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The Trend in Types of Tree Damage in Mangrove Forest Management Areas, East Lampung Regency

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ABSTRACT

Damage to mangrove trees is one of them influenced by the types of tree damage. The more types of tree damage to a single mangrove tree, the worse the health level of the mangrove tree will be. This study aims to obtain damage index trend values and types of tree damage in the east coast mangrove forest area, East Lampung Regency. Measurement of the types of damage to mangrove trees was carried out three times using the Forest Health Monitoring (FHM) method in two FHM cluster plots for each mangrove forest area. Assessment of damage to mangrove trees uses the Damage Index formula. The results showed that the trend index values for mangrove tree damage were 9.3 and 4.5 (Resort Kuala Penet, Way Kambas National Park), 9.2 and 19.8 (Margasari, Labuhan Maringgai), and 6.2. and 9.8 (Purworejo, Pasir Sakti) with the dominant types of damage being open wounds (code 03) 343 damage, damaged foliage/shoots (code 24) 240 damage, and broken/dead (code 22) 158 damage. Thus, the trend of damage index and types of damage to mangrove trees in the east coast mangrove forest area of East Lampung Regency has increased.

INTRODUCTION

Mangrove forest ecosystems are ecosystems in coastal areas that have unique and distinctive characteristics and are at the highest tide level above sea level in protected areas (Chen Q. et al., 2015); and is the main important life-supporting ecosystem in coastal and marine areas. Most of the mangrove forests along the east coast of East Lampung Regency are protected areas (Maulana I. R. et al, 2021); with the dominant mangrove species, namely: Rhizophora sp. and Avicennia sp. On the other hand, the condition of damaged mangrove trees is an important problem in the mangrove forest ecosystem management area, on the east coast of East Lampung Regency. Damage to mangrove trees is one of them influenced by the types of tree damage. The more types of tree damage to a single mangrove tree, the worse the health level of the mangrove tree will be. Damage to mangrove trees is caused by several factors.

According to Rohman, N. A. & Safe'i R. et. al. (2022) that biotic and abiotic factors can cause tree damage. Biotic factors that can damage trees include pests and plant diseases. Abiotic factors include natural disasters and environmental conditions (Safe'i R. et al., 2022). In addition, tree damage can affect physiological functions, reduce the growth rate of tree stands and cause death (Puspita E. N. et al., 2021). A tree can be said to be healthy if it can carry out real physiological functions and has a good level of ecological resistance, such as resistance to pests and diseases, and other external factors (Safe'i R. et al., 2022). The type of tree damage can indicate the factors causing the damage (Ajijah L. N. et al., 2022). This type of tree damage is a form of plant growth disturbance whose symptoms can be seen from the shape, size, color, and texture (Sanjaya F. A. et al., 2022).

Tree health monitoring is intended to determine the status, changes, and trends that occur from tree health conditions. The tree health monitoring method is carried out by measuring the condition of tree damage regularly. Measurement of tree health conditions is carried out at least three times when measuring tree damage conditions. This

is to determine the condition of the status of tree damage, changes in tree damage, and trends that occur from tree damage. Measuring trends in tree damage conditions starts from the location of the roots, stems, and branches, to the leaves (Nurcahyani A. et al., 2022). Measurement of the condition of tree damage is based on the forest health monitoring method (Pangestu A.Y. et al., 2022). This research is the third year of measurement, namely to determine the trend that occurs from damage to mangrove trees in the mangrove forest area of Kuala Penet Resort, Way Kambas National Park; Margasari, Labuhan Maringgai; and Purworejo, Pasir Sakti. Accurate and fast data and information related to the condition of the tendency of damage to mangrove trees in the three mangrove forest areas are very much needed by managers for management decisions, for example for disaster mitigation preparedness.

The assessment of tree damage is intended to obtain appropriate and accurate data and information regarding the condition of tree damage (location, type, and severity of trees) for management decisions of forest managers. This study aims to obtain the value of the trend index of damage and types of tree damage in the east coast mangrove forest area, East Lampung Regency.

MATERIALS AND METHODS

This research is located in a mangrove forest area at the Kuala Penet Resort, Way Kambas National Park; Margasari, Labuhan Maringgai; and Purworejo, Pasir Sakti. The tools used in this study included: Global Positioning System (GPS), compass, camera, meter tape, stationery, tally sheets, and forest health monitoring books. Measurement of the type of damage to mangrove trees was carried out three times (2020, 2021, and 2022) using the Forest Health Monitoring (FHM) method on two FHM cluster plots that have been built for each mangrove forest area (Resort Kuala Penet, Way Kambas National Park; Margasari, Labuhan Maringgai; and Purworejo, Pasir Sakti).

