Multi-Purpose Trees Species Damage Index: Case Study of Wan Abdul Rachman Forest Park Utilization Block, Lampung

Rahmat Safe'i[1], Rico Andrian[2], Tri Maryono[3]

[1]Forestry Study Program, University of Lampung, Indonesia

[2]Computer Science Study Program, University of Lampung, Indonesia

[3]Plant Protection Study Program, University of Lampung, Indonesia

Corresponding Author: Rahmat Safe'i; Email: rahmat.safei@fp.unila.ac.id

ARTICLE INFO

ABSTRACT

The Wan Abdul Rachman (WAR) Forest Park (TAHURA) Utilization Block is a location that can be utilized by the community, especially its non-timber forest products. Utilization of non-timber forest products is the type of Multi-Purpose Trees Species (MPTS). On the other hand, many trees were damaged due to this utilization. This study aimed to obtain the damage index (IK) of MPTS types in the TAHURA WAR utilization block. Data was collected by assessing the IK of trees based on the Forest Health Monitoring (FHM) method on five cluster plots of FHM. Data analysis was carried out using the IK value formula. The results showed that there were 13 types of MPTS found in the TAHURA WAR utilization block; with the range of IK values for each kind of MPTS as follows: *Durio zibenthinus* (0.0-6.1), *Persea americana* (1.4-6.5), *Parkia speciosa* (0.0-5.8), *Archidendron pauciflorum* (1.5-6.1), *Gnetum gnemon* (0.0-6.1), *Hevea brasiliensis* (1.4-6.1), *Theobroma cacao* (1.4-5.0), *Mangifera indica* (1.6-4.3), *Sygyzium malaccensis* (1.6-4.6), *Arthocarpus heterophyllus* (1.6-5.8), *Sygyzium aqueum* (1.4-4.3), *Sygyzium aromaticum* (1.5-3.8) and *Tectona grandis* (1.6-4.9). The location influences the size of the IK value, type and severity of tree damage found. Thus, the average IK values for each kind of MPTS in the TAHURA WAR utilization block were *Hevea brasiliensis* (4.3), *Artocarpus heterophyllus* (4.2), *Archidendron pauciflorum* (4.1), *Theobroma cacao* (4.0), *Tectona grandis* (3.8), *Persea americana* (3.5), *Parkia speciosa* (3.5), *Durio zibenthinus* (3.4), *Sygyzium malaccensis* (3.4), *Gnetum gnemon* (3.2), *Sygyzium aqueum* (2.9), *Mangifera indica* (2.7) dan *Sygyzium aromaticum* (2.4).

INTRODUCTION

TAHURA WAR is a conservation area located in Lampung Province, which was established on August 10, 1993, based on the Decree of the Minister of Forestry No. 408/Kpts-II/1993. The TAHURA WAR has an area of ±22,249.31 ha, divided into several blocks: plant collection blocks, protection blocks, and utilization blocks (UPTD TAHURA WAR, 2017). These blocks are used according to their designation. This is done so that there is harmony and achievement of the conservation function in the TAHURA WAR (Ellannia et al., 2016).

The TAHURA WAR is directly connected to the community's residential area. This causes the precinct to easily access forest areas (Murniati et al., 2022). To avoid over-collecting forest products, districts can only manage use blocks in the TAHURA WAR (Sulistiowati et al., 2021). The utilization block is an area in the TAHURA WAR that can be utilized by the community (Pasaribu et al., 2019). The results are that more than 52% of the land cover in the TAHURA WAR area has turned into mixed gardens and is managed with an agroforestry system through conservation partnerships (Dewi et al., 2019; Paudel & Shrestha, 2022). This management certainly affects the diversity of species (Gautam et al., 2021). However, the community can only take non-timber forest products in the area. This is one of the causes of the

discovery of many Multipurpose Tree Species (MPTS) in the area (Wulandari, et al., 2018).

MPTS is a versatile plant in the form of woody plants whose fruits, flowers, leaves, skin, or sap can be utilized by the community (Martins et al., 2022). Plant types belonging to MPTS that are often found in the TAHURA WAR utilization block include rubber (*Hevea brasiliensis*), durian (*Durio zibenthinus*), pulai (*Alstonia scholaris*), and so on (Safe'i, Latumahina, et al., 2021). One of the causes of forest use by the community in this block is damage to trees due to high human activities or other concomitant causes. Damage caused by humans can arise because of the high value of community dependence on forests(Paudel & Paudel, 2021). Most people living around forest areas will depend on the forest for their lives, so forest sustainability needs to be maintained.

