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Invasive Plants Species Diversity in Nanggala III Nature Tourims Park of Palopo City, South Sulawesi, Indonesia

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ABSTRACT

South Sulawesi, located in Sulawesi Island, Indonesia, is recognized for its high biodiversity, endemicity, and plant diversity. However, these unique plant species are currently undergoing significant structural and compositional changes, attributed largely to human activities and natural disasters. These changes have facilitated the introduction of invasive plant species, posing severe threats to the existence of endemic plants in the region. These invasive species have been observed to detrimentally impact local plant species, habitats, and ecosystem functions, thereby leading to imbalances and a reduction in genetic diversity. Furthermore, they utilize native plant resources, causing species extinction and substantial economic losses. In this study, three transects intersecting contour lines at different locations were established. Along each transect, five observation plots were created at 25-m intervals, yielding a total of 15 plots. The investigation revealed that the Nanggala III Nature Tourism Park, located in Wara Barat District, Palopo City, South Sulawesi, harbors invasive plants from 11 families comprising 19 species at the seedling and understorey levels. The sapling level included 4 families with 4 species, while the pole level consisted of 3 families with 3 species. The tree level comprised 2 families with 2 species. The invasive plant with the highest Important Value Index (IVI) at the seedling or understorey level was *Drymaria cordata* Willd with an IVI of 29,189. *Calliandra calothyrsus* exhibited the highest IVI of 119,088 at the sapling level, whereas *Poronena canesceus* dominated the pole and tree levels with an IVI of 184,178 and 272,332, respectively. The diversity of weeds (H') was recorded as medium at the seedling or understorey level (2.772) and the sapling level (1.311), and low at the pole level (0.924) and tree level (0.308). The findings from this study provide critical insights that could inform the development of a scientifically-based management strategy. This strategy could assist administrative institutes in the ecological restoration of degraded habitats in the area under investigation.

1. INTRODUCTION

South Sulawesi, a province within Indonesia, boasts high biodiversity and endemicity, hosting a diverse range of plant species across distinctive ecosystems and habitats, from aquatic to mountainous regions [1]. An estimated 5000 plant species are dispersed across Sulawesi Island, with 9 out of 57 endemic plant species being located in this region. However, substantial alterations in the structure and composition of plant species, induced by human activities or natural disasters, have been observed [2]. Such disturbances have facilitated the incursion of invasive plants, posing a significant threat to the survival of endemic plants.

The rise of globalization, characterized by increased trade and transportation flows, has enabled various species to traverse long distances and infiltrate new habitats as alien species. These invasive species, upon entering novel ecosystems, adapt and compete with indigenous species [3]. Although some invasive plant varieties and strains can yield economic benefits and contribute positively to social welfare, others grow and spread rapidly, outcompeting native species, and are hence termed invasive alien species (IAS). The importation, dispersion, and utilization of various invasive plant species, either intentionally or unintentionally, have been identified as key factors contributing to the proliferation of invasive species in a region.

Invasive plant species are defined as non-native species that pose threats to ecosystems, habitats, and other species [4]. According to the International Union for Conservation of Nature (IUCN), invasive species are those that establish themselves naturally or semi-naturally in ecosystems or habitats, transition from intermediaries, and become biologically threatening [5]. In a broader context, it can be inferred that weeds are a type of plant originating from a habitat outside the ecosystem.

Invasive Plant Species (IPS), or alien plants introduced into an ecosystem, can proliferate rapidly and extensively dominate a certain habitat, leading to economic losses or negative environmental impacts [6, 7]. They can even result in the extinction of local plants already present in a habitat [8]. As per IUCN's definition, alien species are taxa introduced beyond their natural habitat range, either intentionally or unintentionally, through human intervention [9].