This research is the measurement of the third year. A Measurement of damage to mangrove trees was carried out on location damage, type damage, and severe damage to the trees. The location of the tree damage was measured from the roots to the foliage (Maulana I. R. et al, 2021). The type of tree damage was measured at each damage location and the maximum recorded was for the three types of tree damage with the highest level of severity. Assessment of damage to mangrove trees uses the Damage Index formula:

IK = x.location × y.type of damage × z.severity

Information:
x, y, z = weighting value

Table 1. Tree damage location code, tree damage type code, tree damage severity code, and each weighting value (USDA-FS, 2020)

Tree damage location code	Weighting value (x)	Tree damage type code	Weighting value (y)	Tree damage severity code	Weighting value (z)
0	0	01; 26	1.9	0	1.0
1	2.0	02	1.7	1	1.1
2	2.0	03; 04	1.5	2	1.2
3	1.8	05	2.0	3	1.3
4	1.8	06	1.5	4	1.4
5	1.6	11	2.0	5	1.5
6	1.2	12	1.6	6	1.6
7	1.0	13; 20	1.5	7	1.7
8	1.0	21	1.3	8	1.8
9	1.0	22; 23; 24; 25; 31	1.0	9	1.9

RESULTS AND DISCUSSION

Index of Damage to Mangrove Trees in the East Coast Mangrove Forest area, East Lampung Regency

Based on three measurements of the damaged condition of mangrove trees in each FHM cluster plot in three locations of the east coast mangrove forest area, East Lampung Regency (Kuala Penet Resort, Way Kambas National Park; Margasari, Labuhan Maringgai; and Purworejo, Pasir Sakti), obtained mangrove tree damage index values tend to increase from the first, second, and third measurements. The index value of mangrove tree damage in each FHM plot cluster in three locations of the east coast mangrove forest area, East Lampung Regency is presented in Table 2.

Table 2. Mangrove tree damage index (IK) values in each FHM plot cluster in three locations of the east coast mangrove forest area, East Lampung Regency

Damage Index Value (IK)						
Measurement Time	Mangrove Forest Location					
	Kuala Penet Resort, Way Kambas National Park		Margasari, Labuhan Maringgai		Purworejo, Pasir Sakti	
	CL1	CL2	CL1	CL2	CL1	CL2
1st measurement	6.8	1.8	6.3	14.6	3.2	4.2
2nd measurement	7.4	2.6	7.8	17.4	4.5	4.5
3rd measurement	9.3	4.5	9.2	19.8	6.2	9.8

Information: CL1 = FHM Cluster plot-1; CL2 = FHM Cluster plot-2

Based on Table 2, shows that the index value of damage to mangrove trees in the three locations has an increasing trend. The highest trend of increasing damage index of mangrove trees occurred in cluster plot-2 (CL2) in the mangrove forest locations of Margasari, Labuhan Maringgai (19.8), and Purworejo, Pasir Sakti (9.8). The tendency to increase the high index of damage to mangrove trees can occur due to the increasing number and types of damage to mangrove trees with a severity level above 20%. According to Selvira et al (2012) that the more types of tree damage at each damage location recorded with a severity level of ≥20%, the higher the tree damage index value. The graph of the trend of mangrove tree damage index in each FHM plot cluster in three locations of the east coast mangrove forest area, East Lampung Regency is presented in Figure 1.