Tree damage is a condition where there is damage to tree parts that can be caused by biotic and abiotic factors (Safe'i et al., 2020). In forestry science, tree damage can be seen by observing and calculating through the assessment of the tree damage index (Safe'iet al., 2021). Assessment of the tree damage index is one way to determine how much damage a tree has experienced(Anwar et al., 2021). Through this value, the severity can be known so that if the damage is severe enough, it can be prevented as early as possible (Safe'i et al., 2022). It is crucial to assess the tree damage index, especially for MPTS species found in the TAHURA WAR utilization block area, considering the high community activity towards these species. Thus, this study aimed to obtain the damage index (IK) value of MPTS species in the TAHURA WAR utilization block.

MATERIALS AND METHODS

This research was conducted at the TAHURA WAR utilization block. The tools used are magic cards, permanent markers, mica plastic, and GPS. The materials used are all trees belonging to the MPTS type in the TAHURA WAR utilization block.

Data Collection

Data was collected by direct observation and calculation of the condition of tree damage. Observations included the location, type, and severity of tree damage. The samples were all MPTS-type trees in the observation plot cluster. Five cluster plots are used by following the cluster plot design in the Forest Health Monitoring (FHM) technique (Arwanda & Safe'i, 2021).

Data Analysis

Data analysis was carried out by calculating the value of the location of the damage, the type of damage, and the severity of the injury found (Puspita et al., 2021). After obtaining the damage index value for each tree, the average value of the tree damage index was calculated for each type of MPTS found. As a result, tree damage's location, type, and severity have their respective weighting values (Table 1). These values are then multiplied according to the following formula (Anwar et al., 2021):

IK = xMPTS tree damage location X yMPTS tree damage type X zMPTS tree damage severity level

With information: IK is an index of damage contained in a tree being observed; x, y, and z are weighted values.

Table 1. Weighted values on location, type, and severity of tree damage

Tree damage location code	Weighted value (x)	Tree damage type code	Weighted value (y)	Tree damage severity code	Weighted value (z)
0	0	11	2.0	0	1.5
1	2.0	01	1.9	1	1.1
2	2.0	02	1.7	2	1.2
3	1.8	12	1.6	3	1.3
4	1.8	03; 04; 13	1.5	4	1.4
5	1.6	21	1.3	5	1.5
6	1.2	22;23	1.0	6	1.6
7	1.0	24	1.0	7	1.7
8	1.0	25	1.0	8	1.8
9	1.0	31	1.0	9	1.9

Source: Safe'i et al. (2021)

RESULTS AND DISCUSSION

Based on field observations, it is known that there are 13 types of MPTS plants found in the research location. MPTS include *Durio zibenthinus, Persea americana, Parkia speciosa, Archidendron pauciflorum, Gnetum gnemon, Hevea brasiliensis, Theobroma cacao, Mangifera indica, Syzygium malaccenses, Artocarpus heterophyllus, Sygyzium aqueum, Sygyzium aromaticum,* and *Tectona grandis*. However, the dominant types of MPTS are *Durio zibenthinus* and *Hevea brasiliensis*. This type is most widely planted because it is considered to have high economic value in the form of non-timber forest products, so many farmers choose this type of MPTS (Murniati et al., 2022).

Based on field observations, in cluster plot one, nine species of MPTS were found, namely *Durio zibenthinus, Persea americana, Parkia*

