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Analysis of Tree Health in the Pematangsiantar Animal Park, North Sumatra Province

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Abstract

*This study aims to determine acquire data on the species composition and structure of trees, as well as to analyze the health of trees growing in the Pematangsiantar Animal Park. Using the census approach, data collection was conducted. The health state of trees was determined using the Forest Health Monitoring (FHM) method, which measures tree health by categorizing the kind and severity of damage per every plant. Two indicators are utilized to measure tree health: tree damage and tree crown condition. The method of data collection was conducted on trees with a minimum diameter of 20 centimeters. Techniques of data analysis consisting of descriptive and weighted scoring. At the Pematangsiantar Animal Park, there are 49 species of trees and a total of 153 unique trees. Mahogany (*Swietenia mahagoni*) is the most prevalent tree species, with 21 specimens. The health state of the trees in the Pematangsiantar Animal Park included 48 trees with a healthy status, 93 trees with bad (unhealthy) status, and 12 trees with a sick status, however none were discovered to be in a very sick condition*
Keywords: *Animal park, Monitoring forest health, Tree health*

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INTRODUCTION

Pematangsiantar City is one of the cities in the province of North Sumatra. The position of the city is extremely crucial since the Trans-Sumatra Highway traverses its 79.97 km^2 territory. Low environmental quality has a severe effect on human health, particularly in urban residential areas. Since cities are centers of human activity, they require a healthy environment that can sustain these activities. There are a variety of techniques to regulating the quality of the urban environment, such as the establishment of urban forests in response to the most pressing urban issues (Muslihudin & Setia, 2018).

The city is the center of a big and densely populated community, therefore its center of ordinary human activity occurs more frequently than in rural areas (Silalahi & Subarudi, 2015). The city is also a place for the growth of social, economic, and cultural activities. Cities have an impact on the environment through their activities and

developments, resulting in a tendency for all activities to be concentrated in the urban environment, which may lead to a decline in environmental quality and adverse effects on urban heat, city garbage, noise, and floods (Muslihudin & Setia, 2018).

Green open space (RTH) is a stretch of land without buildings that has the shape, size, and exclusive geographical boundaries with any status of control, and contains woody and annual green plants, with trees as the main characteristic plants and other plants (shrubs, grasses, and other ground cover plants) as complementary plants, along with other objects that also complement and support the function of the green open space in question (Sitinjak et al., 2016). In addition, the varied tree compositions contribute to an area's aesthetic appeal. The presence of supporting elements, such as environmental conditions and the level of adaptation of the tree to its surroundings, enables these activities to be carried out efficiently (Stalin et al., 2013).

The existence of the Pematangsiantar Animal Park as a component of a city park and green open space (RTH) is very important for research because it functions to reduce pollution, neutralize air, reduce noise, as a recreation area and as an aesthetic function. Tree health research at the Animal Park of Pematangsiantar City is very important to do as a reference for maintaining trees at the Animal Park in the future.

METHOD

Time and location

The research was conducted from March to June 2022, at Animal Park of Pematangsiantar City, North Sumatra Province.

Instruments and materials

The required instruments consist of a camera, tally sheet, phiband, hagameter, and stationery. North Sumatra's Pematangsiantar Animal Park is the source of the materials.

Research procedure

Data collection was carried out using the census method. This method is used to assess the health of all trees in the Pematangsiantar Animal Park. Identification of tree health status by observing forest health, or Forest Health Monitoring (FHM), which is a method of assessing tree health by grouping species and the level of damage per individual plant. In assessing tree health, two indicators are used, namely tree damage and tree crown condition. The data collection method was carried out by census, with the criteria of a minimum tree diameter of 20 cm. The data analysis method is a descriptive one with scoring based on weighting values.

Data Collection

Tree Productivity

Tree development may be estimated by measuring the tree's diameter at a height of 1.3 meters above ground level (dbh). Stands with a diameter of at least 20 cm are classified as trees. The value of LBDS (Basic Field Area) is then computed based on this statistics. LBDS describes the pace of expansion. LBDS is calculated using the following formula:

$$\textbf{LBDS} = \frac{1}{4} x\ \pi\ xD^2$$

Information:
LBDS : Basic area / tree
Π : 3,14 (Constant)
D : dbh/diameter at breast high

Tree Damage Indicator

Damage is recorded for a maximum of three locations for every tree. When numerous damages occur at the same area, only the most serious damage is recorded. The damage data is utilized to examine tree damage parameters, including damage location, damage type, and damage severity class (Table 1).

Table 1. Work sheet of Tree Damage Assessment based on the FHM method

No	Tree name	Diameter (cm)	Height (m)	Damage 1			Damage 2			Damage 3		
				Xi	Yi	Zi	Xi	Yi	Zi	Xi	Yi	Zi

Description: Xi = Damage Location; Yi= Damage Type; Zi = Damage Severity Class

Inspection of the tree is carried out on all sides starting from the base of the trunk. The known damage on each tree is a maximum of three damages. The location of the damage on the tree can be coded to make it easier to observe so that it can simplify the process of observing tree health. The damage code for the tree parts uses codefication based on the Environmental Monitoring and Assessment Program (EMAP) standard (Figure 1).