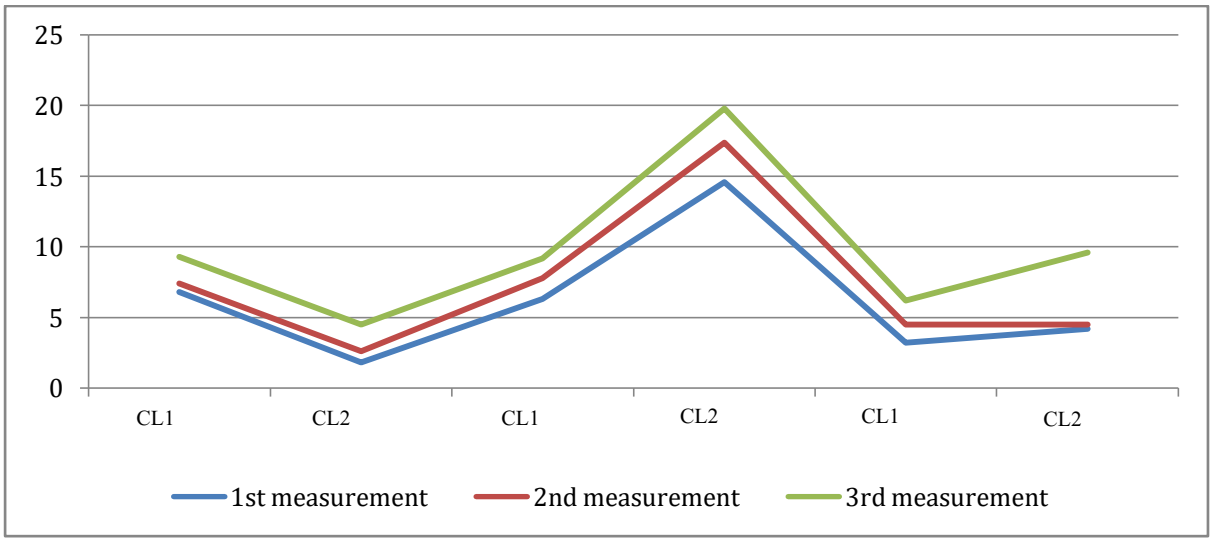

Figure 1. Graph of the trend of mangrove tree damage index in the east coast mangrove forest area, East Lampung Regency

The trend of increasing mangrove tree damage index values in each FHM plot cluster in three east coast mangrove forest areas, East Lampung Regency was caused by the increasing number of types of tree damage. This shows that the health of mangrove trees is not healthy. Increasing types of tree damage are the main cause of environmental, biotic, and abiotic factors, (Ardiansyah F. & Safe'i R., 2021). According to Anwar Y. et al. (2021) that the damage to these trees was caused by biotic, and abiotic factors, and community management actions. Abiotic factors, such as environmental conditions and unfavorable growing places will affect tree damage. Biotic factors are generally caused by pests, diseases, fungi, and other living things which also play an important role in causing damage and even death of trees. Meanwhile, inappropriate management, such as maintenance and weak regulations regarding the use of mangrove forests also have an effect. As found by Tetelepta J. M. S. et al. (2020) that in managing mangrove forests, until now there are still many who are experiencing pressure from forms of utilization and management that do not meet sustainability aspects.

Increased tree damage will be detrimental to tree populations in mangrove forests because tree damage can affect tree physiological functions and growth rates (Ahalya A., 2020). Therefore, tree death will have an impact on reducing tree populations in mangrove forests. Forest management activities have a greater impact on the levels of genetic diversity, individuals, populations, species, and ecosystems (Gautam S. et al., 2021). In addition, mangrove forest management actions that do not pay attention to sustainability cause tree damage. Thus, efforts that can be made to reduce tree damage are with appropriate management measures, such as: fertilizing, weeding, thinning trees, and controlling pests and diseases.

Trends in the Types of Damage to Mangrove Trees in Three Locations of the East Coast Mangrove Forest Area, East Lampung Regency

Measurements of the damaged condition of mangrove trees have been carried out three times (2020, 2021, and 2022) in the Mangrove Forest Kuala Penet Resort, Way Kambas National Park; Margasari, Labuhan Maringgai; and Purworejo, Pasir Sakti. This research is the third measurement (2022). The third measurement is intended to determine the trend of damage to mangrove trees. The trend of types of damage to mangrove trees at three measurement times in the mangrove forest area of Kuala Penet Resort, Way Kambas National Park is presented in Table 3.

Table 3. Trends in the types of tree damage in the mangrove forest area of Kuala Penet Resort, Way Kambas National Park

Measurement Time	Tree Damage Types Code					
	01	03	20	22	24	25
1st measurement	2	2	2	1	-	-
2nd measurement	-	12	-	72	14	19
3rd measurement	-	28	3	85	33	12
Total Tree Damage Types	2	42	5	158	47	31

Information: (-) = No tree damage found

Based on Table 3, six types of damage to mangrove trees have been identified in the mangrove forest area of Kuala Penet Resort, Way Kambas National Park, including cancer (code 01), open wounds (code 03), liana (code 20), broken or dead branches (code 22), damaged foliage or shoots (code 24), and discoloration of foliage (code 25). There are three types of damage to mangrove trees that predominate, namely: broken or dead branches (code 22) 158 damage, damaged leaves or shoots (code 24) 47 damage, and open wounds (code 03) 42 damage. The three types of damage tend to increase. For example, the type of damage to an open wound (code 03) at the time of the first measurement (status) amounted to two damage. At the time of the second measurement (change) amounted to 12 damage. While in the third measurement (trend) there are 28 damages. A graph of the trend in the types of damage to mangrove trees in the mangrove forest area of Kuala Penet Resort, Way Kambas National Park is presented in Figure 2.