speciosa, Archidendron pauciflorum, Gnetum gnemon, Hevea brasiliensis, Theobroma cacao, Mangifera indica, and *Sygyzium malaccenses*. *Parkia speciosa* had the highest average damage index value of 5.2. This is because all *Parkia speciosa* plants in cluster plot one were damaged. *Parkia speciosa* found as many as 14 trees with a reasonably high damage index value. The number of individual trees in each type also affects the average value of the tree damage index, and if many trees are damaged, it will affect the average value produced. The average value of the lowest damage index was found in the *Mangifera indica* species, amounting to 3.2. This is because only three *Mangifera indica* trees were found, and all three were damaged. In detail, the average damage index value for MPTS types in cluster plot one is presented in Figure 1.
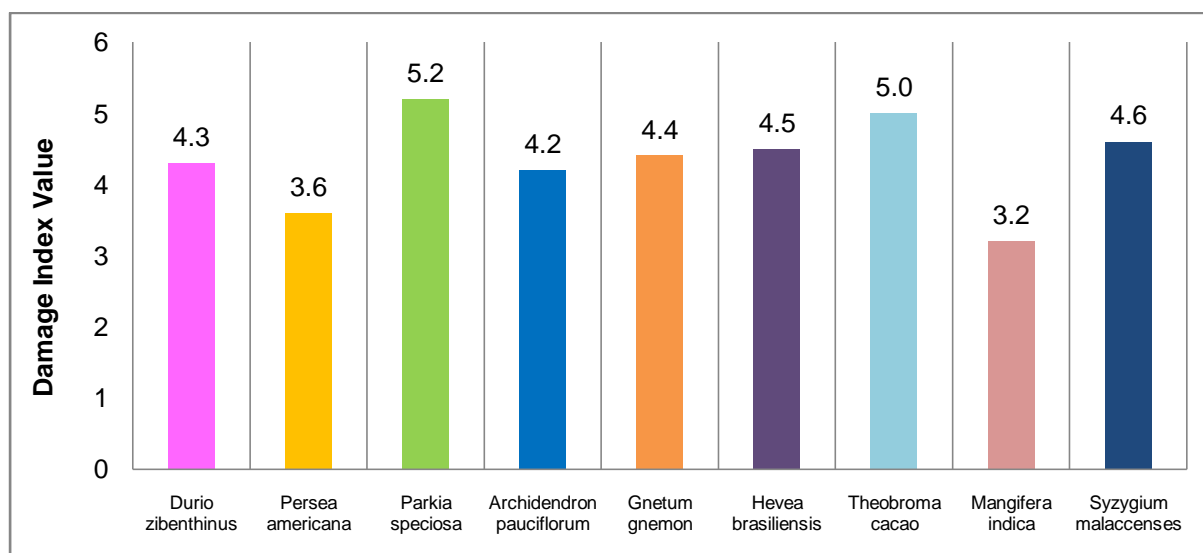

Figure 1. The average value of the MPTS tree damage index in cluster plot 1

In cluster plot two, eight species of MPTS were found, namely *Durio zibenthinus, Persea americana, Parkia speciosa, Gnetum gnemon, Hevea brasiliensis, Theobroma cacao, Sygyzium malaccensis,* and *Artocarpus heterophyllus*. In this cluster, *Durio zibenthinus, Gnetum gnemon,* and *Artocarpus heterophyllus* were the species that had the highest damage index value, which was 4.6. The

type of damage influences the importance of this damage index found, one of which is broken rods with the highest weighting score, so the average value produced is relatively high. The lowest value was found in the *Theobroma cacao* tree, at 4.0. In detail, the damage index value of each MPTS in cluster plot two is presented in Figure 2.
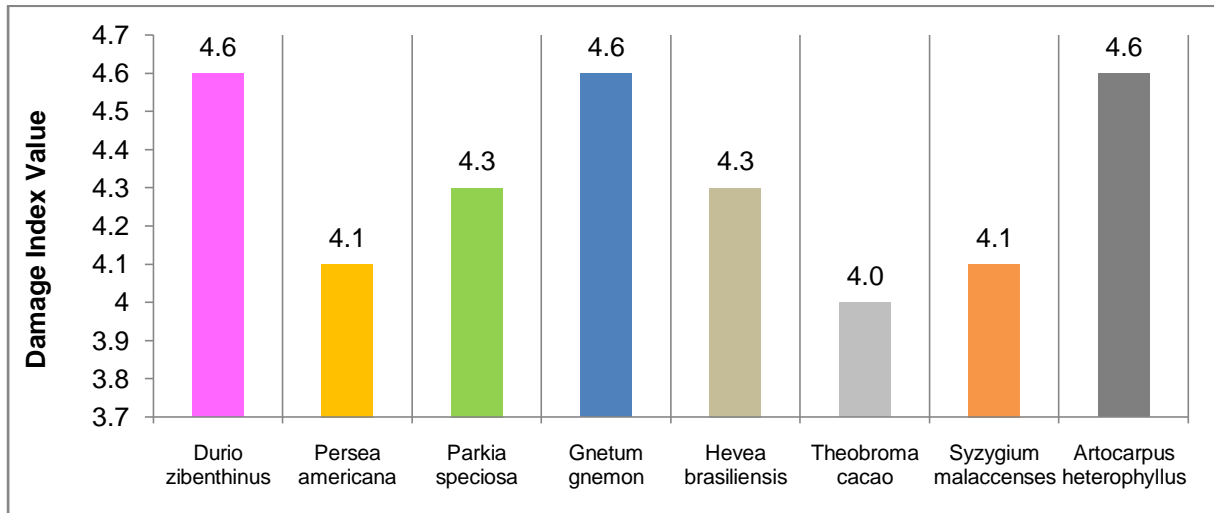
Figure 2. The average value of the MPTS tree damage index in cluster plot 2