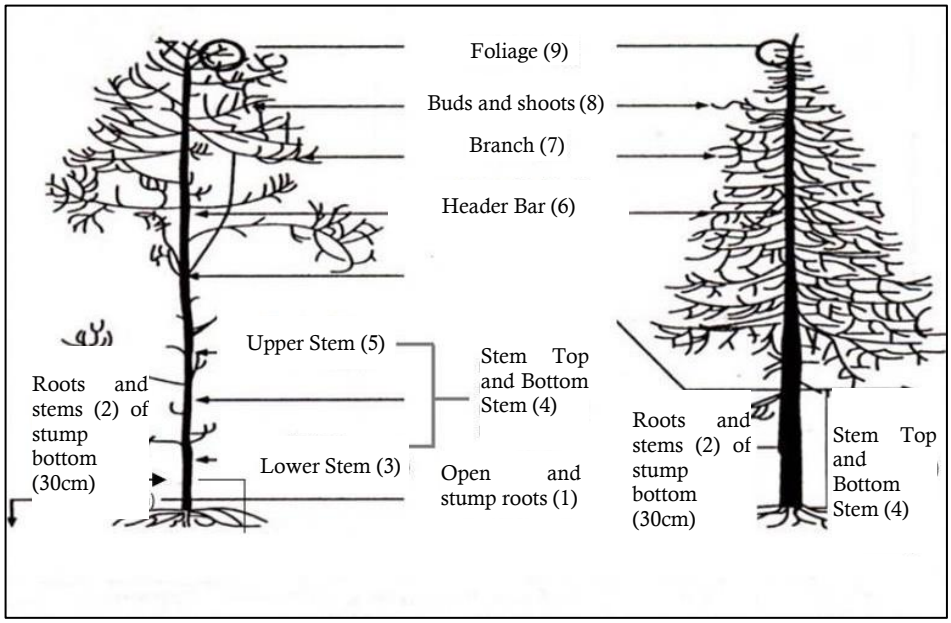

Figure 1. Damage Location on tree (Mangold, R., 1997)

Damage assessment uses criteria based on the FHM method (Alexander & Barnard, 1995). The data obtained from the damage assessment then calculated the

damage index value with the code and Damage Index Value. The final calculation results obtained Damage Index Value, namely the healthy class, light class, medium class and heavy class (Noviadi & Rivai, 2015),

$$IK = \sum_{i=1}^{n} (xi.yi.zi)$$

IK = (xlocation) x (damage type) x (zseverity)

The formula to found Damage Index value of tree level (*Tree Level Index*-TLI) on each cluster :

TLI/NIK = (IK1) + (IK2) + (IK3)

Information:
NIK : Tree Damage Index Value
Xi : Weight values for damage type of damage
Yi : Weight values for damaged tree parts/locations
Zi : Weight values for damage severity

Furthermore, it can be known the class of tree damage according to the weight of the following index values:
1. Class is very healthy
2. Healthy class
3. Unhealthy class
4. Sick class
5. Class is very sick

Table 2. Tree Damage Index Weight

Damage Location		Damage Type		Severity Class	
Code	**Weight**	**Code**	**Weight**	**Code**	**Weight**

Source: (Mangold, 1997)

Table 3. Code and Damage Location

Code	Information	Weight
0	Healthy (No damage)	0
1	Roots (exposed) and stumps (30 cm above ground level)	2
2	Roots and lower stems	2
3	Lower part of the stem (lower half of the stem between the stump and the base of the live crown)	1,8
4	The stem bottom and the stem top	1,8
5	The stem top (upper half of the stem between the stump and the base of the live crown)	1,6
6	Crown trunk (main stem within the living crown area on a living crown basis)	1,2
7	Branch (2.54 cm greater at the point of branching to the main stem or canopy within the living canopy)	1

8	Buds and shoots (last year's growth)	1
9	Foliage	1

Source: (Mangold, 1997)

Table 4. Code and Damage Type

Damage Type Code	Damage Type	Weight
1	Cancer, goal (puru)	1,9
2	Liver Rot, Fruit Body (Fruit Body), and Other Indicators of Advanced Weathering	1,7
3	Open Wound	1,5
4	Exudation (Resinosis and Gumosis)	1,5
11	Broken Bars Less than 0.91 m	1,6
12	Brums on Roots or Stems	1,6
13	Broken or Dead roots less than 0.91 m	1,5
21	Loss of Dominant End (Dead Edge)	1
22	Broken or Dead Branch	1
23	Brum on Branches or Regions in the Crown	1
24	Leaf Damage	1
25	Leaves Changing Color (Not Green)	1

Source: (Mangold, 1997)

Table 5. Code and Damage Severity Class

Code	Severity Class (%)	Weight
0	01-09	1,5
1	10-19	1,1
2	20-29	1,2
3	30-39	1,3
4	40-49	1,4
5	50-59	1,5
6	60-69	1,6
7	70-79	1,7
8	80-89	1,8
9	90-99	1,9

Source: (Mangold, 1997)

Header Damage Indicator

The tree canopy condition parameters measured by the FHM method are as follows:

A. Live Crown Ratio-LCR, namely the closed crown height to the total tree height. Measure the height of the tree at the tip of the branch with leaves as 'TT' using a hagameter. Measure TTBC as 'Ttj' using hagameter and calculate live crown ratio by formula,

$$\mathbf{LCR} = \frac{\boldsymbol{Ttj}}{\boldsymbol{TT}} \times \mathbf{100\%}$$

