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Forest Health Analysis Based on Flora Biodiversity Indicators in Gapoktan Harapan Sentosa KPHL BatuTegi, Lampung

Lis Nur Ajijah[1], Rahmat Safe'i[2], Slamet Budi Yuwono[3], Hari Kaskoyo[4]

[1,4]Department of Forestry, University of Lampung, Bandar Lampung, Indonesia
[2,3]Master of Forestry Study Program, University of Lampung, Bandar Lampung, Indonesia

[2]Corresponding author: rahmat.safei@fp.unila.ac.id
[1]lisnurajijah1199@gmail.com
[3]slamet.budi@fp.unila.ac.id
[4]hari.kaskoyo@fp.unila.ac.id

Abstract. The BatuTegi KPHL controlled area has relatively high biodiversity, including tree species diversity. Therefore, the health of the KPHL BatuTegi forest can be assessed by considering the diversity of existing tree species and identifying them as a measure of the sustainability of the forest ecosystem. This study aims to clarify the diversity of tree species as an index for assessing the health status of KPHL BatuTegi forests. This study was conducted in the GapoktanHarapanSentosa KPHL Batutegiarea using the Forest Health Monitoring (FHM) method. The result obtained is that the average health of the forest inBatutegi KPHL is moderate at a value of 2.72. Therefore, the health of the BatuTegi KPHL forest is reasonably healthy (stable).

Keywords: Forest health; Forest Health Monitoring (FHM); tree diversity

1. Introduction

According to the Forestry Act No. 41 of 1999, the main function of protected areas is to protect life support systems to regulate water management, prevent flooding, control erosion, prevent seawater intrusion and maintain soil fertility. The protected forest at Banjaran Resort in Batutegi KPHL administrative district is one of the strategic areas for community life support. If forests are not managed properly, various important aspects related to their existence can be disrupted[1], [2], [3]. According to Act No. 41 of 1999 on Forest Management, the FMU is the smallest unit of a site-level forest management system. Forest management is an attempt to involve communities in supporting forest sustainability[4], [5]. In their management, community participation becomes a key factor[6], [7], [8].

Through the social forest system, the government established the community forest system (HKm)[9]. According to the Regulation of the Minister of Forestry of the Republic of Indonesia No. P.88/Menhut-II/2014 on Community Forests or abbreviated as HKm, or State-owned Forests, its use is aimed at improving the welfare areas of people living in and around forests. One of the state-owned forests designated as HKm's work area is a protected forest[10]. For Lampung province, HKm is expected to minimize damage to remaining forests and restore damaged forests through the involvement of communities surrounding the forests[11], [10], [12]. One of the HKm's in Lampung is

the Harapan Sentosa HKm, whose management is located in a forest reserve with a variety of tree species.

Biodiversity or biodiversity is important for life. Biodiversity acts as an indicator and means of ecological systems and species changes. Biodiversity in it also includes species richness and complex ecosystems that can affect the community of organisms, the stability and development of the ecosystem [13].

Tree species diversity is a useful indicator of forest health[9]. A forest can be said to be a healthy forest if it is still able to perform the main functions previously identified[13]. According to this statement, it is necessary to measure forest health to understand the physical and biological state of the forest. Measuring forest health is an indicator of sustainable forest management[14]. Forest health measurements are designed to determine the state of the forest and identify the right plan to overcome and improve it. From an ecological point of view, a healthy forest refers to a forest in which all components contained in the forest exhibit balanced interactions[15].

Forest Health Monitoring (FHM) is a method for monitoring, assessing and reporting the status, changes and long-term trends of forest health using measurable ecological indicators[16], [17]. One of the indicators for assessing forest health is tree species diversity, which has been identified as a criterion for the sustainability of forest ecosystems [18]. Changes in land cover can lead to a decline in biodiversity, which in turn leads to changes in forest health in the KPHL area of BatuTegi. Therefore, this study aimed to identify the diversity of existing tree species as an indicator for assessing forest health.