In cluster plot three, nine species of MPTS were found: *Durio zibenthinus, Persea americana, Parkia speciosa, Archidendron pauciflorum, Gnetum gnemon, Hevea brasiliensis, Artocarpus heterophyllus, Sygyzium aromaticum,* and *Tectona grandis. Artocarpus heterophyllus* was the species with the highest damage index value in cluster plot three, and this was due to the presence of lianas in that species. Liana is a type of damage with a reasonably high weighting value (Safe'i et al., 2020). The average index value of tree damage in cluster plot three is presented in Figure 3 below.
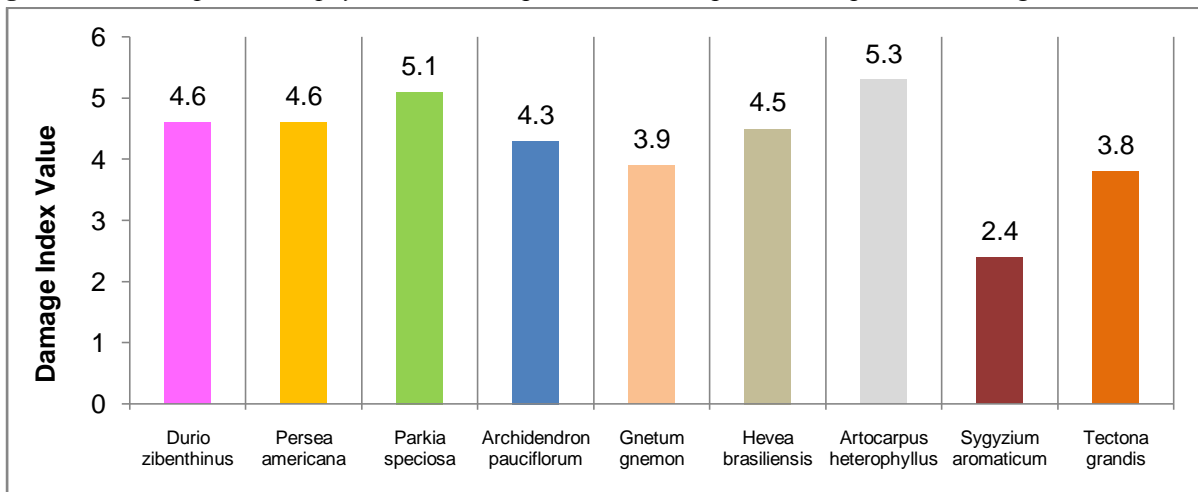

Figure 3. The average value of the MPTS tree damage index in cluster plot 3

In cluster plot four, eight species of MPTS were found: *Durio zibenthinus, Persea americana, Parkia speciosa, Archidendron pauciflorum, Gnetum gnemon, Hevea brasiliensis, Theobroma* *cacao*, and *Mangifera indica. Hevea brasiliensis* is the species that has the highest damage index value of 4.2. The other types of damage index values are presented in Figure 4.
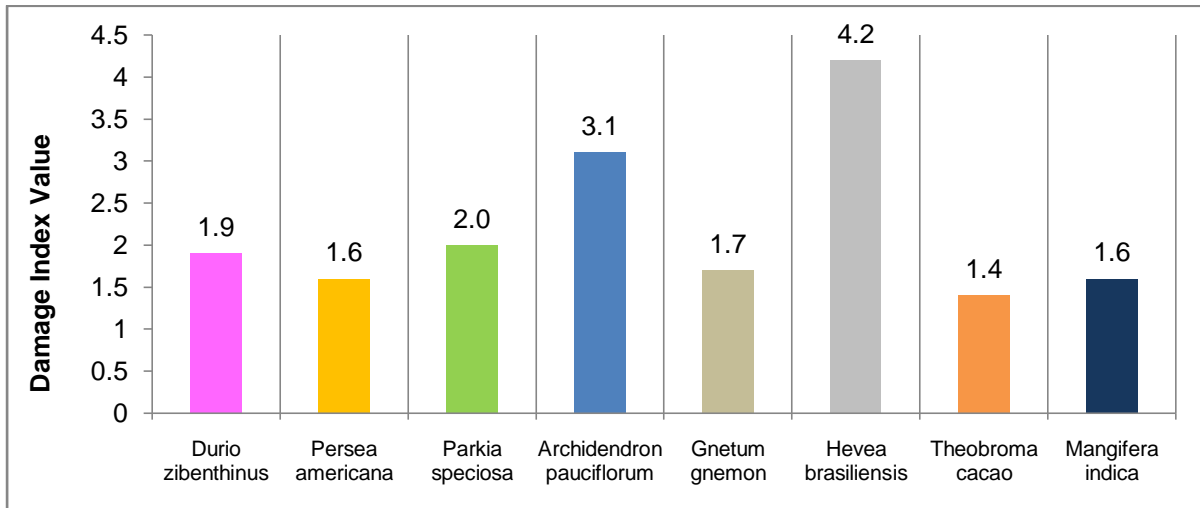
Figure 4. The average value of the MPTS tree damage index in cluster plot 4

