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The Regeneration Potential of Kasa (*Castanopsis acuminatissima* Blume) in Kalaena Nature Reserve, East Luwu Regency

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Abstract

Kasa is one of the important species among 120 species in the genus Castanopsis (Fagaceae), which thrives in secondary and primary lowland forest areas up to 1000 m above sea level. This plant species exhibits tolerance to full sunlight. The objective of this study is to assess the regeneration potential of Kasa (*Castanopsis acuminatissima* Blume) in the Kalaena Nature Reserve, Indonesia. The research plots consisted of two 50 m x 50 m plots, with a nested 10 m x 10 m subplot placed using purposive sampling. The findings regarding the regeneration potential of Kasa in the Kalaena Nature Reserve revealed varying numbers of seedlings, saplings, poles, and trees. The regeneration potential of Kasa is influenced by the growth stages of seedlings and trees. During the seedling phase, the regeneration potential of Kasa is classified as very good. However, the density of trees, although in the productive category, is low due to environmental factors and the characteristics of the parent tree. Conversely, the sapling and pole phases exhibit very poor regeneration potential. In plot 1, there were 1964 individual seedlings, 6 individual saplings, 4 individual poles, and 21 individual trees. Meanwhile, plot 2 recorded 844 individual seedlings, 5 individual saplings, 1 individual pole, and 18 individual trees. The growth of Kasa in both plots displayed a clustered pattern.

Keywords: Distribution of Kasa, Kalaena Nature Reserve, Regeneration Potential

1. Introduction

Conservation areas are forested regions with distinct characteristics aimed at preserving the biodiversity of plants, wildlife, and ecosystems. These areas are protected and designated by the government based on various criteria according to their importance. Conservation areas encompass two main groups: Wildlife Reserves and Nature Reserves. Nature reserves include national parks, forest reserves, and nature reserves, with the goal of protecting life support systems, preserving biodiversity of plant and animal species, and sustainably utilizing biological resources and ecosystems. Meanwhile, wildlife reserves consist of nature reserves and wildlife reserves, aimed at protecting life support systems and conserving biological resources and their ecosystems. One of the nature reserves in South Sulawesi is the Kalaena Nature Reserve.

The Kalaena Nature Reserve is one of the conservation areas within the jurisdiction of the South Sulawesi Natural Resources Conservation Center. According to Minister of Forestry Decree No. 428/Kpts-II/1987, the Kalaena Nature Reserve covers an area of 110 hectares and is located in Margolembo Village, Mangkutana District, East Luwu Regency. The Kalaena Nature Reserve is home to various biodiversity, both rare and common species found in almost all forested areas of Sulawesi. One of the plants that can be found in the Kalaena Nature Reserve is the Kasa plant (*Castanopsis acuminatissima* Blume).

Kasa is one of the important species among 120 species of the Castanopsis genus (Fagaceae) that grows in secondary and primary lowland forests up to 1,000 meters above sea level. The distribution of Kasa trees extends from India, Southern China, and Japan through Indochina, the Philippines, and Indonesia to New Guinea. This plant species is abundant in Maluku, Sulawesi, and Kalimantan [1]. Kasa, as one of the indigenous species, plays a crucial role in mountain ecosystems with its wide canopy. These trees serve as habitats for wildlife, especially birds and mammals, providing food, shelter, and nesting sites [2]. Natural regeneration of Kasa is difficult to find due to easily perishable or animal-consumed fruits [1].

The conservation status of Kasa trees (*Castanopsis acuminatissima* Blume) according to the IUCN is classified as Least Concern (IUCN, 2018). The Least Concern category is assigned to species that have been evaluated and are not categorized as threatened. Kasa tree distribution occurs in natural forests, especially in conservation areas, where patrols and law enforcement are essential parts of conservation efforts for naturally rare trees [3,4].

Regeneration is closely related to forest structure and composition. Regeneration is a process through which trees pass their life cycles in the forest to survive in varying environments. Regeneration status can be assessed by observing the availability of individuals at the tree level and its lower generations. Knowledge of forest regeneration plays a crucial role in forest management and serves as a driving force in forestry [4]. This stage represents a selection period to determine which species can grow and survive, ultimately influencing the composition and diversity of the forest community [5].