2. Method

This research was carried out in 3 cluster plots in the arable land of Gapoktan Harapan Sentosa KPHL BatuTegi. This research was conducted in November 2021. The research location can be seen in **FIGURE** 1.
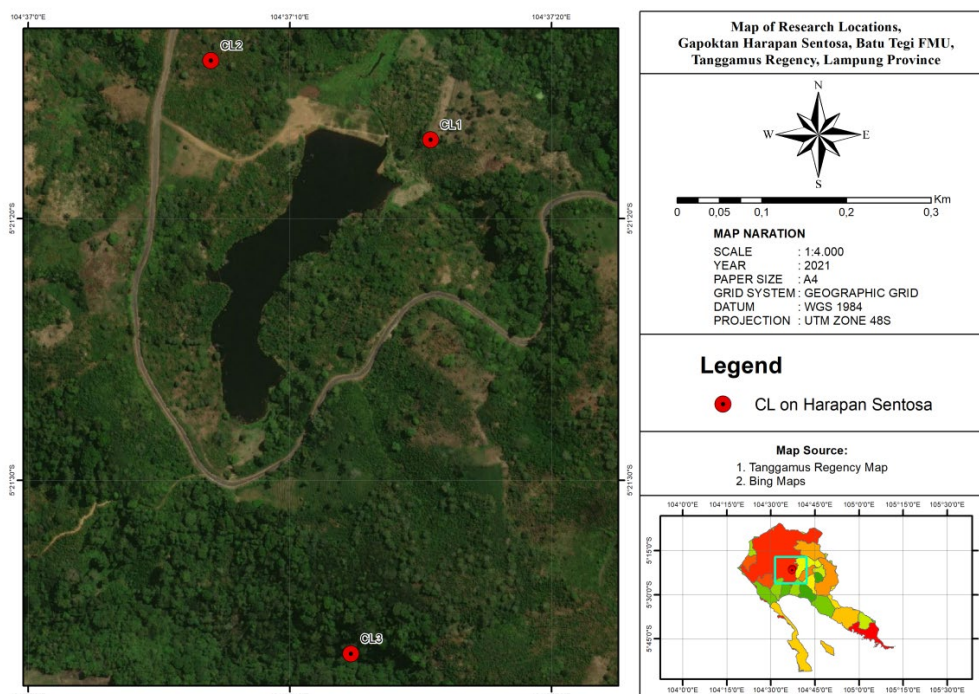

Figure 1. Map of research location

Forest health indicator data taken is biodiversity based on tree species diversity [19]. Measurement data was collected in Gapoktan Harapan Sentosa to determine the health status of the forest using the Forest Health Monitoring (FHM) method [20]. The cluster plots used in the measurement are 3 cluster

plots at three research locations. The number of cluster plots is determined based on a management perspective on the type of location/planting pattern consisting of monoculture, jungle, and agroforestry cropping patterns.

Making clusters – plots or measuring plots are carried out to take several objects representing the entire observed area. The cluster-plot design was made based on the reference of the FHM technique [21]. For example, one cluster plot has an area of 0.4 ha, representing one (1) ha of forest area [18]. 1 The cluster plot consists of 4 annular plots, four subplots, and four micro plots with radii of 17.95 m, 7.32 m, and 2.07 m, respectively.
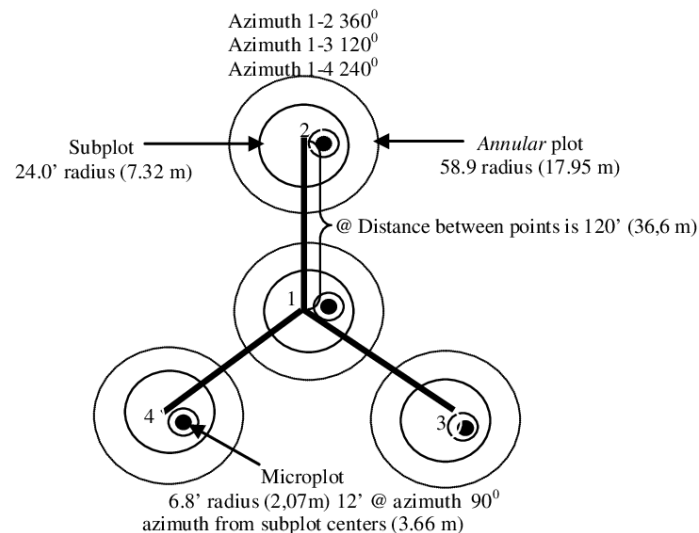
Figure 2. FHM plot cluster design

The measurement of biodiversity indicators is carried out based on the species diversity index, which can be calculated using the Shannon-Wiener Index calculation formula, namely:

$$H' = -\sum p_i . \ln . p_i$$

where H' is the diversity index and pi is ni/N. Ln is the natural logarithm, ni is the number of individuals of the ith species, and N is the number of individuals of all species.

If H' < 1, the environmental conditions of the vegetation community are less stable; if the value of H' is between 1-2, the vegetation community is in a stable environmental state; if H' > 2, the vegetation community is in a very stable environment Environmental status [22].