The introduction of invasive plant species has resulted in various adverse impacts in conservation areas [10]. Invasive plants present a significant challenge in the management of protected areas globally [11], as they are hazardous and difficult to control [12]. Species invasion is a critical issue in ecosystem management, as it forms a major component of global environmental change [13, 14]. It is reported that approximately 1,936 species of invasive plants are spread across Indonesia, some of which have become invasive. These species, comprising shrubs, trees, herbs, grasses, aquatic plants, and ferns, originate from tropical America, Africa, Australia, and South Asian countries [15].

It was reported that the impact of the introduction of invasive plant species in Indonesia has occurred in various natural ecosystems including conservation areas [16]. An example of an invasive plant that has had a negative impact on several conservation areas in Indonesia is *Acacia decurrens* which invaded and dominated the existence of native plant species on burned land in Mount Merbabu National Park. Introduction of *Casia tora*, *Auspoeupawrium inulifolium*, and *Lantana camara* to Sadengan pastures in Alas Purwo National Park, also introduction of *Acacia nilotica* to savanna ecosystems in Baluran National Park which had an impact on changes in the structure and species composition of grassland plants, thus suppressing populations of grasses that are a food source for banteng, conservation priority animals in both areas [17]. In addition, there is also *Chromolaena odorata* in Pangandaran and Ujung Kulon National Parks [18], *Passiflora* sp. in Gede Pangrango National Park, West Java, Indonesia [19].

The Nanggala III Natural Tourism Park, designated as a conservation and tourism area, is divided into five blocks: special, utilization, traditional, rehabilitation, and protection. The utilization block, intended for plantations, community settlements, and tourism, is separated by a trans road, indicating a high possibility of invasive plant introductions. However, information on invasive plant populations in this park has not been previously reported.

Given these considerations, research aimed at determining species diversity, species composition structure, and important value index of invasive plant species in the Nanggala III Natural Tourism Park, South Sulawesi, is of paramount importance. The findings of this study are anticipated to serve as a reference for future management efforts in this conservation area.

2. MATERIAL AND METHODS

2.1 Time and study sites

This research was conducted for 4 months starting from March to June 2022. This research was conducted at the Nanggala III Nature Tourism Park, Wara Barat District, Palopo City, South Sulawesi, Indonesia. The map of the research location can be seen in Figure 1. Geographically, this area located at Latitude: 02°13'06" South Latitude - 02°32'40" South Latitude and Longitude: 120°45'52" East Long - 121°17'32" East Longitude. This area was determined based on the Decree of the Minister of Forestry No. 663/Kpts-II/1992 dated 7 January 1992. Nanggala III Natural Tourism Park is located in Wara Utara District, Palopo City, Luwu Regency, South Sulawesi Province. This area has an area of ± 500 Ha, hilly to steep topography with altitude about 270 m asl. According to Schmidt and Ferguson's climate classification, Nanggala III Nature Tourism Park includes climate type C with an average rainfall of 2,200 mm per year. The maximum air temperature is 28℃ and minimum 22℃ (20). Identification of unknown plant species in the field was carried out at Herbarium Celebense (UPT. Sulawesi Biological Resources), Tadulako University, Palu, Indonesia.

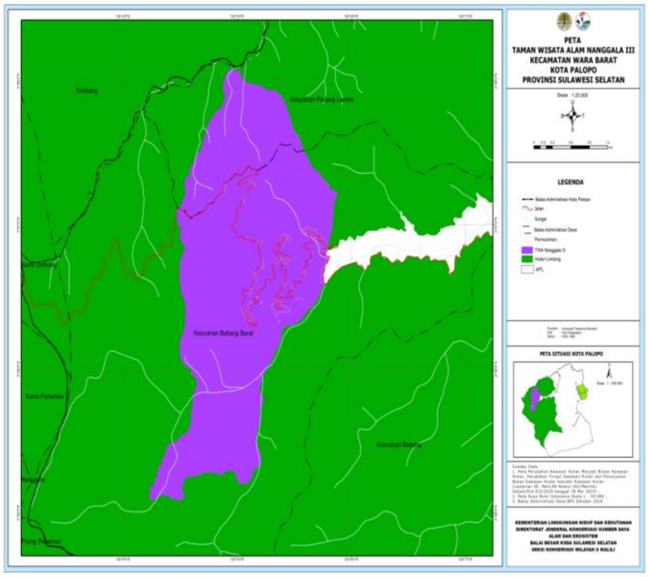

Figure 1. Research locations in Nanggala III Natural Tourism Park, Palopo City, South Sulawesi