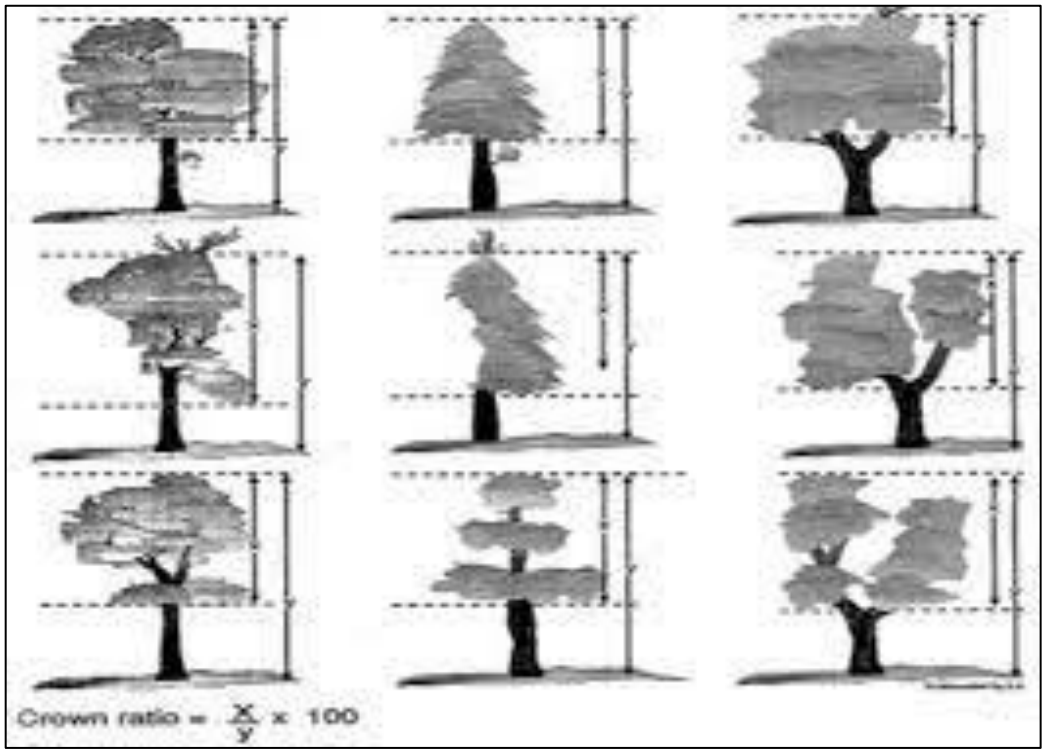

Figure 2. Measurement of the ratio of living canopy (Mangold, 1997)

B. Crown density (Cden), namely the percentage of sunlight that is retained by the crown so as not to reach the ground surface. Cden is calculated using the header density scale card.

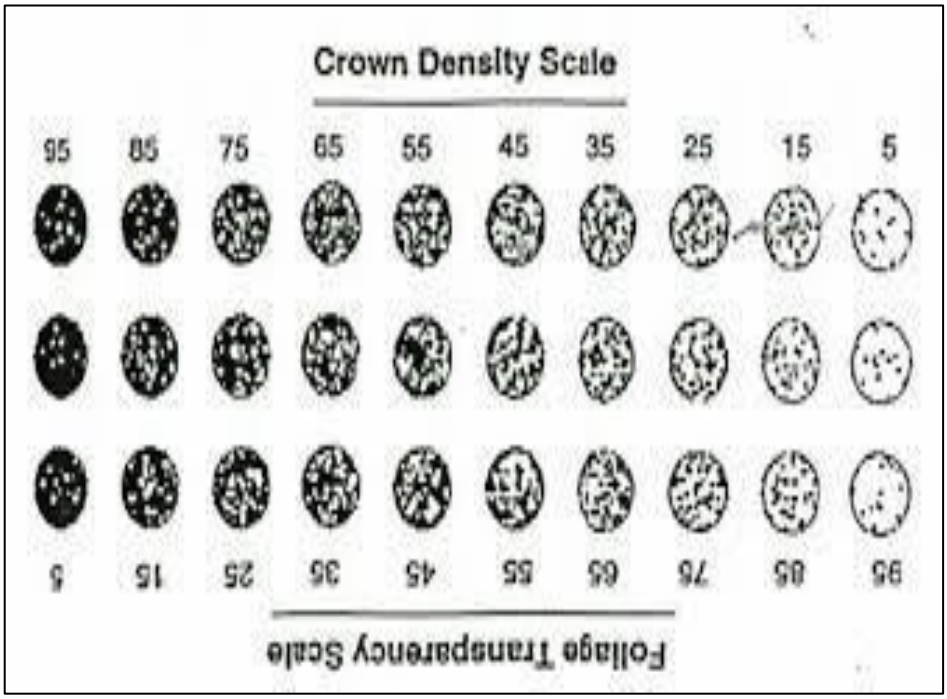

Figure 3. Canopy Density Scale Card (Mangold, 1997)

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C. Canopy transparency (Foliage Transparency-FT), namely the percentage of sunlight that can pass through the canopy and reach the ground surface. The FT is calculated using the header transparency scale card.