Considering the current condition where the population of Kasa trees in the wild is declining, it is necessary to understand the regeneration process of Kasa trees in the Kalaena Nature Reserve. Efforts to prevent Kasa from becoming rare and extinct due to excessive exploitation, given its very slow regeneration nature, are crucially important. Information regarding the distribution patterns of Kasa seedlings under the parent tree canopy is essential for natural forest management planning, as well as to understand the availability and dynamics of natural seedlings as seed sources beneath the parent tree canopy. Therefore, research on the regeneration potential of Kasa trees in the Kalaena Nature Reserve, East Luwu Regency, is needed.

2. Materials and Methods

2.1. Data Collection and materials

This research was conducted for 2 months, starting from April to May 2021, in the Kalaena Wildlife Sanctuary, Luwu Timur Regency. The tools used in the field data collection process consisted of the Global Positioning System (GPS), a roll meter, a tape measure, a camera, millimeter paper, a compass, a machete, and a tally sheet. This research collected two types of data primary data and secondary data. Primary data were obtained from field activities through direct observation and measurement. This data included coordinate points, habitat conditions, the distribution of kasa trees, the number of individuals in each plot, and the growth rate of seedlings, saplings, poles, and trees, as well as the total number of individuals in the entire plot. Secondary data were obtained from existing sources, such as literature studies from journal article and published theses and the area data of the Kalaena Wildlife Sanctuary.

The data collection process in the Kalaena Wildlife Sanctuary was conducted at two different locations based on the distribution of kasa trees. Before field data collection activities, observation plot determination was carried out using purposive sampling techniques. Plot determination was based on the clustered distribution of kasa trees. In each location, observation plots measuring 50 m × 50 m were placed, and each plot was subdivided into sub-plots measuring 10 m × 10 m to determine the distribution patterns of seedlings, saplings, poles, and trees. Observations were then made, and field data was recorded, including measurements of the circumference or diameter of each individual at the pole, sapling, and tree levels. The number of individuals at each growth stage was then calculated, and the positions of kasa growth stages were drawn. A total of 25 sub-plots were created (Figure 2).

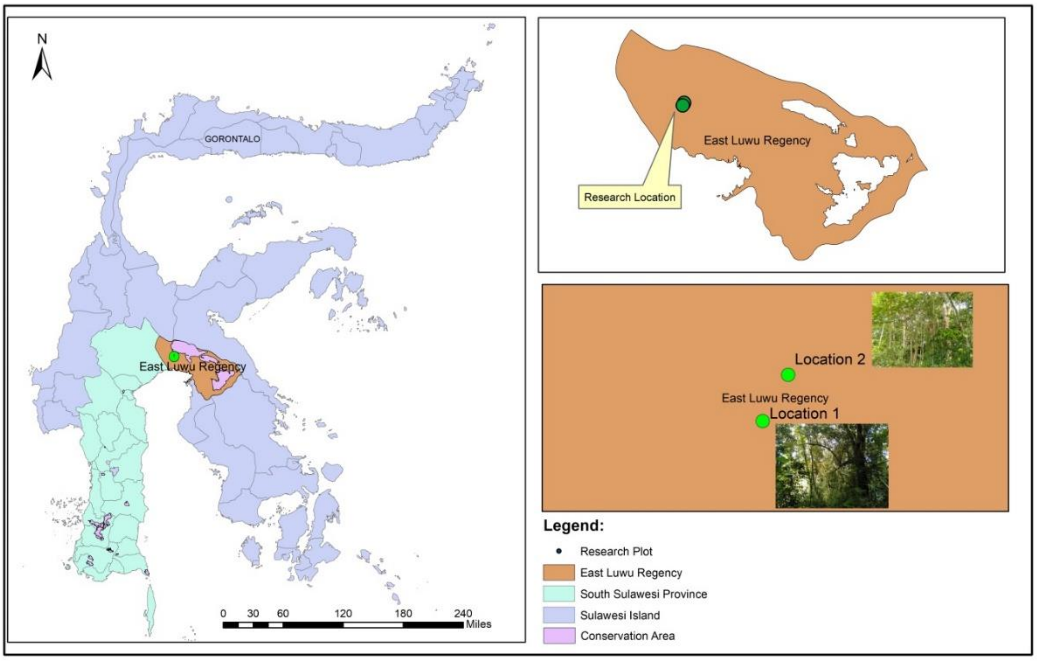

Figure 1. Research site map figures and illustrations.