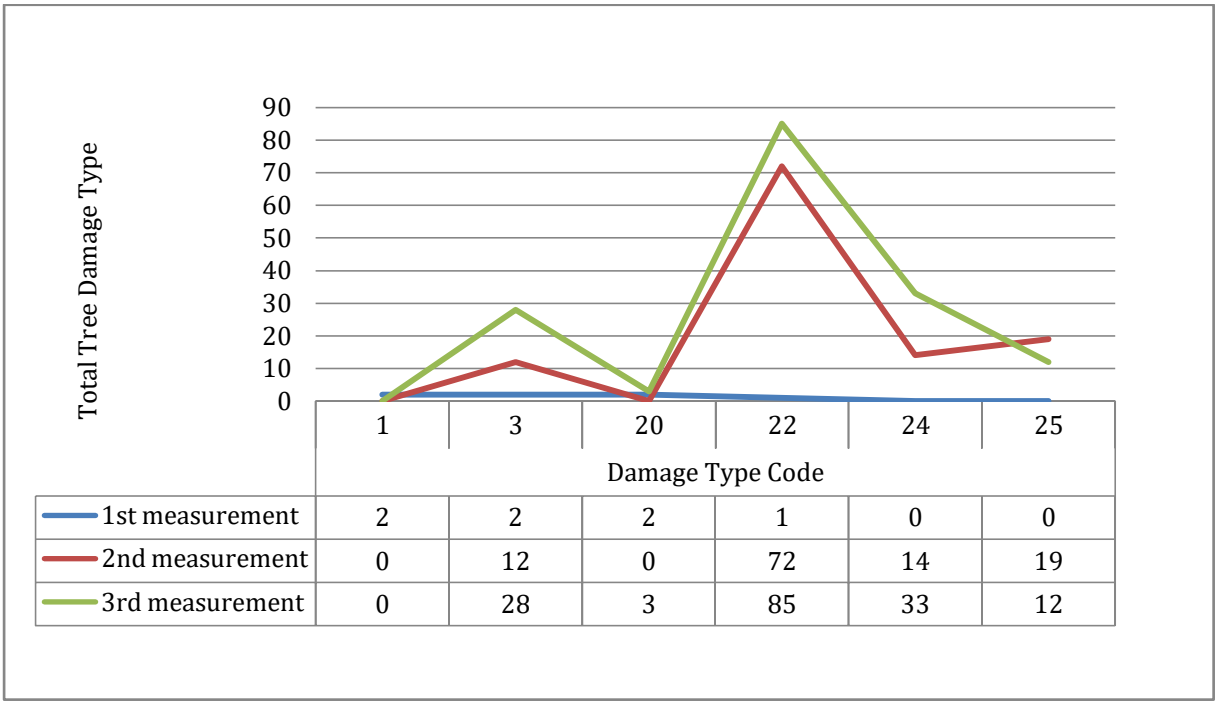

Figure 2. Graph of trends in the types of damage to mangrove trees in the mangrove forest area of Kuala Penet Resort, Way Kambas National Park

The trend of types of damage to mangrove trees at three measurement times in the mangrove forest area of Margasari, Labuhan Maringgai is presented in Table 4.

Table 4. Trends in the types of tree damage in the mangrove forest area of Margasari, Labuhan Maringgai

Measurement Time	Tree Damage Types Code												
	02	03	04	05	06	11	13	20	21	22	24	25	26
1st measurement	6	168	8	-	-	2	-	-	20	122	2	6	-
2nd measurement	-	56	2	7	-	1	-	-	33	27	26	1	-
3rd measurement	4	119	5	3	4	1	6	1	10	22	65	1	4
Total Tree Damage Types	10	343	15	10	4	4	6	1	63	171	93	8	4

Information: - = No tree damage found

Based on Table 4, 13 types of damage to mangrove trees were identified in the mangrove forest area of Margasari, Labuhan Maringgai, including conks (code 02), open wounds (code 03), resinosis/gummosis (code 04), broken branches (code 05), termite nests (code 06), broken bole/roots (code 11), broken/dead roots (code 13), lianas (code 20), loos of apical dominance, dead terminal (code 21), broken or dead branches (code 22), foliage damaged/shoots (code 24), discoloration of foliage (code 25), and puru/tumor rust (code 26). There are four types of damage to mangrove trees that dominate, namely: open wounds (code 03) 343 damage, broken or dead branches (code 22) 171 damage, damaged leaves or shoots (code 24) 93 damage, and Loos of apical dominance, dead terminal (code 21) 63 damage. There are two types of damage to mangrove trees that tend to increase, namely open wounds (code 03) and damaged foliage/shoots (code 24). In addition, there were four new types of damage identified in the third measurement (trend), namely: broken/dead roots (code 13), termite nests (code 06), puru/tumor rust (code 26), and lianas (code 20). A graph of the trend of damage to mangrove trees in the mangrove forest area of Margasari, Labuhan Maringgai is presented in Figure 3.

