of three IAP species have been determined in the whole study area. *Eichhornia crassipes* had the highest relative density (accounting for 87.32%), followed by *Mimosa pigra* (45.02%). *Eupatorium odoratum* had the lowest relative density (32.39%).

3.2.3. Canopy area

From the field surveyed results, combined with satellite image interpretation, the study determined the canopy area of three AIP species in both seasons shown in Table 4.

Table 4. Canopy area and canopy level of three IAP species

Species	Canopy area (m ²)			Canopy level (%)
	Rainy season	Dry season	Average area (m ²)	
<i>Mimosa pigra</i>	1,395	189,256	95,325	4.52
<i>Eupatorium odoratum</i>	16,421	9,424	12,922	0.62
<i>Eichhornia crassipes</i>	409,116	4,720	206,918	17.39

Mimosa pigra has grown and invaded strongly in the dry season and the total coverage area was estimated 189,256 m². They grow in large clumps along the dikes and the canals. In contrast, in the rainy season, the water in the swamps and canals rises very high, causing the *Mimosa pigra* areas living along the two banks of the dike to be deeply flooded, so the *Mimosa pigra* in these areas dies. Only *Mimosa pigra* has scattered on the surface of the dike or high

mounds can survive, so the area of *Mimosa pigra* has decreased significantly compared to this in the dry season (about 1,395 m²).

Similarly, *Eupatorium odoratum* grew and invaded both in rainy season and dry season. They grew in groups along the dike or along the trails, mainly in zone A4 and A2. They are strongest in the rainy season with the canopy area of 16,421 m². At the end of May, in some

sections of the dike in A2 and A4, the *Eupatorium odoratum* wilted and dried, so the canopy area in the dry season was only 9,424 m².

In the rainy season, *Eichhornia crassipes* dominated and invaded in canals stronger than in the dry season. Especially, in rainy season, its canopy area was very large (409,116 m²), while it decreased seriously in dry season (4720 m²). *Eichhornia crassipes* has often gathered in large clumps, with a very high number and density of individuals, covering many sections of canals in the park, most in A2, followed by areas A4, A1, obstructing the circulate and inhibit the growth of other aquatic plants. However, in the dry season, due to an increase in the concentration of alum in the water along with the gradually drying of the water source, *Eichhornia crassipes* was massively dead.

On average, in the whole study area, for canal and lake habitats, the canopy area of *Eichhornia crassipes* was very high with 206,918 m² and canopy cover accounted for 17.39% of the study area. *Mimosa pigra* had an average canopy area in the whole study area of 95,325 m² and canopy cover made up 4.52% of the study area. *Eupatorium odoratum* had the lowest with an average canopy area of 12,922 m² and canopy cover at 0.62% of the study area.

3.3. Assessment of the invasive level

Based on relative occurrence frequency, relative density and canopy level, the study has identified IVI of each IAP species. Combined with the association level, the study identified the invasive levels of these three species shown in Table 5.

Table 5. Invasive level of three IAP species in Tram Chim National Park

Index	<i>Mimosa pigra</i>	<i>Eupatorium odoratum</i>	<i>Eichhornia crassipes</i>
Life form	Bush	Grass	Aquatic
RF (%)	21.25	11.98	51.09
RD (%)	45.02	32.39	87.32
Canopy level (%)	4.52	0.62	17.39
IVI (%)	70.79	44.99	155.80
Association level of plants	4	3	4
The threat level	High	Average	Very high

Note: Association level of plants: 3 - grows into small groups; 4 - grows into large groups; 5 - grows into a thicket.

Among three surveyed IAP species, *Eichhornia crassipes* was at highest threat with its IVI reaching 155.80% and the association at level 4. They have grown into large clumps and high density. It invaded on the habitats of other aquatic plants and reduced the diversity of aquatic flora in the park. Besides, the overgrowth of *Eichhornia crassipes* in the canals caused many difficulties for the water exchange and forest fire control. The strong and dominant growth of *Eichhornia crassipes* also affects the respiration of aquatic animals, and makes it difficult to prevent forest fires. The negative impact of decomposed *Eichhornia crassipes* also causes organic pollution in the water areas.