2.2 Research methods

The method used in this research is the path transect method which is placed by Purposive sampling. In this observation, 3 paths were made to cut the contour line at different locations on each path, 5 observation plots were made so that the total number of observation plots was 15 plots. The transect line method is a method that can be used to analyze the vegetation of a large area and its research locations which vary in altitude, soil conditions and topography [20, 21].

2.3 Research procedure

The research began with a survey conducted to observe the conditions of the research location and to determine the location of the paths and observation plots. Next, paths and observation plots were made. The paths made are 3 lanes with a length of 200 m at different locations, with coordinate points; 2°56'42"S 120°04'55"E, 02°58'10.2"S 120°58'18.7"E and 02°57'44.7"S 120°05'0.7"E). For each line, 5 observation plots were made with a distance of 25 m each along the transect line so that the total number of successive plots was 15 plots with a size of 20 × 20 m for tree-level observations, then sub-plots with a size 10 m × 10 m were made inside for pole level observation. Observation plot for sapling level was 5 m × 5 m and observation plot for seedlings and understory was 2 m × 2

m. A sketch of the path laying and observation plots is presented in Figure 2.

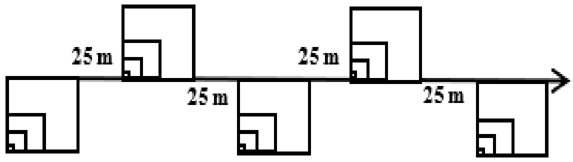

Figure 2. Sketch of path laying and observation plot

Observation of invasive plant species in each observation plot was focused on all plant species in the observation plot which included the name of the plant species, number of individuals, and documentation. Identification of plant species was carried out to find out the scientific name of the family and the origin of the weed species in the observation plots. Identification of invasive plant species was carried out using a field guide on invasive plants entitled; 75 Important invasive plant species in Indonesia, Invasive alien plant species in Indonesia and Regulation of the Minister of Forestry (Permenhut) Number 94 of 2016 concerning Invasive Species in Indonesia.

2.4 Data analysis

Data on invasive plant species obtained were then tabulated in tabular form and then analyzed to determine structure and composition, number of individuals of each species, Importance Value Index and Species Diversity Index (H') of invasive plants in Nanggala III Nature Tourism Park, Wara Barat District, Kota Palopo, South Sulawesi.

Important Value Index

Important value index (IVI) as a variable that can be used to determine the dominance of species of organisms in a community. The species that has the largest IVI is included as the dominant species in a community [22].

IVI is calculated using the following formula:

INP = KR + FR + DR for the level of saplings, poles and trees;

INP = KR + FR for seedling and understory plants;

Note: INP = important value index, KR = relative density, FR = relative frequency, DR = relative dominance.

Determination of KR, FR, DR for sapling, pole and tree levels:

a. Density (K)

$$K = \frac{\text{The number of individuals of the species}}{\text{Sample plot area}}$$

b. Relative Density (KR)

$$KR = \frac{\text{Density of a species}}{\text{Density of all speies}} x100\ \%$$

c. Frequency (F)

$$F = \frac{\text{Number of plots found a species}}{\text{Total number of plots}}$$

d. Relative Frequency (FR)

$$FR = \frac{\text{Frequency of a spceies}}{\text{Frequency of all species}} \times 100$$

e. Base area = ¼. $\pi . d^2$, where, $d=k/\pi$

f. Dominance (D)

$$D = \frac{\text{The total area of the base of a species}}{\text{Sample plot area}}$$

g. Relative Dominance (DR)

$$DR = \frac{\text{Dominance of a species}}{\text{Dominance of all species}} \times 100\%$$