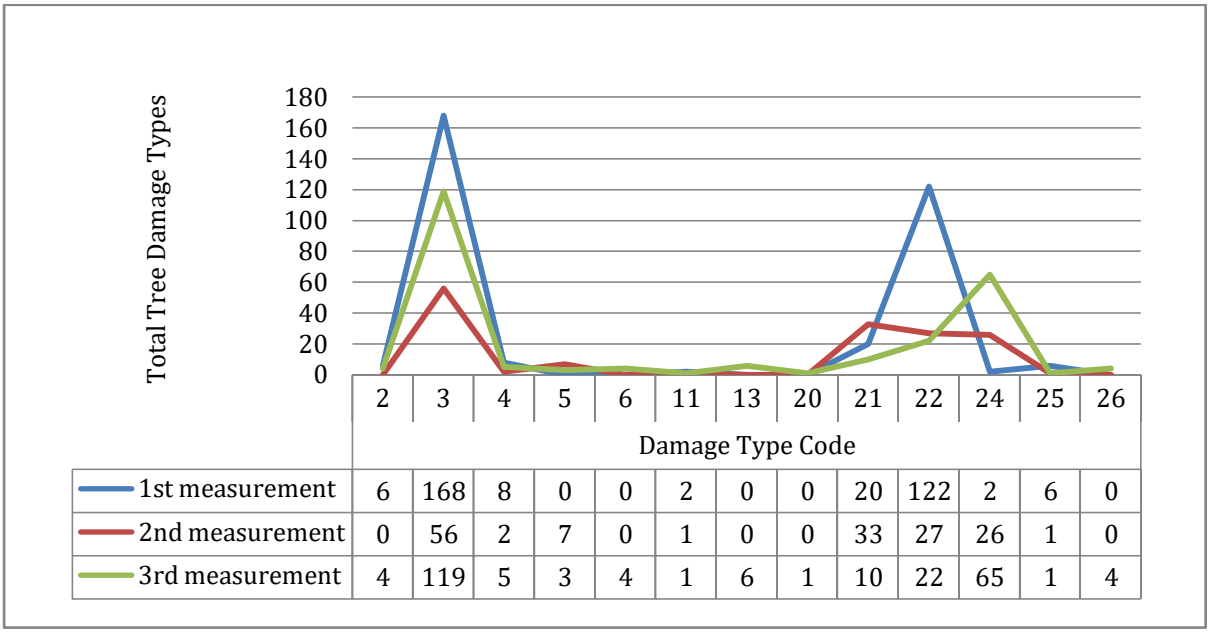

Figure 3. Graph of trends in the types of damage to mangrove trees in the mangrove forest area of Margasari, Labuhan Maringgai

The trend of types of damage to mangrove trees at three measurement times in the mangrove forest area of Purworejo, Pasir Sakti is presented in Table 5.

Table 5. Trends in the types of tree damage in the mangrove forest area of Purworejo, Pasir Sakti

Measurement Time	Tree Damage Types Code						
	03	04	0 5	21	22	24	25
1st measurement	34	-	-	-	108	7	14
2nd measurement	38	2	2	2	123	6	18
3rd measurement	17	-	1	-	5	227	-
Total Tree Damage Types	89	2	3	2	236	240	32

Based on Table 5, seven types of damage to mangrove trees were identified in the mangrove forest area of Purworejo, Pasir Sakti, including open wounds (code 03), resinosis/gummosis (code 04), broken branches (code 05), loos of apical dominance, dead terminal (code 21), broken or dead branches (code 22), damaged foliage/shoots (code 24), and discoloration of foliage (code 25). There are three types of damage to mangrove trees that dominate, namely: open wounds (code 03) 89 damage, broken or dead branches (code 22) 236 damage, and damaged leaves or shoots (code 24) 240 damage. There is only one type of damage to mangrove trees that tends to increase, namely damaged foliage/shoots (code 24) and there are three types of damage that experience a decrease (no more damage) in the third measurement (trend), namely: resinosis/gummosis (code 04), Loos of apical dominance, dead terminal (code 21), and discoloration of foliage (code 25). A graph of the trend of damage to mangrove trees in the mangrove forest area of Purwerejo, Pasir Sakti is presented in Figure 4.