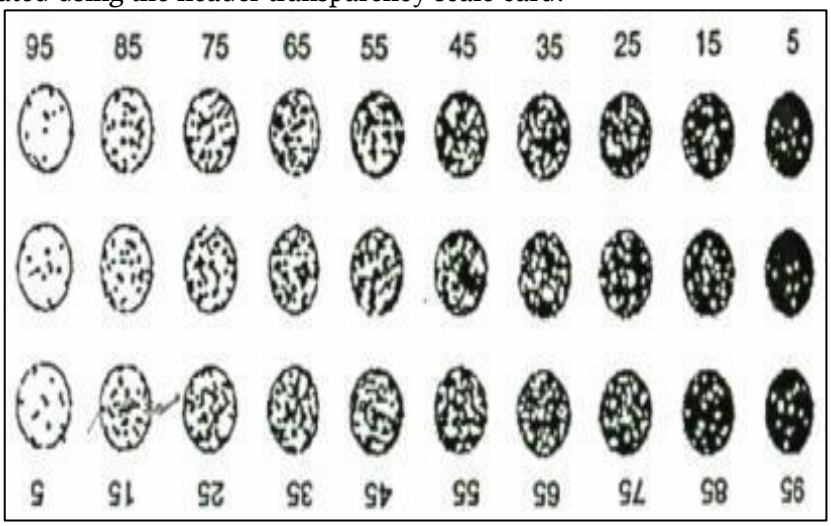

Figure 4. Header Transparency Scale Card (Mangold, 1997)

D. Crown Diameter (Crown Diameter Width and Crown Diameter 90°), which is the average value of measuring the length and width of the crown of the tree in question. CDW is calculated based on measuring the length and width of the outer canopy using a tape measure.

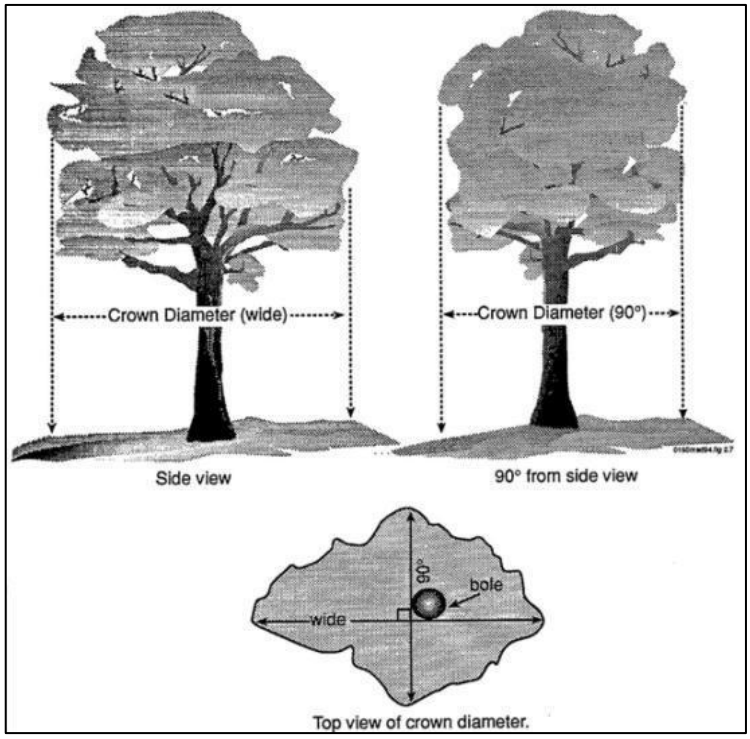

Figure 5. Determination of Canopy Diameter (Mangold, 1997)

E. Crown Dieback (CDB), namely branches and twigs that have just died where the dead parts start from the tip and then spread to the base.

Table 6. Parameters for measuring tree canopy conditions

Parameter	Classification		
	Good (Score=3)	Moderate (Score=2)	Bad (Score=1)
Live Title Ratio	≥ 40%	20 – 35%	5 – 15%
Heading Density	≥ 55%	25 – 50%	5 – 20%
Header Transparency	0 - 45%	50 – 70%	≥ 75 %
Dieback	0 - 5%	10 – 25%	≥ 30 %
Header Diameter	≥ 10,1 m	2,5 – 10 m	≤ 2,4 m

Each tree's *Visual Crown Rating* (VCR) is comprised of all parameters measuring the condition of the tree canopy. VCR has values of 1,2,3, and 4 determined by the measured magnitude of each canopy condition parameter.

Table 7. *Visual Crown Rating* (VCR) Value of Individual Trees (Mangold, 1997)

VCR Value	Criteria
4	All parameters have a value 3, or only 1 parameter has a value 2, no parameters have a value 1.
3	More combinations of value 3 and value 2 in the header parameter, or all values 2, but no parameter value 1.
2	At least 1 parameter is 1, but not all parameters.
1	All header condition parameters have a value 1.

Data Analysis

The determination of the health status of trees in Pematangsiantar City Animal Park is based on the scores obtained from determining the intervals for the values of each observation parameter (productivity, tree damage and crown condition) which represent indicators of tree health. The weighting of scores for each indicator is given at intervals of 0-10. The final value of tree health is obtained from the sum of the weighted scores of all indicators with intervals between 0-20. The higher the weight score indicates the higher the level of health. The distribution of scores is very sick (1-4), sick (5-8), unhealthy (9-12), healthy (13-16) and very healthy (17-20).

RESULTS AND DISCUSSION

General Conditions of Research Location

Pematangsiantar Animal Park (*Taman Hewan Pematangsiantar*/THPS) opened on November 27, 1936 with an area of 4.5 hectares. The Pematangsiantar Animal Park is located on Jalan Gunung Simanuk-manuk, Pematangsiantar City, North Sumatra. THPS has successfully carried out its role as a conservation organization and can be classified as a leading Animal Park among Animal Parks in Indonesia. THPS received approval in the form of a Decree of the Minister of Forestry with Number. SK.84/Menhut-II/2007 issued on March 15th 2007.