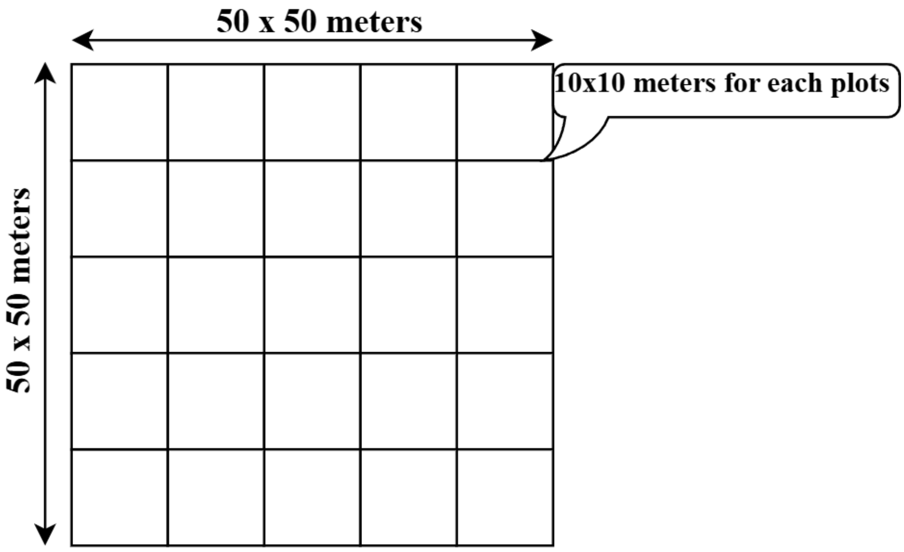

Figure 2. Plot design, 50 m × 50 m was placed, and each plot was subdivided into sub-plots measuring 10 m × 10 m to determine the distribution patterns of seedlings, saplings, poles, and trees.

2.2. Data analysis

The data obtained from measurements will be used to assess the regeneration status and calculate the frequency, density, basal area, and tree volume. These parameters can be calculated using the following formulas:

a. Density of a species

$$K = \sum \frac{\text{Individuals of a species}}{\text{Area of sample plot}} \quad (1)$$

b. Frequency of a species (F)

$$F = \sum \frac{\text{Subplots where a species is found}}{\text{Total subplots in the sample}} \quad (2)$$

c. Tree Base Area

$$Tree\ Base\ Area = \frac{1}{4}\ \pi . D^2 \tag{3}$$

d. Crown Base Area

$$\text{Crown Base Area} = \frac{\frac{1}{4}\pi(D1 + D2)}{Area\ of\ plot\ (m)}^{2} \tag{4}$$

Where:

D1 = First crown diamater measurement from east to west (m)

D2 = Second crown diamater measurement from south to north (m)

e. Tree Volume

The potential volume of a tree can be determined by calculating the tree volume [1]. the formula is as follows:

$$Volume = \frac{1}{4}\pi d^2 2.t.f \tag{5}$$

Where:

V = Volume of the standing tree

π = 3.14

d = Diameter of the tree (cm)

t = Height of the tree (m)

f = Form factor (0.7)

f. Criteria for Regeneration Potential

The result of relative density can be used to determine the regeneration process capability in Kalaena Nature Reserve, with 5 criteria/status of regeneration: 1-20% (very poor), 20.1-40% (poor), 40.1-60% (fair), 60.1-80% (good), and 80.1-100% (very good). The regeneration potential of Kasa can be determined by comparing the species richness and diversity between tree growth stages and their generations, namely seedlings, saplings, poles, and trees. The presence of tree seedlings in the forest reflects the vegetative forest's ability to regenerate, while the abundance of tree species reflects the potential biodiversity as well as the potential germplasm within the forest area [4,6].

g. Sketch of Canopy Distribution

The canopy distribution sketch is analyzed using qualitative descriptive analysis. The data analyzed consists of sketches of canopy distribution based on growth levels found within 10 m × 10 m subplots. Canopy distribution will be clearer based on the canopy distribution map.