Species Diversity Index

The species diversity index is calculated using the formula [23], namely:

$$H' = -\Sigma\ (pi\ Ln\ pi)\ ;\ pi=Ni/N$$

Notes:

H' = Shannon index of general diversity

pi = Importance probability for each species

Ni = importance value for each species

N = total importance value

Categories of species diversity index values according to namely:

1. If H' > 3 then the species diversity is high.
2. If H' is between 1-3 then the species diversity is moderate.
3. If H' < 1 then the species diversity is low.

3. RESULTS AND DISCUSSIONS

3.1 Structure and composition of invasive plant species

The results showed that invasive plant species in the Nanggala III Nature Tourism Park, Wara Barat District, Palopo City, South Sulawesi, at the seedling and understorey level, consisted of 11 families with 19 species. The sapling level consists of 4 families with 4 species. Pole level 3 families with 3 species. As for the tree level, it consists of 2 families with 2 species. The composition of these invasive plant species can be seen in Table 1.

The results in Table 1 show that the number of invasive plant species at the seedling/undergrowth level in Nanggala III Nature Tourism Park was higher than the species at the sapling, pole and tree growth stages. This is because at the level of seedlings or undergrowth, it is easier to grow and develop properly, especially in un-shaded environmental conditions and with sufficient sunlight. Table 1 also shows that the family with the highest number of species is the Asteraceae family consisting of 7 species, namely *Acmella paniculata* (Wall-ex. Dc), *Ageratum conyzoides* L., *Bidenz pilosa* L., *Choromlaena ordata*, *Dichrocephala integrifolia*, *Elephantopus mollis* Kunth, *Austrroeupatoriu inulaefolium* (Kunth). The results of this research are supported by the statement of Kurniawan et al. [24], who said that the Asteraceae family is found in large numbers because the species diversity of this family is quite high and can grow well in tropical areas that have high sunlight intensity. Confirmed by Cronguist [25] the Asteraceae family is a group of plants consisting of 1,100 genera covering 20,000 species, which are widespread throughout the world. Furthermore, it was reported that in the sub-tropical regions of Pakistan, Himachal Pradesh Himalayas India and Europe and China, the dominant invasive plant species found were from the Asteraceae and Poaceae families [25-29].

Table 1. Structure and composition of invasive plant species

Growth Level	Local Name	Scientific Name	Family	Individual Number
Seedlings and understory plants	Sarodong bulu	*Clidania hirta* L.	Melastomataceae	27
	Senggani	*Melastoma malabathricum* L.		16
	Semanggi	*Drymaria cordata (*L.) Willd. ex Schult.	Caryophyllaceae	73
	Getang	*Acmella paniculata* (Wall-ex. Dc)	Asteraceae	25
	Badotan	*Ageratum conyzoides* L.		41
	Tedak	*Bidens pilosa* L.		28
	Laruna	*Choromlaena ordata*		7
	Wedahan	*Dichrocephala integrifolia* (L.F.) Kuntze)		5
	Reu Tonggo	*Elephantopus mollis* Kunth		3
	Golkar	*Austroeupatorium inulaefolium* (Kunth)		9
	Pegaga	*Centella asiatica* (L.) Jurb.	Mackinlayaceae	22
	Sintong Pangala	*Crassocephalum crepidiodes* (Benth.) S. Moore	Composetae	8
	Reu Bunga	*Cuphea carthagenensis* (Jacq.) J.F. Macbr	Lythraceae	16
	Swalang	*Hyptis capitata* Jacq	Lamiaceae	15
	Doa'-Doa'	*Ipomoea cairica* (L.) Sweet	Convolvulaceae	15
	Kassi-kassi	*Lantana camara*	Verbenaceae	4
	Jarong	*Stachytarpheta indica* (L.) Vahl		8
	Putri malu	*Misoma pudica*	Fabaceae	27
	Rumput Teki	*Cyperus rotundus*	Cyperaceae	31
Sapling	Kaliandra	*Calliandra calothyrsus*	Fabaceae	21
	Golkar	*Austroeupatorium inulaefolium* (Kunt)	Asteraceae	11
	Pune	*Cibotium glucum*	Cibotiaceae	6
	Sungkai	*Poronena canesceus*	Lamiaceae	13
Pole	Kaliandra	*Calliandra calothyrsus*	Fabaceae	5
	Sungkai	*Poronena canesceus*	Verbenaceae	12
	Pune	*Cibotium barametz* (L.) J. Sm	Cibotiaceae	3
Tree	Kaliandra	Calliandra calothyrsus	Fabaceae	2
	Sungkai	*Poronena canesceus*	Verbenaceae	19