In cluster plot five, six species of MPTS were found: *Durio zibenthinus, Persea americana, Parkia speciosa, Hevea brasiliensis, Artocarpus heterophyllus,* and *Sygyzium aqueum*. Based on the calculations, it is known that *Hevea brasiliensis* is also a type of MPTS with the highest damage index value in this cluster. This value is influenced by the kind of damage found on the tree, namely the type of broken stem damage with the highest weighting value. The damage index values for other classes are presented in Figure 5.
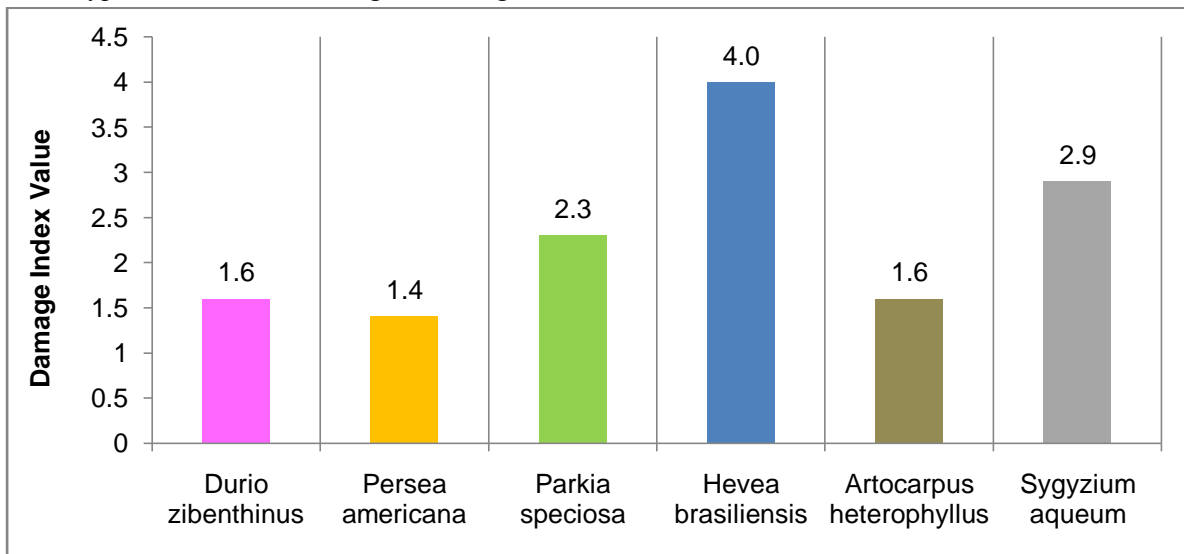

Figure 5. The average value of the MPTS tree damage index in cluster plot 5

Durio zibenthinus was the most commonly found species, with 123 trees observed spread over five clusters of observation plots. This species has a range of tree damage index values between 0.0-6.1. The most common damage location was found on the lower stem with a weight value of 1.8. The most common types of damage were cancer and open wounds with a weight of 1.9 and 1.5. The highest damage index value in *Durio zibenthinus* was caused by the kind of stem damage at the rootstock damage location, with more than 50% of the injury's severity. This type of damage certainly affects the value of the tree damage index. This is because the type of broken stem damage is the damage with the highest weight value of 2.0, so the damage index value will be pretty high. *Durio zibenthinus* generally suffered the most injury to leaves and stemmed from damaged leaf damage and open wounds (Safe'i et al., 2020).