3. Results and Discussion

3.1. Result

3.1.1. Population Structure of Kasa

Castanopsis, which belongs to the Fagaceae family, has the local name saninten. Saninten wood is often used as a house building material in West Java. West Java and saninten bark can be used as a natural dye on rattan. In addition saninten seeds can also be used as food ingredients for human consumption, usually utilized as food ingredients by boiling or grilling. Based on the observations conducted in Kalaena Nature Reserve, the results obtained are presented in Table 1.

Table 1. Recapitulation of kasa growth levels, density, and frequency, in plot 1 and plot 2.

PLOT	Growth Level	Quantity (individual)	Density (Individual/ha)	Frequency
1	Seedling	1964	7856	1
	Sapling	6	24	0.12
	Pole	4	16	0.12
	Tree	21	84	0.60
Total		1995	7980	
2	Seedling	844	3376	0.48
	Sapling	5	20	0.12
	Pole	1	4	0.04
	Tree	18	76	0.48
Total		868	3476	

3.1.2. Regeneration Potential of Kasa

The regeneration potential of Kasa can be determined by comparing the species richness and diversity between tree growth stages and their generations, namely seedlings, saplings, poles, and trees. The presence of tree seedlings in the forest reflects the vegetative forest's ability to regenerate, while the abundance of tree species reflects the potential biodiversity as well as the potential germplasm within the forest area [4,6,7]. The growth levels of seedlings, saplings, poles, and trees of Kasa can be seen in Table 2.

Table 2. Recapitulation of kasa growth levels, quantity, relative density, and regeneration category.

Plot	Growth Level	Quantity	Relative Density (%)	Regeneration Category
1	Seedling	1964	98.4	80.1-100% (very good)
	Sapling	6	0.30	1-20% (very poor)
	Pole	4	0.20	1-20% (very poor)
	Tree	21	2.49	1-20% (very poor)
2	Seedling	844	97.1	80.1-100% (very good)
	Sapling	5	0.58	1-20% (very poor)
	Pole	1	0.12	1-20% (very poor)
	Tree	18	2.19	1-20% (very poor)

3.1.3. Characteristics of Parent trees

The spread of gauze trees is influenced by several factors including seed dispersal, topography, species density, growing conditions, soil nutrients, and groundwater conditions. Kasa trees in plot 1 and plot 2 tend to be closely spaced and dispersed. From the inventory that has been carried out at the research site as a whole in plot 1 gauze trees found as many as 21 trees, in plot 2 found as many as 19 trees as in Table 3 and Table 4.

Table 3. Recapitulation of tree levels in plot 1.

NO	Stem Diameter (cm)	Tree Height (m)	Crown Base Area (m^2/ha)	Tree Base Area (m^2/ha)	Tree Volume ($m^{3)}$
1	1.08	21	0.58	0.92	1.29
2	0.22	18	0.12	0.04	0.19
3	0.60	19	0.20	0.28	1.36
4	0.24	17	0.06	0.04	0.18
5	0.46	20	0.20	0.04	1.52
6	0.38	19	0.25	0.11	0.24
7	0.48	21	0.33	0.18	0.77
8	0.55	18	0.38	0.24	0.84
9	0.53	18	0.23	0.22	0.76
10	0.39	15	0.20	0.12	0.50
11	0.47	23	0.26	0.17	0.85
12	0.32	21	0.06	0.08	0.52
13	0.36	19	0.06	0.10	0.57
14	0.42	22	0.23	0.14	0.99
15	0.40	17	0.13	0.13	0.72
16	0.43	19	0.20	0.15	1.02
17	0.34	16	0.14	0.09	0.44
18	0.48	17	0.43	0.18	0.76
19	0.68	17	0.32	0.36	1.00
20	0.63	21	0.23	0.31	1.53
21	0.40	19	0.15	0.13	0.80