Table 2. Importance value index of invasive plants based on the growth levels

No.	Local Name	Scientific Name	Seedling	Sapling	Pole	Tree
1	Sarodong bulu	*Clidania hirta* L.	17.083	-	-	-
2	Semanggi	*Drymaria cordata* (L.) Willd. ex Schult.	29.189	-	-	-
3	Getang	*Acmella paniculata* (Wall-ex. Dc)	11.568	-	-	-
4	Badotan	*Ageratum cpnyzoides* L.	20.767	-	-	-
5	Tedak	*Bidens pilosa* L.	14.852	-	-	-
6	Pegaga	*Centella asiatica* (L.) Jurb.	12.026	-	-	-
7	Laruna	*Choromlaena ordata*	6.831	-	-	-
8	Sintong pangala	*Crassocephalum crepidiodes* (Benth.) S. Moore	5.847	-	-	-
9	Reu Bunga	*Cuphea carthagenensis* (Jacq.) J.F. Macbr	6.705	-	-	-
10	Wedahan	*Dichrocephala integrifolia* (L.F.) Kuntze	3.810	-	-	-
11	Swalang	*Hyptis capitata* Jacq	10.184	-	-	-
12	Reu Tonggo	*Elephantopus mollis* Kunth	3.284	-	-	-
13	Doa'- doa'	*Ipomoea cairica* (L.) Sweet	6.442	-	-	-
14	Kassi-kassi	*Lantana camara*	3.547	-	-	-
15	Senggani	*Melastoma malabathricum* L.	9.200	-	-	-
16	Putri malu	*Misoma pudica*	10.847	-	-	-
17	Golkar	*Austroeupatorium inulaefolium* (Kunth)	4.863	52.602	-	-
18	Jarong	*Stachytarpheta indica* (L.) Vahl	7.094	-	-	-
19	Rumput Teki	*Cyperus rotundus*	15.861	-	-	-
20	Kaliandra	*Calliandra calothyrsus*	-	119.088	71.525	27.668
21	Pune	*Cibotium barametz* (L). J. Sm	-	44.529	44.297	-
22	Sungkai	*Poronena canesceus*	-	83.781	184.178	272.332
	Total		200	300	300	300

3.2 Important value index of invasive plants

The important value index of invasive plants species in Nanggala III Nature Park is presented in Table 2.

The results in Table 2 show that the important value index for invasive plant species that dominates at the seedling/undergrowth level is *Drymaria cordata* (L.) Willd. ex Schult with an important value index of 29.189, and the species that has the lowest important index value is *Elephantopus mollis* Kunth with an IVI value of 3.284. At the growth rate of saplings, the dominant invasive plant species was *Calliandra calothyrsus* with an IVI of 119.088, and the lowest was *Cibotium barametz* (L). J. Sm with an IVI of 44,529. At the pole and tree growth levels, the dominant invasive plant species was *Poronena canesceus* with IVIs of 184,178 and 272,332 respectively, while the species that had the lowest IVI was *Calliandra calothyrsus* with IVIs at the pole and tree level of 71,525 and 27,668 respectively.