Hevea brasiliensis was the second most abundant species after *Durio zibenthinus,* with 109 trees spread across the five cluster plots. This plant has a damage index value with a damage value range of 1.4-6.1. This damage index value is

influenced by the location, type, and severity of damage which is quite diverse. The most common area of damage was found in the leaves, with the kind of damage to the leaves changing color. The highest damage index value with a value of 6.1 was influenced by the type of cancer damage at the location of root and rootstock damage with a severity of more than 50%. The location of rootstock damage and the type of cancer damage are locations and types of damage with a reasonably significant weighting value, namely 2.0 and 1.8. Cancer damage is a type of damage that has a terrible effect on the growth of *Hevea brasiliensis*. Therefore, the rubber tree with the location and type of damage has the highest damage index value.

Gnetum gnemon is the species with the third highest number, 37 trees in plot clusters 1 to 4. *Gnetum gnemon* has a damage index value range of 0.0-6.1. The lowest value was caused by the type of leaf damage, while the kind of stem damage caused the highest value. The type of broken stem damage is the most common type of damage found in this type. However, different levels of severity cause the index value of harm experienced by each tree to be also additional (Safe'i et al., 2021).

Theobroma cacao was the species with the fourth largest number, as many as 16 trees found in cluster plots 1, 2, and 4. *Theobroma cacao* had a damage index value range of 1.4-5.0. The lowest value was caused by the type of leaf damage, while the kind of stem damage caused the highest value. Termite nests are the most common type of damage found in this species.

Persea americana and *Parkia speciosa* were found in as many as 15 and 14 trees spread across the five cluster plots. *Persea americana* has a range of damage index values of 1.3-5.8, while *Parkia speciosa* ranges from 0.0-5.8. This value is influenced by the location of damage to the rootstock, leaves, and branches. The most common types of injury were open wounds and leaf damage. This condition then affects the tree damage index value. In addition, this plant is generally susceptible to wear to the location of the stems and leaves (Kumar et al., 2020).

Tectona grandis and *Artocarpus heterophyllus* are MPTS species found at the study site with 4 and 3 trees, respectively. *Tectona grandis* was only found in cluster three, while *Artocarpus heterophyllus* was found in clusters two, three, and five. *Tectona grandis* has a range of damage index values of 1.6-4.9, while *Artocarpus heterophyllus* ranges between 1.6-5.8. The damage was located on the lower stem, branches, leaves, and upper stem. The most common type of damage found was the type of open wound damage with a weight value of 1.5. The highest damage index value for *Tectona grandis* trees was caused by the kind of available wound damage at the rootstock damage location with more than 50% severity. As for *Artocarpus heterophyllus*, the highest damage index value was caused by broken stems. This condition has an elevated site and type of damage, thus causing a high damage index value. The various injuries experienced need special attention to improve the quality of the desired forest products (Anwar et al., 2021).

Other types of MPTS were found only in small numbers, ranging from 1 to 2 trees. These species include *Mangifera indica*, *Sygyzium malaccensis*, *Sygyzium aqueum*, and *Sygyzium aromaticum*. *Mangifera indica* was only found in clusters two and four, as many as two trees. The damage index value ranges from 1.6-4.3. *Sygyzium malaccensis* was found in two trees with an index range of 1.6-4.6. *Sygyzium aqueum* was seen in as many as two trees with a range of damage index values of 1.4-4.3. As for *Sygyzium aromaticum*, only one tree was found in cluster plot three with a damage index value of 1.6.