Diversity Species of Tree Vegetation

Based on observations in the field, there are 153 trees with a diameter of 20 and above in the Animal Park of Pematangsiantar City consisting of Acacia (*Acacia*), Mango (*Mangifera indica*), Rain Tree (*Samanea saman*), Orange Jasmine (*Murraya paniculata*), Flamboyant or Royal Poinciana (*Delonix regia*), Blackboard Tree (*Alstonia scholaris*), Weeping Fig (*Ficus benjamina*), Mahogany or West Indies Mahogany (*Swietenia mahagoni*), Honduran Mahogany (*Swietenia macrophylla*), Alexandrian Senna (*Senna*), Water Apple (*Syzygium aqueum*), Sea Hibiscus or Mahoe (*Hibiscus tiliaceus*), Terap (*Arthocarpus elasticus*) , Alexandrian Laurel (*Calophyllum inophyllum*), Cocoa (*Theobroma cacao*), Indian Mulberry (*Morinda citrifolia*), Durian (*Durio*), Common Fig (*Ficus carica*), Indian Prune (*Flacourtiarukam*), Pride of India (*Lagerstroemia*), Spanish Cherry (*Mimusops elengi*), Sandbox Tree (*Hura crepitans*), Breadfruit (*Arthocarpus altilis*), Avocado (*Persea americana*), Golden Shower Tree (*Cassia fistula*), Kukui or Candlenut Tree (*Alleurites moluccanus*), Bishop Wood (*Bischofia javanica*), Red Sandalwood (*Adenanthera pavonina*), Madagascar Almond (*Terminalia mantaly*), African Tulip Tree (*Spathodea campanulata*), Levant Cotton (*Gossypium*), Spanish Cherry (*Mimusops elengi*), Shorea (*Shorea* sp.), Tree Bean (*Parkia timoriana*), Jackfruit (*Artocarpus heterophyllus*) and Rambutan (*Nephelium lappaceum*).

The most common tree species found were Mahogany (*Swietenia mahagoni*) with 21 individuals (13.73%) and the fewest trees found were 10 tree species namely Candlenut Tree, Bishop Wood, Rosary Pea, Wattles or Acacia, Shorea, Avocado, Jackfruit, Indian Mulberry, Tree Bean and Rambutan with the number of each tree species amounting to 1 tree (0.65%).

Table 8. Diversity Species and Total of Trees

No	Species	Latin Name	Total	Percentage (%)
1	Wattles or Acacias	*Acacia*	4	2,61
2	Mango	*Mangifera indica*	5	3,27
3	Flamboyant	*Delonix regia*	3	1,96
4	Blackboard Tree	*Alstonia scholaris*	3	1,96
5	Rain Tree	*Samanea saman*	8	5,23
6	Species 1		1	0,65
7	Weeping Fig	*Ficus benjamina*	9	5,88
8	Terap	*Arthocarpus elasticus*	5	3,27
9	Alexandrian Senna	*Senna*	7	4,58
10	Water Apple	*Syzygium aqueum*	6	3,92
11	Alexandrian Laurel	*Calophyllum inophyllum*	2	1,31
12	Honduran mahogany	*Swietenia macrophylla*	17	11,11
13	West Indies Mahogany	*Swietenia mahagoni*	21	13,73
14	Indian Mulberry	*Morinda citrifolia*	1	0,65
15	Indian Prune	*Flacourtia rukam*	2	1,31
16	Pride of India	*Lagerstroemia*	8	5,23
17	Levant cotton	*Gossypium*	1	0,65
18	Spanish Cherry	*Mimusops elengi*	4	2,61
19	Sandbox Tree	*Hura crepitans*	2	1,31
20	Breadfruit	*Arthocarpus altilis*	2	1,31
21	Avocado	*Persea americana*	1	0,65
22	acacia	*Cassia fistula*	1	0,65
23	Candlenut Tree	*Aleurites moluccanus*	1	0,65
24	Shorea	*Shorea SP*	1	0,65

25	Bishop Wood	*Bischofia javanica*	1	0,65
26	Red sandalwood	*Adenanthera pavonina*	1	0,65
27	African Tulip Tree	*Spathodea campanulata*	2	1,31
28	Madagascar Almond	*Terminalia mantaly*	6	3,92
29	Spike Oak	*Lithocarpus elegans*	2	1,31
30	Tree Bean	*Parkia timoriana*	1	0,65
31	Jackfruit	*Arthocarpus heterophyllus*	1	0,65
32	Sea Hibiscus or Mahoe	*Hibiscus tiliaceus*	7	4,58
33	Species unknown		16	9,75
34	Rambutan	*Nephelium lappaceum*	1	0,65
Total			153	100,00

Source: Research Data (2022)

Tree Damage Indicator

Assessment of tree damage is carried out by observing each tree in Pematangsiantar Animal Park (*Taman Hewan Pematangsiantar*/THPS). Tree damage is declared damaged or diseased when signs and indications of aggression by pests, pathogens, other animals and humans are found on the tree. According to Cahyono (2014), biotic damage can be caused by pathogens, namely all organisms that can cause disease and abiotic factors are caused by physical and chemical environmental factors that do not support normal plant growth and development.

Damage Location

Based on field observations, the location of damage to trees is generally found in the lower trunk and the upper part of the tree. From figure 6 the Damage Location Diagram below shows the location of damage to a tree at the Pematangsiantar Animal Park, the location of the damage found in the lower trunk is 5.60% (33 Location Points), the lower trunk is 13.07% (77 Location Points), the bottom and top of the stem 20.37% (120 Location Points) the location of the damage in general is cancer, exudation, open wounds, liver rot and other indicators of advanced weathering and the top of the stem is 11.88% (70 Location Points), the crown stem is 8.66% (51 Location Points), branches are 21.73% (128 Location Points), buds and shoots are 3.40% (20 Location Points), and leaves are 15.82% (90 Point Location) damage location found leaf damage and leaf discolored.