The results of this study indicate a higher number of invasive plant species compared to the results of Solfiyeni et al. [30]. They reported that in the Lembah Anai Nature Reserve, West Sumatra, Indonesia, there were 19 invasive plant species belonging to 12 families, with the highest Importance Value Index being the *Arenga obtusifolia* species, namely 27.36% and the least being the *Rubus moluccanus* species, namely 1.55%. The diversity index of invasive plant species is moderate (H'=2.80). Furthermore, the results of research by Sunaryo et al. [3] showed that there are four species of invasive plants that have potential threats to ecosystems and natural species in Mount Halimun Salak National Park, West Java, Indonesia, namely *Piper aduncum* (Piperaceae, with Important Value Index 20.70); *Calliandra calothyrsus* (Mimosaceae, INP = 9.11), *Austroeupatorium inulaefolium* (Asteraceae, INP = 18.77) and *Clidemia hirta* (Melastomataceae) as shrubs.

Ecologically, it can be argued that the importance value shown by each plant species is an indication that the species concerned is considered dominant in that area. The dominant species in a place can be used as a habitat indicator [31]. The dominance of a certain species in an area can have a negative impact on the ecosystem of the area occupied by that species. According to Tjitrosoedirdjo [32] that dominance is very closely related to invasion. Invasion is a trait that describes the performance of a plant or animal species that becomes dominant and threatens ecosystems, habitats and species found in a location.

The invasive plant species that are most dominant at each growth level are the species that have a better level of suitability for growing sites than other species, and vice versa, the species that have the lowest IVI at each growth level are likely to be the species with the highest suitability level. or the ability to adapt to the environment is not good [33].

3.3 Invasive plants species diversity

Table 3 shows that the highest species diversity index (H') of invasive plant species is at the seedling/undergrowth level followed by saplings, poles and trees. The diversity index value (H') at the seedling level was 2.772 (medium). The diversity index at the sapling level was 1.311 (moderate). The diversity index (H') at the pole level is 0.924 (low). The diversity index (H') at the tree level is 0.308 (low). The diversity index (H') refers to the magnitude of the diversity index according to Shannon-Winner (23) which states that if H' > 3 indicates high diversity of plant species. H' at a value of 1-3 indicates a moderate diversity of plant species. If H' < 1 indicates the diversity of plant species is low.

Table 3. Diversity index of invasive plant species based on the growth level

No.	Local Name	Scientific Name	Index of Species Diversity (H') Based on the Growth Level			
			Seedling	Sapling	Pole	Tree
1	Sarodong bulu	*Clidania hirta* L.	0.210	-	-	-
2	Semanggi	*Drymaria cordata* (L) Willd. ex Schult.	0.281	-	-	-
3	Getang	*Acmella paniculata* (Wall-ex. Dc)	0.165	-	-	-
4	Badotan	*Ageratum cpnyzoides* L.	0.235	-	-	-
5	Tedak	*Bidens pilosa* L.	0.193	-	-	-
6	Pegaga	*Centella asiatica* (L.) Jurb.	0.169	-	-	-
7	Laruna	*Choromlaena ordata*	0.115	-	-	-
8	Sintong pangala	*Crassocephalum crepidiodes* (Benth.) S. Moore	0.103	-	-	-
9	Reu bunga	*Cuphea carthagenensis* (Jacq.) J.F. Macbr	0.114	-	-	-
10	Wedahan	*Dichrocephala integrifolia* (L.F.) Kuntze	0.075	-	-	-
11	Swalang	*Hyptis capitata* Jacq	0.152	-	-	-
12	Reu Tonggo	*Elephantopus mollis* Kunth	0.067	-	-	-
13	Doa'- doa'	*Ipomoea cairica* (L.) Sweet	0.111	-	-	-
14	Kassi-kassi	*Lantana camara*	0.072	-	-	-
15	Senggani	*Melastoma malabathricum* L.	0.142	-	-	-
16	Putri malu	*Misoma pudica*	0.158	-	-	-
17	Golkar	*Austroeupatorium inulaefolium*(Kunth)	0.090	0.305	-	-
18	Jarong	*Stachytarpheta indica* (L.) Vahl	0.118	-	-	-
19	Rumput Teki	*Cyperus rotundus*	0.201	-	-	-
20	Kaliandra	*Calliandra calothyrsus*	-	0.367	0.342	0.220
21	Pune	*Cibotium barametz* (L). J. Sm	-	0.283	0.282	-
22	Sungkai	*Poronena canesceus*	-	0.356	0.300	0.088
		Jumlah	2.772	1.311	0.924	0.308