Overall, the types of MPTS in the TAHURA WAR utilization block have different average damage index values. This value is influenced by the number of trees and the value of the damage index in each of these trees. For example, the type of MPTS with the highest average damage index value is the *Hevea brasiliensis* type. In contrast, the kind of MPTS with the lowest average damage index value is *Sygyzium aromaticum*. In detail is presented in Figure 6.
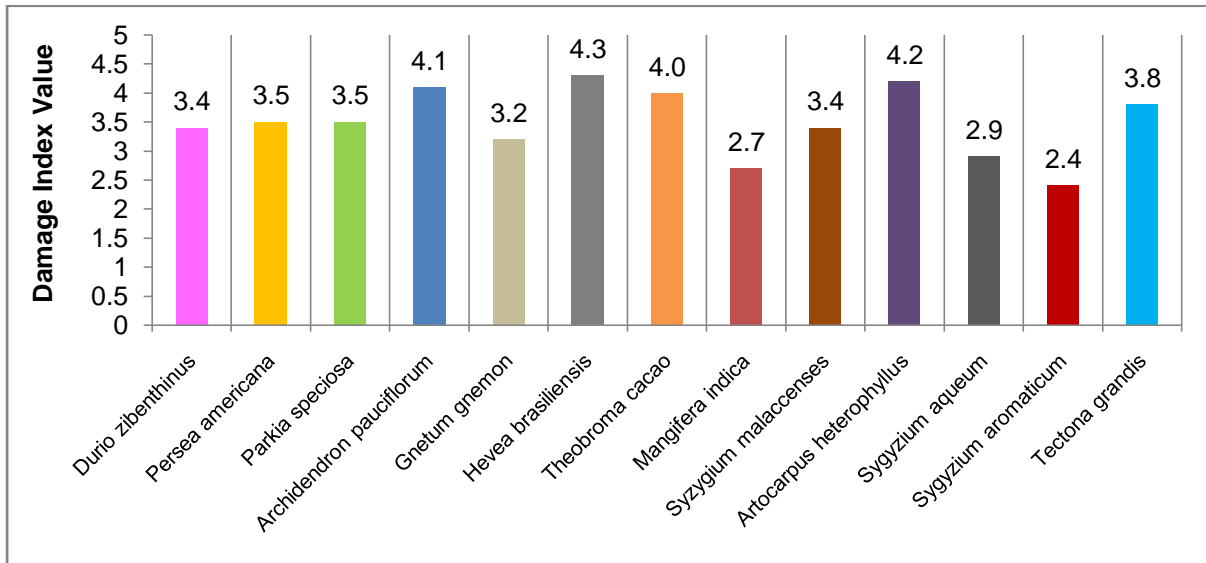
Figure 6. The average value of tree damage index for MPTS species in the TAHURA WAR utilization block

Various factors can cause tree damage. Biotic and abiotic factors mean that all objects around the tree can cause damage (Safe'i & Upe, 2022). The tree damage index value provides an opportunity regarding what conditions and actions are needed to maintain tree sustainability (Ajijah et al., 2022). As in the research location, it is known that there are many locations and types of damage experienced by each tree. Both within and between classes. This damage can continue to grow if it is not handled (Puspita et al., 2021). Therefore, regular treatment and maintenance are needed, especially for MPTS plants planted to obtain non-timber forest products.

CONCLUSION

MPTS plants in the TAHURA WAR utilization block totaled 11 species with an average damage index value for each of these MPTS types, including *Hevea brasiliensis* 4.3, *Artocarpus heterophyllus* 4.2, *Archidendron pauciflorum* 4.1, *Theobroma cacao* 4.0, *Tectona grandis* 3.8, *Persea americana* 3.5, *Parkia speciosa* 3.5, *Durio zibenthinus* 3.4, *Sygyzium malaccensis* 3.4, *Gnetum gnemon* 3.2, *Sygyzium aqueum* 2.9, *Mangifera indica* 2.7 and *Sygyzium aromaticum* 2.4. Therefore, intensive care and maintenance are needed to reduce the damage experienced by each MPTS tree, especially the type of *Persea americana* with the highest damage index value.

REFERENCES

Ajijah, L. N., Safe'i, R., Yuwono, S. B., & Kaskoyo, H. (2022). Forest Health Analysis Based on Flora Biodiversity Indicators in Gapoktan Harapan Sentosa KPHL Batutegi, Lampung. *IOP Conference Series: Earth and Environmental Science*, 1–9.

Anwar, P. S., Safe'i, R., & Darmawan, A. (2021). Landscape Characteristics on Forest Health Measurement Plots in Several Forest Functions. *IOP Conf. Series: Earth and Environmental Science 950*, 012101.

Arwanda, E. R., & Safe'i, R. (2021). Assessment of forest health status of Panca Indah Lestari Community Plantation Forest (case study in Bukit Layang Village, Bakam District, Bangka Regency, Bangka Belitung Province). *IOP Conf. Series: Earth and Environmental Science 918*, 012031.

Dewi, B. S., Harianto, S. P., Febryano, I. G., Rahmawati, D. I., Dewara, N., Tokita, N., & Koike, S. (2019). Diversity of fauna is one of indicator of forest management in Tahura Wan Abdul Rachman. *IOP Conf. Series: Earth and Environmental Science*, 1–6.

Ellannia, L. D., Setiawan, A., & Niswati, A. (2016). Litter and Soil Carbon Stock in Cultivated and Natural Area of Intergrated Forest for Conservation Education of Wan Abdul Rachman Great Forest Park. *Journal of Tropical Soils*, *21*(3), 171–178.