Table 4. Recapitulation of tree levels in Plot 2

NO	Stem Diameter (cm)	Tree Height (m)	Crown Base Area (m^2/ha)	Tree Base Area (m^2/ha)	Tree Volume ($m^{3)}$
1	0.39	19	0.14	0.12	0.34
2	0.44	14	0.17	0.15	0.63
3	0.32	18	0.09	0.08	0.34
4	0.50	18	0.04	0.20	1.25
5	0.40	17	0.15	0.13	0.72
6	0.58	18	0.34	0.27	0.93
7	0.48	17	0.07	0.18	0.76
8	0.47	16	0.05	0.17	0.96
9	0.53	18	0.05	0.22	1.40
10	0.36	16	0.05	0.10	0.43
11	0.73	20	0.09	0.42	0.88
12	0.64	18	0.18	0.32	1.14
13	0.57	17	0.17	0.25	0.71
14	0.47	19	0.04	0.17	0.61
15	0.62	23	0.19	0.31	1.50
16	0.59	21	0.10	0.27	1.72
17	0.67	19	0.13	0.35	1.72
18	0.60	21	0.16	0.28	1.75

3.1.4. Distribution of Growth Levels

Seedling dispersal is influenced by fruit dispersal, both through wind and animals so that each species in different locations has a different dispersal pattern. But generally have a grouped distribution, the tendency of individuals to group or gather because they are looking for environmental conditions that suit their needs and the existence of mutually beneficial interactions. Based on the growth levels of seedlings, saplings, poles, and trees, Plot 1 is more dominant than Plot 2.

3.2. Discussion

Based on the calculation of the population structure of *Castanopsis acuminatissima* Blume in Kalaena Nature Reserve in plots 1 and 2, it was found that the number of seedlings in both plots is larger than the number of tree-level growth. Research results from plot 1 found a total of 1,964 seedlings, 6 saplings, 4 poles, and 21 trees. Meanwhile, for plot 2, the results found a total of 844 seedlings, 5 saplings, 1 pole, and 18 trees. The number of seedlings is higher compared to the growth stages of saplings, poles, and trees, with a significant difference observed in both plots from the sapling stage to the pole stage. This indicates that the population of *Castanopsis acuminatissima* Blume in both plots is experiencing disturbances and high mortality rates.

Castanopsis acuminatissima Blume has growth stages of seedlings, saplings, poles, and trees. The density values for each growth stage found in plots 1 and 2 indicate a very different variation. In plot 1, the highest density is found at the seedling growth stage, with 7,856 ha from 1,964 individuals. The lowest density is found at the pole stage, with 16 ha from 4 individuals, which is caused by the number of poles found in only 3 subplots out of 25 subplots. Meanwhile, in plot 2, the highest density is found at the seedling growth stage, with 3,376 ha from 844 individuals, and the lowest at the pole growth stage, with 4 ha from 1 individual, caused by the number of poles found in only one subplot.

According to Arista et al. [8], density is categorized into four categories: very low (20-50 individuals/ha), moderate (51-100 individuals/ha), good (101 – 200 individuals/ha), and very good (>201 individuals/ha). Based on these criteria, the density values for the seedling growth stage in plot 1 and 2 from the Kalaena Nature Reserve location are considered very good. Meanwhile, the sapling, pole, and tree levels in both plots fall into the low-density category.

Based on the data processing results, the frequency values of the growth stages found in plots 1 and 2 are very different. In plot 1, the seedling frequency value is 1, caused by the presence of seedlings in all subplots, while the lowest frequency value is found in poles, which is 0.12, indicating uneven distribution and only found in four subplots. Meanwhile, in plot 2, a seedling frequency of 0.48 is found, caused by the scattered seedlings in 19 subplots, indicating an uneven distribution pattern, while the lowest frequency value is found in poles, which is 0.04, caused by the scattered poles found only in one subplot.

According to Brown J.H. [9], the frequency can indicate the spread of species in an area or region. Species that can spread evenly have a large frequency value, whereas species with small frequency values have less extensive distribution areas. Therefore, frequency indicates the degree of spread or presence of individuals of a related species. In tropical forests, the distribution pattern of a species is closely related to the reproductive capacity and adaptation ability to the environment. The environment where plants grow is a complex system, where various factors interact and mutually influence, both directly and indirectly, towards plant communities. Based on the growth stages of Kasa in Table 2, a table graph will be created and presented in Figure 3 and Figure 4.