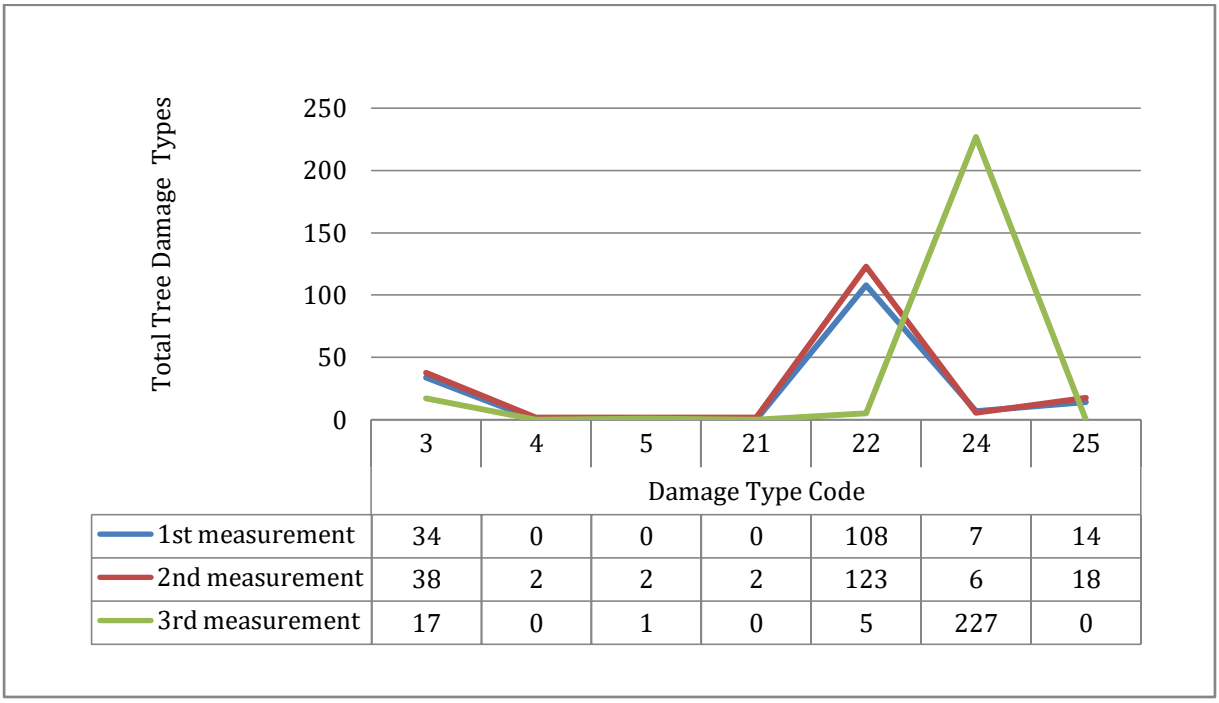

Figure 4. Graph of trends in the types of damage to mangrove trees in the mangrove forest area of Purworejo, Pasir Sakti

The third measurement shows an increasing trend caused by an increase in the type and amount of tree damage. The kind of tree damage was dominated by the type of damage of open wounds (code 03), damaged foliage or shoots (code 24), and broken or dead branches (code 22). This shows the diversity of the number and type of tree damage in each measurement. The variety of tree damage in the shoot-to-root area significantly affects tree growth so it impacts overall forest health. The condition of this tree damage needs to be known as early as possible to overcome the tree damage (Rahmawaty et al., 2018)

The increasing trend of open-wound tree damage indicates high activity at this location, both human activities, and friction between trees (Safe'i R. et al., 2021). Usually open wounds are also caused by pruning activities on wood (Indrawati I. & Nurhasan N., 2021). Open wounds can be caused by external factors, namely human behaviors or conflict between trees. The cause of open injuries is high human activity or the activity of the tree itself (Rochmah S. F. et al., 2021). Damage to open wounds can cause more severe damage because it can become a growing space for pathogens. Open wounds are indicated by peeling bark or inner wood without continued weathering (Safe'i & Upe, 2022). Open wounds will impact the decline in tree health so that trees cannot carry out their main functions properly (Rizky P. M. et al., 2022).