Gautam, S., Timilsina, S., & Shrestha, M. (2021). The Effects of Forest Management Activities on Genetic Diversity of Forest Trees. *Indonesian Journal of Social and Environmental Issues*, *2*(2), 110–118.

Kumar, M., Gupta, P., Madhav, P., & Sachin. (2020). Disease Detection in Coffee Plants Using Convolutional Neural Network. *2020 5th International Conference on Communication and Electronics Systems (ICCES)*, 755–760.

Martins, J., Pinto, G., & Canhoto, J. (2022). Biotechnology of the Multipurpose Tree Species Arbutus unedo: A Review. *Journal of Forestry Research*, *33*, 377–390.

Murniati, Suharti, S., Minarningsih, Nuroniah, H. S., Rahayu, S., & Dewi, S. (2022). What Makes Agroforestry a Potential Restoration Measure in a Degraded Conservation Forest? *Journal Forests*, *13*, 267–284.

Pasaribu, S. W., Kaskoyo, H., & Safe'i, R. (2019). The Gender Role in Agroforestry Management in Sungai Langka Village, Gedong Tataan District, Pesawaran Regency, Lampung Province. *Journal of Sylva Indonesiana*, *2*(2), 62–69.

Paudel, Y., & Paudel, A. (2021). Contribution of Forestry in Economy and Employment Generation in Nepal. *Indonesian Journal of Social and Environmental Issues*, *2*(2), 188–195.

Paudel, Y., & Shrestha, S. (2022). Agroforestry Practices Prevailing in SAARC Countries: A Review. *Indonesian Journal of Social and Environmental Issues*, *3*(1), 10–18.

Puspita, N. E., Hari, K., & Safe'i, R. (2021). Forest health study in efforts to preserve community forest agroforestry patterns in Kubu Batu Village, Gedong Tataan District, Pesawaran Regency, Lampung Province. *IOP Conf. Series: Earth and Environmental Science 886*, 012075.

Safe'i, R., Darmawan, A., Irawati, A. R., Pangestu, A. Y., Arwanda, E. R., & Syahiib, A. N. (2022). Cluster Analysis on Forest Health Conditions in Lampung Province. *International Journal of Design, Nature and Ecodynamics*, *17*(2), 257–262.

Safe'I, R., Darmawan, A., Kaskoyo, H., & Rezinda, C. F. G. (2020). Analysis of Changes in Forest Health Status Values in Conservation Forest (Case Study: Plant and Animal Collection Blocks in Wan Abdul Rachman Forest Park (Tahura WAR)). *Journal of Physics: Conference Series*, *1842*(1).

Safe'i, R., Latumahina, F. S., Dewi, B. S., & Ardiansyah, F. (2021). Short Communication: Assessing the state and change of forest health of the proposed arboretum in Wan Abdul Rachman Grand Forest Park, Lampung, Indonesia. *Biodiversitas: Journal of Biological Diversity*, *22*(4), 2072–2077.

Safe'i, R., Latumahina, F. S., Suroso, E., & Warsono. (2020). Identification of Durian Tree Health (Durio zibenthinus) in The Prospective Nusantara Garden Wan Abdul Rachman Lampung Indonesia. *Plant Cell Biotechnology and Molecular Biology*, *21*(41–42), 103–110.

Safe'i, R., Sari, R. N., Iswandaru, D., Latumahina, F. S., Taskirawati, I., & Kaskoyo, H. (2021). Biodiversity and Site Quality as Indicators of Mangrove Forest Health Pasir Sakti, Indonesia. *Annals of R.S.C.B.*, *25*(2), 4400–4410.

Safe'i, R., & Upe, A. (2022). Mapping of Tree Health Categories in Community Forests in Lampung Province. *IOP Conference Series: Earth and Environmental Science*, 1–9.

Sulistiowati, R., Ali, S., Wulandari, C., Riniarti, M., & Melinda, S. D. (2021). ollaborative Strategy for the Sustainability of the Wan Abdul Rahman Forest Park (Tahura WAR) in Supporting Ecotourism in Lampung Province. *In: 2nd International Indonesia Conference on Interdisciplinary Studies (IICIS 2021)*.

Wulandari, C., Bintoro, A., Rusita, Susanto, T., Duryat, Kaskoyo, H., Erwin, & Budiono, P. (2018). Community forestry adoption based on multipurpose tree species diversity towards to sustainable forest management in ICEF of University of Lampung, Indonesia. *Biodiversitas*, *19*(3), 1102–1109.