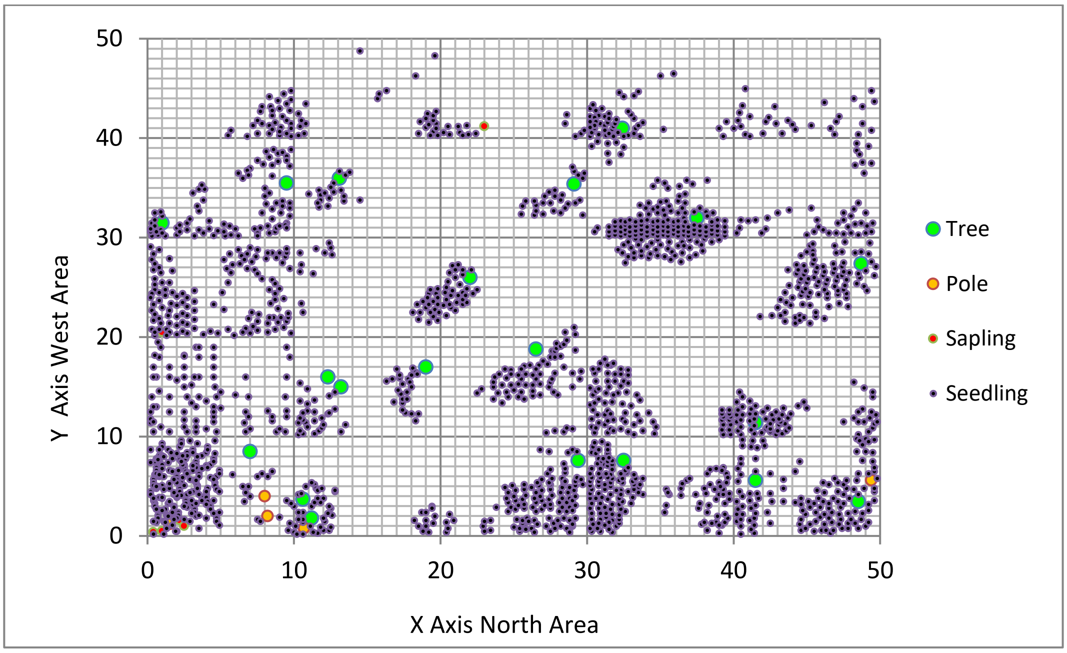

Figure 3. Distribution of kasa growth levels in plot 1

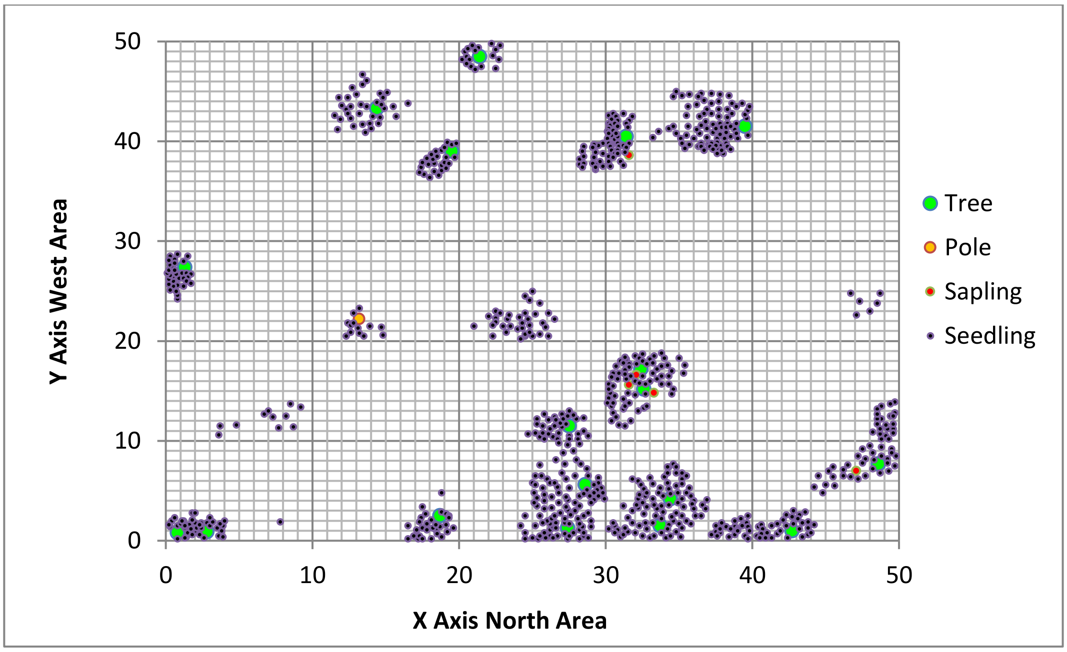

Figure 4. Distribution of kasa growth levels in plot 2

The number of seedling levels is more abundant, while the sapling level is the least encountered. This indicates that the growth density in both observation plots, especially at the sapling and pole levels, is experiencing disturbances such as death, breakage, entanglement with vines, or being crushed by fallen trees, as well as fungal infections during growth. Deaths during growth are caused by competition for nutrients, aging of the Kasa trees leading to falling and death, and insufficient sunlight. Kasa is a plant species tolerant to full sunlight, meaning it requires full sunlight during the growth process from seedling to tree phase. According to Aras et al. [10], *Castanopsis acuminatissima* Blume is a plant species that requires full sunlight and thrives in direct sunlight.

There is a significant difference between the population density of seedling, sapling, and pole levels in both observation plots, likely due to competition among individuals or with other plant species during the seedling, sapling, and pole stages, resulting in a smaller number of poles compared to seedlings and saplings, with a considerable difference. According to Witno et al. [11], stated that competition occurs when individuals from one group of plants are present in a group of plants growing in a particular area.

According to Ansari and Amintarti [12], the population of an individual tree is considered to be sufficiently developed if the age of the population or the proportion of very young individuals is large at its growth stage. The population structure of Kasa found in both plot 1 and plot 2 can be described as a young population, where the population has the highest number of individuals at the seedling level, gradually decreasing at the sapling, pole, and tree levels, or in other words, this structure is characterized by significant growth in the pre-reproductive phase and moderate growth in the reproductive phase. Such a population structure is expected to maintain the population's existence in the long term because it has individuals at every growth stage, particularly related to population regeneration.