When measuring forest health, one indicator is used, the diversity of tree species. The data obtained were used to determine forest health as measured by FHM. Forest health is determined by multiplying the weighted value by the score for each forest health indicator. The NKHKm value is the final value of forest health and can be calculated using the following formula [18].

$$NKHKm = \sum(NT \times NS)$$

Description :

NKHKm = Final value of community forest health condition

NT = Parameter weighted value of each ecological indicator of community forest health

NS = Parameter score of each ecological indicator of communityforest health

The weighted value is obtained through pairwise comparisons of the forest health indicators. In contrast, the score value is obtained by transforming the value of each parameter of the ecological forest health indicators.

3. Result and Discussion

Community forest management has the principle of getting the benefits of forest resources optimally and fairly with sustainable management. Forest monitoring is important to know in carrying out a HKm management [9]. The assessment of biodiversity indicators does require an understanding of the degree of flexibility of species in a given forest ecosystem by understanding the composition of the flora contained within it [20]. Biodiversity includes plants, animals, fungi, bacteria and other microorganisms.All organizational levels demonstrate that biodiversity refers to the diversity of genes, species and ecosystems. Biodiversity also refers to the types of ecological structures, functions or processes at any of the above levels [23].

The level of biodiversity in an area, especially species diversity, is closely related to the level of ecological stability in an ecosystem [19]. A high level of biodiversity will have a positive effect on the condition of the stand because the ecosystem in it is stable and flexible to pressure and disturbance. Biodiversity in a forest ecosystem can be used as a basis for considering conservation efforts for species and ecosystems that constitute their habitat [18]. In addition, biodiversity can support productivity functions through its role in being able to recover from disturbance [(18)].

One of the biological components found in the forest is trees [(15)]. If biodiversity refers to all living things in the forest, then tree diversity is all types of trees in the forest [(19)]. Therefore, only trees in the sub-plot were measured by measuring forest health using biodiversity indicators (tree diversity) in KPHL Batu Tegi. Biodiversity measurements were carried out using the Shannon-Wiener diversity index formula on three plot clusters representing the research location.

The tree species diversity index is an indicator of community structure. The better the species diversity index, the more stable the ecosystem[(24)], [(25)]. Based on the results of the field study, the diversity values in each cluster map were determined. The lowest H' value was in the cluster plot 3 of the monoculture mode, that is, H'=0. The low value of H' is due to the lack of diversity in the monoculture cropping pattern. Meanwhile, the highest value of H' is found in cluster plot one, namely jungle forest, with an H value of 2,067. Furthermore, in cluster plot 2, H' obtained value is 1,401, which is classified as moderate. The percentage of diversity values in each cluster can be seen in **FIGURE** 3.
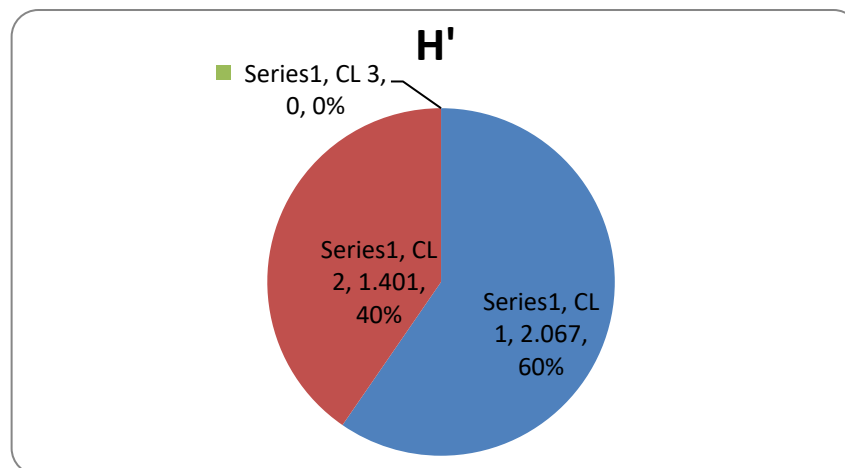
Figure 3. The percentage value of H' in each cluster

Based on the Shannon-Wiener formula [(26)], the average value of H' in the 3 cluster plots, which is 1.156, indicates that the vegetation community is in a stable environmental condition. On the other hand, only cluster plot 3 has a monoculture cropping pattern which shows the vegetation community is in unstable environmental conditions with a value of H'=0.

Tree species diversity [27] can be used as an indicator for forest health assessment due to its high sensitivity to change, indicators of ecosystems, and spatial, temporal, and nutritional heterogeneity. Furthermore, biodiversity is easily affected by the environment, interactions between organisms and

their environment [(18)]. Therefore, after obtaining the biodiversity values, the next step is to determine the score for each cluster map, as shown in **Table 1**.