Of the two terrestrial IAP species, *Mimosa pigra* holds a higher threat level than *Eupatorium odoratum* with the high IVI value (70.79%) and an association level of level 4. In zone A5, *Mimosa pigra* has grown into dense clumps and invaded the habitat of other terrestrial flora species. Because of high reproduction and persisting for a long time in the soil, its adaptability and competitiveness were higher than other natural plant species. Thus, preventing ecological damages caused by this exotic species, the park should apply effective methods to control its invasion in the near future.

The threat level of *Eupatorium odoratum* was medium in this park with IVI = 44.99%

and association level being level 3. *Eupatorium odoratum* mainly distributed in zones A2 and A4 and grown into small groups along dikes being full of sunlight. Although the threat level of this alien species has not been serious yet, its invasion risk to other close areas is very high. Because of very small and light seeds, it is easy to spread by the wind and follow the channels to other zones.

3.4. Evaluation of solutions for managing and preventing IAP species in Tram Chim National Park

Based on the natural and biological characteristics of the three IAP species, Tram Chim National Park applied several measures to control these species from 2015 to 2019. Figure 2 described the controlled area and the effectiveness of used methods (Source of Tram Chim National Park, 2020).

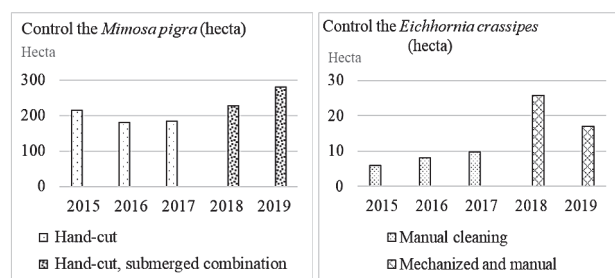


Figure 2. The effectiveness of applied measures to control *Mimosa pigra* and *Eichhornia crassipes* from 2015 to 2019

From 2015 to 2017, the control of *Mimosa pigra* was only applied by hand cutting and helped control 113.52 hectares of the park. Starting in 2018, the control of *Mimosa pigra* by means of combination of cutting by hand and submerged were implemented. This combined method has been shown to be more effective in controlling *Mimosa pigra* than using a hand-cut thread and has helped to control an area up to 281 hectares in 2019.

The management of *Eichhornia crassipes* invasion by manual cleaning (using a net or a tree section with a sickle to pick up *Eichhornia crassipes* on the dike banks) was carried out from 2015 to 2017 with low efficiency. *Eichhornia crassipes* control area was recorded less than 10

hectares. In 2018, the park applied the combination of mechanization (using an excavator placed on a barge to pick up *Eichhornia crassipes* from canals to shores) and manual method to control the invasive area of *Eichhornia crassipes*. The combined method was more effective than the manual. The controlled area for *Eichhornia crassipes* in 2018 amounted to more than 25 hectares. However, in 2019, it only applied the mechanization method, and the *Eichhornia crassipes* control area decreased significantly compared to 2018, for less than 20 hectares. Thus, for *Eichhornia crassipes*, the combined application of mechanization and the manual method gave the highest control efficiency.

Previously, *Eupatorium odoratum* invasion control in Tram Chim National Park has not been carried out, because the invasive level of this exotic species was not high and mainly concentrated in zones A2 and A4. However, in the future the park needs to control this exotic species because the natural environment will be changed by climate change, and its potential invasion to neighbor areas will not be limited.

4. Conclusion

Mimosa pigra, *Eupatorium odoratum* and *Eichhornia crassipes* have been the three common IPA species in the Tram Chim National Park. They have distributed throughout the A1 to A5 zones in both the rainy and dry seasons. In the canal and swamp habitats, *Eichhornia crassipes* had a very high invasive level, especially in the rainy season. In habitat along the canal and the edges of dike, in the dry season, *Mimosa pigra* held the higher threat level than *Eupatorium odoratum*, while *Eupatorium odoratum* grew strongly in the rainy season. The park has applied effective control measures, including combining manual methods and mechanization to control *Eichhornia crassipes* or combining manual methods and appropriate flood to control *Mimosa pigra*. But, *Eupatorium odoratum* has not been controlled strictly due to the invasive level of this exotic species is low in the nature of this park.

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