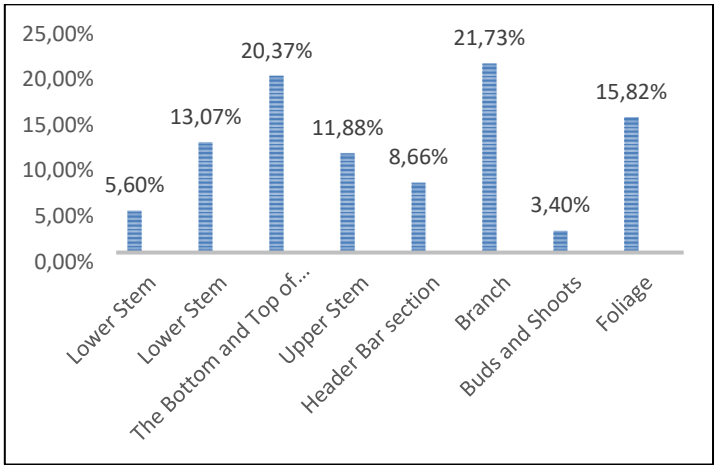

Figure 6. Damage Location Diagram

After roots and leaves, the stem plays a crucial part in the continuation of a tree's existence. The damage that occurs at the site of the stem is produced by the usage of the stem as a place to hang banners and as a seat using nails or iron wire, which causes the damage to worsen with the entrance of agents that cause damage, such as fungi that penetrate the wood and create cancer on the stem (Tsani & Safe'i, 2017).

Damage Type

Tree damage has an effect on the physiological function of trees, lowering their growth rate and causing their demise. The observed damage is caused by the blocking of the tree's physiological systems by pathogens, insects, or other abiotic agents. Changes in shape, color, texture, and size are some of the symptoms that can be detected as a result of a disruption in tree growth (Tsani & Safe'i, 2017).

The damage to the trees in the Animal Park has various types. From the research that I have done, the most dominant type of damage to trees is the type of damage in the form of open wounds with a total of 128 open wounds with a percentage of 22.15% of the total trees in the Animal Park. Based on the results of observations made at the Pematangsiantar Animal Park, there are various types of tree damage with different levels of severity presented in Figure 7.

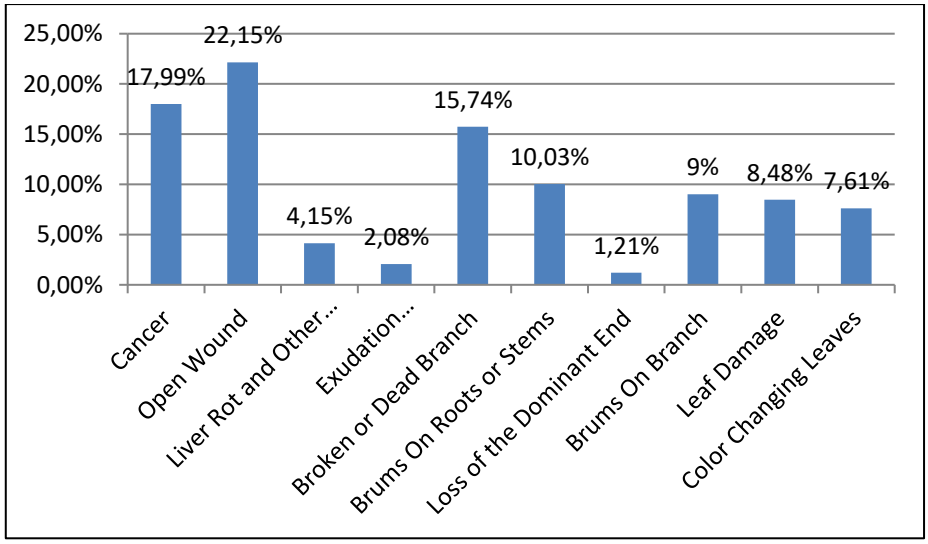

Figure 7. Tree Damage Type Diagram

Table 9. Type and Forms of Damage to Trees

No	Damage Type	Damage Form	Information
1	Cancer		Cancer is typically brought on by pathogens that cause illness in plants and pathogens that typically cause harm due to fungi (Rahayu. 1999), Cancer attack is usually on the cambium which turns off the function of transporting nutrients

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			and distributing nutrients (Pracaya, 2003).
2	Open Wound		Open wounds are a series of wounds observed on the peeling bark or exposed interior wood of a tree with no additional weathering (Rahayu. 1999). Open wounds were found to occur due to human intervention, for example cutting/trimming that was not done properly, vandalism. Arwanda et al., (2021) stated that sharp objects, such as nails used to mount billboards and ads, can cause mechanical damage to the trunks of trees.
3	Liver Rot and Other Indicators of Lacking Advanced Weathering		This damage is formed because the injured tree is attacked by microorganisms and causes weathering. Based on research of Rahayu (1999), wood weathering processes vary widely depending on the microorganisms that cause weathering, the type of plant and the habitat in the food source. Heart rot fungus is a wood rot fungus or wound parasite.
4	Exudation (Resinosis/Gummosis)		Exudation is the discharge of fluids from damaged plant tissues. It can be differentiated based on the liquid it secretes: a) Gummosis, when it secretes gum or slime, and b) Resinosis, when it secretes resin (Rahayu. 1999).
5.	Broken or Dead Branch		Winds with a speed of approximately 45 km/hour can cause mechanical damage such as broken branches or twigs, fallen leaves, broken tree trunks and uprooted trees along with their roots (Simajorang & Safe'i, 2018). This generally occurs due to parasitic, non-parasitic or pest diseases (Pracaya, 2003)