Table 1. Interval score for each measurement parameter

Score	H'
1	0-0,19
2	0,20-0,40
3	0,41-0,61
4	0,62-0,82
5	0,83-1,03
6	1,04-0,24
7	1,25-1,45
8	1,46-1,66
9	1,67-1,87
10	1,88-2,07

According to Table 1, the highest score is 10, and the category value is 1.88-2.07 species diversity. While the lowest score is 1, its value is 0-0.19. This shows that the score of the ecological indicators of forest health has a greater impact on the final score of forest health. The higher the score, the higher the forest health. The final forest health score is obtained by multiplying the score for each parcel cluster by the weighted score. The weighting value of 0.15 used in this study is based on a previous study by Safe'i et al. 2019, which assessed forest health in different forest types. The results of the final forest health assessment are shown in **Table 2**.

Table 2. Interval score for each measurement parameter

Category of Community Forest Health Status	Final Grades
Good	3,19-4,80
Medium	1,59-3,19
Bad	0-1,58

The forest health condition category was obtained based on the final score. The final score for forest health is 4.80, and the lowest is 0. This categorization indicates that intensive treatment is needed to improve forest health status [28] in KPHL BatuTegi. Forest health status is generated from the final forest health scores and forest health categories shown in **TABLE 3**.

Table 3. Forest health status threshold

No. Cluster-plot	Forest Health Final Score	Category of Community Forest Health Status
1	4,80	Good
2	3,36	Good
3	0	Bad

The healthiest forest condition can be found in Cluster 1, with a final value of 4.80 for the forest health category. In contrast, the worst health was found in clustering Figure 3, with a final value of 0 for forest health. This bad category indicates a low diversity of tree species in the cluster graph. Therefore, proper and intensive management is required to improve and improve the health of forests in planted areas. Based on the data obtained, the percentage of forest health of Batu Tegi KPHL in Harapan Sentosa farmland is shown in Figure 3. The mean forest health of the three cluster plots was 2.72, which means that the forest health of the Gapoktan Harapan Sentosa farmland is moderate. .Some of the trees in each cluster diagram can be seen in Figures 4, 5, and 6.
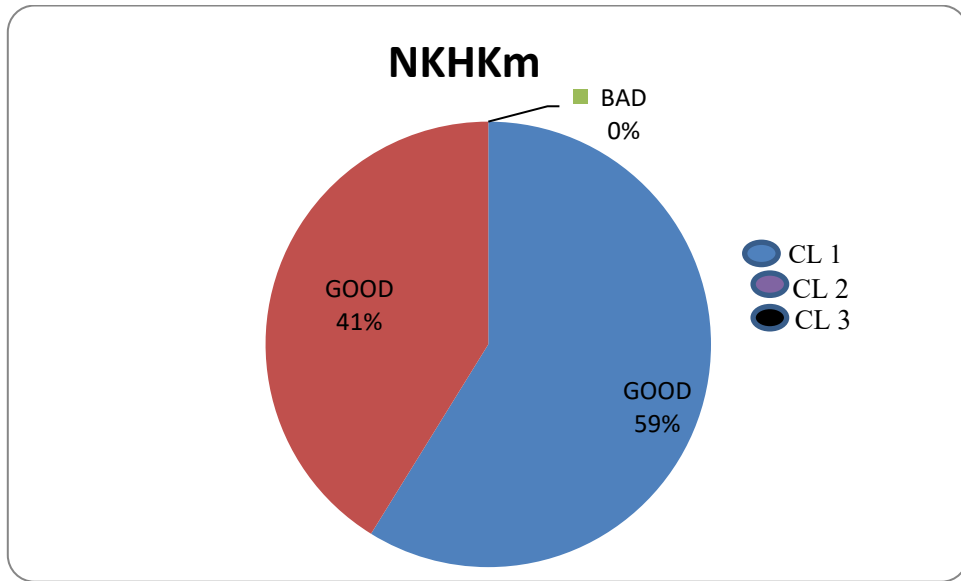
Figure 4. Percentage of final forest health scores in each cluster plot

Figure 5. *Ficus auriculata*

Figure 6. *Dipterocarpusretusus*

Figure 7. *Dilleniagrandifolia*

Based on **Figures** 4, 5, and 6, it is known that the diversity of tree species in the Gapoktan Harapan Sentosa arable area is quite large. These three tree species were found in the cluster location of plot 1, where this location is a jungle forest that has a lot of tree species diversity. This is evidenced by the

high value of H' in cluster plot 1, which means that the vegetation community in this cluster plot one is in a stable environmental condition.

4. Conclussion
The results showed that the value of the current condition diversity (status) of forest health in KPHL Batutegi was in the moderate criteria (2.72), thus indicating that the forest in KPHL Batutegi had a fairly healthy (stable) condition. Therefore, the health of the protected forest can be assessed using the indicator of biodiversity (diversity of tree species).

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