The second type of damage is damaged shoots or shoots (code 24). Symptoms caused by the damage are hollow leaves and dead tree shoots from the young parts spreading to the older features (Doria C. et al., 2021). Damaged leaves can be caused by fungi, pests, or diseases (Arwanda & Safe'i, 2021). Leaves attacked by fungus or disease will experience abnormalities such as hollow leaves, yellowing, and fall. This is because the leaves cannot properly carry out the photosynthesis process (Feriansyah A. et al., 2022).

The type of damage to broken or dead branches at mangrove forest locations is caused by unstable weather and environmental conditions and the presence of pests or diseases that attack mangrove trees (Safe'i R. et al., 2022). Broken or dead branches are indicated by the loss of the shoot tips' twigs, leaves, and weathering (Maulana I. R. et al., 2022). The leading causes of this damage are pests or diseases, fungi, and old tree age (Anwar P. S. et al., 2022). In addition, broken branch damage is generally caused by external factors in the form of strong winds when it rains (Widodo L. M. et al., 2022). In addition, another cause is the condition of weak and weathered branches due to pests and diseases.

CONCLUSION

The value of the trend index of damage to mangrove trees in each cluster of FHM plots in the East Coast mangrove forest area, East Lampung Regency is Kuala Penet Resort, Way Kambas National Park 9.3 (CL1) and 4.5 (CL2); Margasari, Labuhan Maringgai 9.2 (CL1) and 19.8 (CL2); and Purworejo, Pasir Sakti 6.2 (CL1) and 9.8 (CL2). There are three types of damage to mangrove trees that tend to dominate, namely: open wounds (code 03), damaged foliage/shoots (code 24), and broken or dead branches (code 22). Thus, the trend of damage index values and types of damage to mangrove trees in the East Coast mangrove forest area, East Lampung Regency has increased. Therefore, appropriate management actions need to be taken to overcome the problem of damage to mangrove trees with routine maintenance (eg. pest control) and periodic monitoring of the health condition of mangrove trees.

REFERENCES

Ahalya, A. (2020). Floral Distribution, Diversity, and Ecology of Mangrove Forests in Mandaitivu and Arali, Sri Lanka. *Indonesian Journal of Social and Environmental Issues (IJSEI)*, *1*(3), 151–160.

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*, 995(1).

Anwar, P. S., Safe'i, R., & Darmawan, A. (2022). Landscape Characteristics on Forest Health Measurement Plots in Several Forest Functions. *IOP Conference Series: Earth and Environmental Science*, 950(1).

Anwar, Y., Setyasih, I., Ardiansyah, A., Partini, D., Dewi, R. P., & Wibowo, Y. A. (2021). Identification of Mangrove Forest Damage, and Effort to Conservation in Balikpapan City, East Kalimantan, Indonesia. *GeoEco*, *7*(2), 121.

Ardiansyah, F., & Safe'i, R. (2021). Analysis of Changes in Health of Coastal Mangrove Forest on The East Coast of Lampung. *IOP Conference Series: Earth and Environmental Science*, 755(1).

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 Conference Series: Earth and Environmental Science*, 918(1).

Chen, Q., Li, J., Zhang, L., Lu, H., Ren, H., Jian, S. (2015). Changes in the macrobenthic faunal community during a succession of a mangrove forest at Zhanjiang, South China. *Journal Coast Res*, 31(2), 315–25.

Doria,C., Safe'i, R., Iswandaru, D., &Kaskoyo, H. (2021). Fauna Biodiversity as One of Repong Damar Forest Health Indicators. *IOP Conference Series: Earth and Environmental Science*, 886 (1)

Feriansyah, A., Safe'i, R., Darmawan A., & Kaskoyo, H. (2022). Comparison of Crown Health Assessment Using Forest Health Monitoring and Remote Sensing Techniques. *IOP Conference Series: Earth and Environmental Science*, 1115(1).

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 (IJSEI)*, *2*(2), 110–118.

Indrawati, I., & Nurhasan, N. (2021). The damage trees study for a good and save roadside greenery planning in Surakarta City, Central Java. *Journal of Physics: Conference Series*, 1858(1).

Maulana, I. R., Safe'i, R., Febryano, I. G., Kaskoyo, H., & Rahmat, A. (2022). The Relationship Between The Health of Mangrove Forests and The Level of Community Welfare. *IOP Conference Series: Earth and Environmental Science*, 1027(1).

Maulana, I. R., Safe'i, R., & Rochmah, S. F. (2021). Analysis of The Vitality of The Agathis dammara Tree at Situ Gunung Resort, Gunung Gede Pangrango National Park. *IOP*

Conference Series: Earth and Environmental Science, 912(1).