6	Brums On Roots or Stems		Original brums/shoots that sprout on aberrant tree trunks or roots and restrict the growth of the tree, causing it to become unhealthy.
7	Loss of the Dominant End		Trees with loss of dominant shoots can be seen from the tips of the trees which die and experience significant leaf discoloration at the ends of the trees (Rahayu, 1999).
8	Brums on Branch		Brum disease on branches was found in Animal Parks at 9.00%. If it continues, it will cause competition for sunlight for the process of photosynthesis.
9	Leaf Damage		Leaf damage in THPS was 8.48%, the symptoms were insect ingestion, crazed or splayed leaves. The percentage value of buds or shoots attacked > 50%, at least 30% of the leaves, buds/shoots.
10	Color Changing Leaves		Leaves change color due to lack of nutrients or other factors. This damage results in disruption of photosynthesis so that tree growth becomes less than optimal.

Severity Class of Damage Vegetation

In the study, it was found that the severity class varied for each tree found in the Pematangsiantar Animal Park, it was known that the most severe class was 1-9%, namely 140. From table 11 showed that there are 3 severity classes at the Pematangsiantar Animal Park, namely 01-09% at 91.50%, 10-19% severity at 1.96% and 70-79% severity at 6.54%.

Table 10. Severity Class

No	Code	Total	Percentage (%)
1	01-09	140	91,50
2	10-19	10	1,96
3	20-29	0	0
4	30-39	0	0
5	40-49	0	0
6	50-59	0	0
7	60-69	0	0
8	70-79	3	6,54
9	80-89	0	0
10	90-99	0	0

Source: Research Data (2022)

Table 11. Damage Index Value

Damage Index Value	Code	Total
2,00 - 4,16	10	23
2,17 - 6,32	9	33
6,33 - 8,48	8	35
8,40 - 10,64	7	24
10,65 - 12,8	6	20
12,9 - 14,96	5	10
14,97 - 17,12	4	3
17,13 - 19,28	3	3
19,29 - 21,44	2	0
21,45 - 23,62	1	2

Source: Research Data (2022)

Heading Indicator

Trees with wide spacing will have a broad crown or be more side-directed, whereas trees with narrow spacing will have a small, towering crown (Safe'i, et al., 2019). Lanisa (2015) stated that canopy structure and conditions affect fruit production. There are five parameters used to measure tree crown conditions, namely live crown ratio (LCR), crown density (C-Den), crown transparency (foliage transparency-FT) crown diameter (CDW). , and crown dieback (CDB). From the assessment of the five parameters, the crown sighting rating values were obtained, namely 21.18% for CDW, 21.18% CDB, and 20.14% C-Den, 20.09% FT and 17% LCR. 41%. After the parameter value is obtained, then the parameter is classified which is coded with a value of 3 = good, 2 = moderate, 1 = bad.

Live Crown Ratio (LCR), this parameter shows the proportion of crown length to tree height. From the results of the study, the classification of the dominant live canopy ratio was found to be 3 or good. The better the quality of the live canopy ratio, the better the physiological function of the leaves on the tree. Based on the figure below, it can be seen that the ratio of good live crowns is 49.33%, 48% is medium and 2.67% is bad.

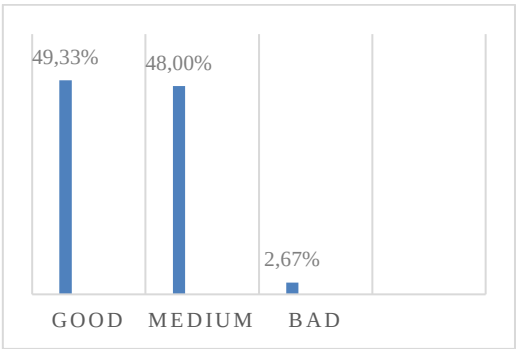

Figure 8. Tree Live Crown Ratio diagram at Pematangsiantar Animal Park

Crown density (C den), this parameter shows the percentage of a tree's crown in blocking sunlight from entering the forest floor/soil surface (Safe'i et al., 2020). At the research location, the dominant classification of crown density was found to be 3 or good (88%), the good condition of the crown density described the dense/shady tree canopy (Figure 9).

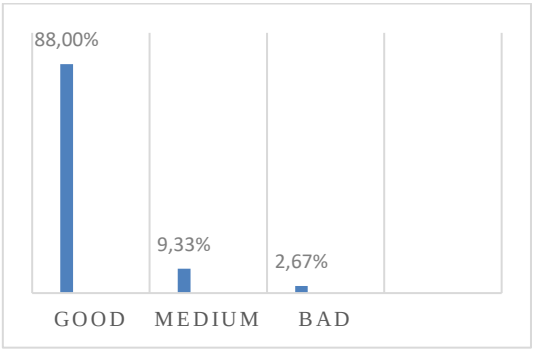

Figure 9. Crown Density Diagram (Crown density-C den)

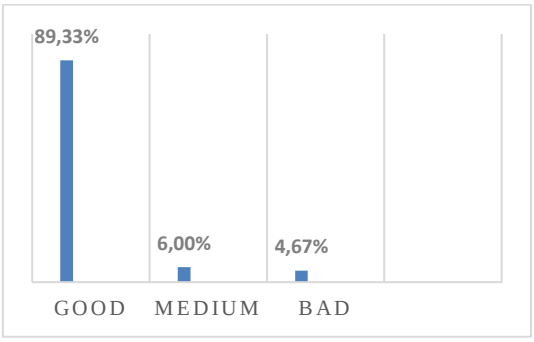

Figure 10. Crown Transparency Diagram (Foliage Transparency-FT)

Canopy transparency (Foliage Transparency-FT), this parameter shows the percentage of sunlight that enters the floor/ground surface, this parameter is the opposite of the canopy density parameter. The less sunlight that enters the floor/ground surface, the better the ability of the canopy to absorb and utilize sunlight (Safe'i et al., 2020). In this study, it is known that the dominance of the transparency classification is worth 3 or good, namely 89.33% (Figure 10).