The observations conducted in plot 1 show that the number of seedlings is greater than the number of saplings, which is greater than the number of poles but less than the number of trees. Based on the relative density values for potential Kasa regeneration in Table 2, regeneration potential is categorized as 80.1-100% (very good) for the seedling stage, and 1-20% (very poor) for the sapling, pole, and tree stages. Considering the regeneration criteria or status, it can be stated that the regeneration in plot 1 ranges from very good to very poor. Similarly, in plot 2, the number of seedlings is greater than the number of saplings, which is greater than the number of poles but less than the number of trees. The regeneration potential of Kasa in plot 2 falls into the categories of 80.1-100% (very good) for the seedling stage, and 1-20% (very poor) for the sapling, pole, and tree stages. Considering the regeneration criteria or status, it can be stated that the regeneration in plot 2 ranges from very good to very poor.

3.2.1. The Potential Regenerations and Characteristics of Parent trees of Kasa

According to Rachmanadi et al. and Yumna et al. [13,14], the ability of tree regeneration can be seen from the reproductive capacity of trees, which is reflected in the availability of seedlings. Although the density of parent trees found is lower, the parent trees at the research site are categorized as productive parent trees. This is influenced by the good environmental factors of the growing area and the characteristics of the parent trees such as large diameter, wide canopy, and tall height. According to Liana et al. [15], the characteristic diameter of parent trees has a diameter above 0.2 m or 20 cm. The larger the diameter of the stem, the wider the canopy. Based on Liana et al.;Muin et al. & Samsul et al. [15–17], the criteria for parent trees is having a height above 20 m, and the parent trees found in both plots have a height above 20 m. The diameter and height of trees are very important in assessing parent trees because both are the result of the accumulation of photosynthetic products. Trees with large diameters and high branch-free heights indicate that they have good abilities in utilizing environmental factors such as light, nutrients, water, and CO_2. Therefore, these trees will produce a lot of photosynthesis, and most of the results will be used for generative growth.