Nahlunnisa et al. [34] pointed out that, differences in the value of the diversity index of each species at the growth rate of a plant species, can be caused by several factors such as latitude, rainfall and the place and method of reproduction of each plant. The growth rate of seedlings/undergrowth had a higher diversity index than the levels of saplings, poles and trees. This is because plants at the growth level of seedlings/undergrowth are plants that easily adapt and thrive in open areas that are not too shaded or get enough sunlight. In addition, plants at the growth level of seedlings/undergrowth also have a short life cycle. Meanwhile, for the level of stakes and trees, it takes a long time to grow and develop until they finally form groups.

In the long term, the presence of these invasive plants can endanger the stability and sustainability of the ecosystem. Invasive foreign plants can dominate an area, so that local plants cannot grow anymore, due to disturbance mechanisms that are generated, for example through secondary metabolites (allelopathy). Of course, the diversity of plant species will continue to decrease over time and it is certain that these ecosystems will experience changes in the structure and profile of vegetation, community organisms, energy cycles, and lead to a decline in the function and quality of the environmental services provided. Based on information from Bappenas, in Indonesia there are 50 species that become extinct every year. In addition, there is 70% degraded natural habitat. Invasive alien species have become a major issue in various global discussions in addition to issues of climate change, pollution and marine debris [35]. Species extinction and habitat degradation occur due to the complexity of the threats posed by these invasive alien species. Furthermore, it is emphasized that invasive species can also cause extinction of local species as well as rare species, indirectly there will be a decrease in biodiversity in certain ecosystems and even ecosystems in the world [15].

The values generated from each invasive plant species obtained are very influential on the level of species diversity in the Nanggala III Nature Park location. The index value of the diversity of invasive plant species in the Nanggala III Nature Park area is moderate, namely 2.80. As a species that has been identified and is included in the invasive plant species, it is very feared that the diversity of these invasive plant species can reduce the diversity of living things in the Nanggala III Nature Park area. As a conservation area, special monitoring is needed for the development of invasive plant species in this area.

There are several mechanisms used by invasive plant species to affect natural communities, including through competition, which can cause changes in processes in an ecosystem. As explained by Anderson et al. [36] that high adaptation and fast reproduction will also affect the life of a species so that it successfully reaches its life cycle and develops in the area where it grows.

4. CONCLUSIONS

There are as many as 22 species of invasive plant in the Nanggala III Nature Tourism Park, Wara Barat District, Palopo City, Sulawesi. The Importance Value Index of each invasive plant species differs depending on its growth rate in the field. The weed species that had the highest IVI at the seedling level were Drymaria cordata Willd with an IVI of 29.189, at the sapling level it was Calliandra calothyrsus with an IVI of 119.088, at the pole and tree level it was Poronena canesceus with an IVI at the pole level of 184.178 and at the tree level it was 272,332. Furthermore, weed species diversity (H') at the seedling level was 2.772 (medium), sapling level was 1.311 (medium), pole level was 0.924 (low) and at tree level was 0.308 (low). The results of this research will become important information for future management policies for invasive species in this conservation area.

There is a need for efforts to control invasive plant species which have threatened the preservation of ecosystems and the existence of native flora in this area. Control can be done by planting native plant species in open areas and accelerating the closing of the forest canopy. If invasive plant species have controlled a certain area, eradication by uprooting and burning outside the forest area is an action that must be taken.

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