Crown Diameter (Crown Diameter Width and Crown Diameter 900), this parameter is a measurement of the width of the crown of a tree which is measured from the outer crown length and continued with the crown length of 900. In this study, the overall classification of crown diameter was worth 3 or good with a percentage of 100% (Figure 11).

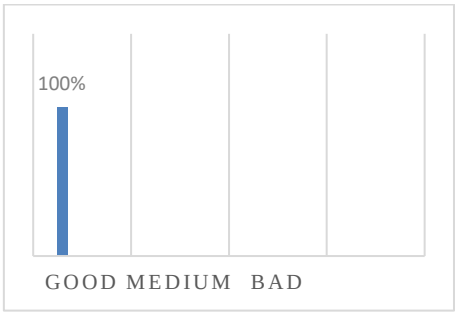

Figure 11. Crown Diameter (Crown Diameter Width and Crown Diameter at 90^{o})

Crown Dieback (CDB), this parameter is seen from the death of the branch tip to the base. This parameter can directly affect other canopy condition parameters, because the leaves are generally located on the branches so that if the tree's dieback is good, the physiological processes of the leaves on the tree will also be good. At the research location, the dominance of dieback was also worth 3 or good with a percentage of 100% (Figure 12).

Figure 12. Crown Dieback (CDB)

The five parameters above are then collected into a canopy appearance rating (VCR). Canopy condition is one of the parameters used in assessing the health of a tree using the FHM method, because crown conditions can affect the production of quality seeds. A healthy crown will produce healthy and quality seeds.

From the data obtained the VCR values obtained at the Animal Park showed that 87.33% of 131 trees had a high VCR, 10 trees had a moderate VCR of 6.67% and 9 trees had a low VCR of 6%. Trees that have a high VCR value will carry out the photosynthesis process well and the results of photosynthesis in the form of carbohydrates will be more optimal. Meanwhile, a low VCR value indicates a poor or bad condition of the canopy and the results of photosynthesis are less or not optimal if the crown is in a less good condition (Supriyanto & Iskandar, 2018). For the 3 types of trees found in the Animal Park, the dominant tip has disappeared so that the parameter values for each of these tree

species cannot be determined, these plant types are Bendo, Sena and Jambu Air.

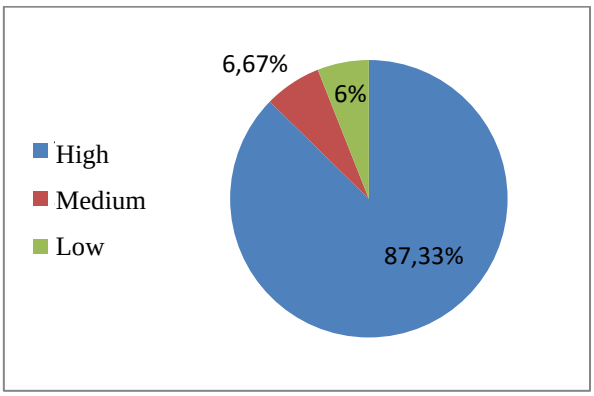

Figure 13. VCR diagram of Pematangsiantar Animal Park

Table 12. VCR Weighted Scoring Value

Score	VCR	Total
1	2 – 2,2	9
2	2,3 – 2,4	0
3	2,5 – 2,6	0
4	2,7 – 2,8	0
5	2,9 – 3	10
6	3,1 – 3,2	0
7	3,3 – 3,4	0
8	3,5 – 3,6	0
9	3,7 – 3,8	0
10	3,9 – 4	131

Source: Research Data (2022)

Assessment of Tree Health Status in Pematangsiantar Animal Park

The final value of the tree health condition is the result of multiplying the weighted value with the parameter score value of each tree health indicator. In Table 13. Showed that 153 trees with various health conditions such as trees, healthy tree health conditions totaling 48 trees, unhealthy health conditions totaling 93 trees and sick health conditions totaling 12 trees. Sodikin (2014) inform that a forest is showed to be healthy if the forest can still fulfill its uses as its main function.

Table 13. Scoring Assessment of tree health in Pematangsiantar Animal Park

Damage Index Value	VCR	∑Score	Information	Tree Total
10 9	10 9	20 18	Very healthy	0
8 7	8 7	16 14	Healthy	48
6 5	6 5	12 10	Less healthy	93
4 3	4 3	8 6	Sick	12

2 1	2 1	4 2	Very sick	0

Source: Research Data (2022)

CONCLUSION

1. There are 49 tree species in the Pematangsiantar Animal Park with a total of 153 unique trees. With 21 individuals, Mahogany (*Swietenia mahagoni*) is the most frequent tree species.
2. There were 48 trees with a healthy health status, 93 trees with a poor health status, 12 trees with a sick health status, and none with a very sick health status.
3. There are 3 severity classes at the Pematangsiantar Animal Park, namely: 01-09% at 91.50%, 10-19% severity at 1.96% and 70-79% at 6.54%.

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