Nurcahyani, A., Safe'i, R., Bintoro A., & Kaskoyo, H. (2022). Study of Vitality Change in Teak Community Forest Management. *IOP Conference Series: Earth and Environmental Science*, 1115(1).

Pangestu, A. Y., Safe'i, R., Darmawan, A., Kaskoyo, H., &Andrian, R. (2022). Black-Box Testing on Web-GIS of Forest Health Monitoring Using Equvalence Partitioning Techniques. *IOP Conference Series: Earth and Environmental Science*, 2563 (1)

Puspita, E.N., Safe'i, R., Kaskoyo, H. (2021). Forest Health Study in Efforts to Preserve Community Forest Agroforestry Patterns in Kubu Batu Village, Gedong Tataan District, Pesawaran Regency, Lampung Province. *IOP Conference Series: Earth and Environmental Science*, 886 (1)

Rahmawaty, Sembiring, I. E. P., Batubara, R., & Patana, P. (2018). Mapping of Tree Damage Classification in the Western Part of Medan City Green Belts Using Geographic Information System. *IOP Conference Series: Earth and Environmental Science*, 166(1).

Rizky, P. M., Safe'i, R., Kaskoyo, H., & Febryano, I. G. (2022). Forestry value For Health Status: An Ecological Review. *IOP Conference Series: Earth and Environmental Science*, 995(1).

Rochmah,S. F., Safe'i, R., Bintoro A., Kaskoyo, H., & Rahmat A. (2021). The Effect of Forest Health on Social Conditions of The Community. *IOP Conference Series: Earth and Environmental Science*, 739(1).

Rohman, N. A., &Safe'i, R. (2022). Health Assessment of Tahura Banten as an Effort to Protect Biodiversity. *IOP Conference Series: Earth and Environmental Science*, 2563(1).

Safe'i, R., Ardiansyah, F., Banuwa, I. S., Yuwono, S. B., Maulana, I. R., & Muslih, A. M. (2021). Analysis of internal factors affecting the health condition of mangrove forests in the coastal area of East Lampung Regency. *IOP Conference Series: Earth and Environmental Science*, *912*(1).

Safe'i, R., Andrian, R., &Maryono, T. (2022). Multi-Purpose Trees Species Damage Index : Case Study of Wan Abdul. *Indonesian Journal of Social and Environmental Issues (IJSEI)*, *2*, 146–153.

Safe'i, R., Rezinda, C. F. G., Banuwa, I. S., Harianto, S. P., Yuwono, S. B., Rohman, N. A., &Indriani, Y. (2022). Factors Affecting Community-Managed Forest Health. *Environment and Ecology Research*, 10(4), 467–474.

Safe'i, R., & Upe, A. (2022). Mapping of Tree Health Categories in Community Forests in Lampung Province. *IOP Conference Series: Earth and Environmental Science*, 995(1).

Safe'i, R., Maulana, I. R., Ardiansyah, F., Banuwa, I. S., Harianto, S. P., Yuwono, S. B., & Apriliyani, Y. (2022). Analysis of Damage to Trees in the Coastal Mangrove Forest of East Lampung Regency. *International Journal of Sustainable Development and Planning*, 17 (1), 307–312.

Selvira, Safe'i, R., & Yuwono, S. B. (2022). Assesment of The Health of Community Forest Based on Rubber (Hevea brasiliensis) in Tulang Bawang Regency. *IOP Conference Series: Earth and Environmental Science*, 1104 (1).

Sanjaya, F. A., Safe'i, R., Winarno, G. D., & Setiawan, A. (2022). Health Assessment of Conservation Forest-Based on Biodiversity Indicator Tree Types (Case Study at Elephant Respont Unit Margahayu Way Kambas National Park). *IOP Conference Series: Earth and Environmental Science*, 950(1).

Tetelepta, J. M. S., Loupatty, S., & Wawo, M. (2020). Sustainable Management Strategy for Mangrove Forest of Pelita Jaya Bay and Kotania Bay, Western Seram, Indonesia. *TRITON: Jurnal Manajemen Sumberdaya Perairan*, *16*(2), 53–67.

USDA-FS. (2020). Forest Ecosystem Health Indicators. Campus Boulevard, 25p.

Widodo, L. M., Safe'i, R., Winarno, G. D., & Yuwono, S. B. (2022). Plant Success Rate in Program Forest and Land Rehabilitation in Unity Batutegi Forest Management. *IOP Conference Series: Earth and Environmental Science*, 1030(1).