The growth stages of Kasa in both plots are mostly found at the seedling level, followed by trees, with the least encountered growth stage being poles. In the growth phase of Kasa, not all seedlings can grow into saplings, not all saplings can grow into poles, and not all poles can grow into trees. This is due to competition for sunlight, nutrients, external disturbances such as pests and diseases, and animals. This can be seen in both research plots where there are many seedling stages, but not all can grow into saplings, poles, and trees. According to Witno et al. [11], competition affects the ability of individuals to survive and reproduce, as shown by changes in population size over time. As time goes on, individuals experience growth that requires a lot of energy, leading to competition among individuals or species to survive and grow.

According to Suryo et al. [18], tree distribution is influenced by several factors including seed dispersal, topography, species density, growing conditions, soil nutrients, and groundwater conditions. According to Albasri et al., and Hasibuan and Riniarti [19,20], the selection of parent trees is based on tree height, stem diameter, branch-free height, resistance to pests and diseases, natural pruning ability, and fruit production. The distance between trees and the number of parent trees present is crucial to determine the potential for Kasa tree regeneration.

From the comprehensive inventory conducted at the research site, 21 Kasa trees were found in plot 1, while 18 Kasa trees were found in plot 2. In this study, all identified Kasa trees within the observation plots were inventoried. The information or data collected was limited to circumference, diameter, total height, branch-free height, canopy area, stem basal area, and tree volume.

Based on the observations in Table 3, the largest tree has a diameter of 1.08 m, a height of 21 m, a canopy area of 0.58 m^2, a stem basal area of 0.92 m^2, and a tree volume of 1.29 m^3. Meanwhile, the smallest tree has a diameter of 0.22 m, a height of 18 m, a canopy area of 0.12 m^2, a stem basal area of 0.04 m^2, and a tree volume of 0.19 m^3. For a summary of the trees in plot 2, we can see the characteristics of parent trees presented in

Table **4**.

Based on the observations in

Table **4**, the largest tree has a diameter of 0.73 m, a height of 20 m, a tree base area of 0.42 m^2, and a volume of 0.88 m^3. Meanwhile, the smallest tree has a diameter of 0.32 m, a height of 18 m, a canopy area of 0.09 m^2, and a volume of 0.34 m^3. During the study, fruiting Kasa parent trees were found, and many seedlings were found around these parent trees. This is an indicator that the parent trees have previously fruited and produced seeds. The presence of these seedlings is important not only for their role in stand regeneration but also for meeting seedling needs in the form of natural offspring, especially during non-fruiting seasons.

3.2.2. Distribution of Growth Levels

Based on data on seedlings, saplings, poles and trees, plot 1 had a better growth rate than plot 2. This is because of competition for growing space among the different growth stages and with other plant species. According to Kusmana and Susanti [21], competition for light and nutrients leads to natural selection. Plants that can compete effectively with others during growth will survive, while weaker ones may not.

The dispersal of seedlings is influenced by fruit dispersal, either by wind or animals, resulting in different dispersal patterns for each species in different locations. Individuals tend to cluster in favorable locations where there are no disturbances to their growth [11,22]. According to Witno et al. [11], uniform distribution rarely occurs in nature. Typically, distributions are clustered, with individuals grouping to find suitable environmental conditions and benefit from mutual interactions. The distribution of Kasa growth stages in plot 1 can be seen in Figure 3.

Based on Figure 3, the distribution of growth stages in plot 1 forms clustered patterns. For the growth stages of trees and seedlings, they tend to cluster, with seedlings growing more abundantly beneath the canopy of their parent trees. This is because fruits that fall typically remain near their parent trees and may later germinate into seedlings. This is because fruits that fall do not stray far from their parent trees and germinate into seedlings. According to Liana et al., and Samsul et al. [15,17], fruits produced by trees with large physiological conditions, such as large diameter, maximum height, and wide canopy, will yield many seedlings. The growth stage of seedlings tends to cluster in almost all subplots and is the most abundant growth stage found in both research locations.

According to Witno et al., and Abywijaya et al. [11,23], clustered distribution at various growth stages results in mutually beneficial interactions among individuals, such as defence against diseases, but it can also lead to competition for nutrients, space, and environmental factors. This can be observed in plot 1 of the study, where environmental factors influence the abundance of seedlings growing in open spaces or open areas. According to Basrudin et al. [1], Castanopsis prefers habitats in open areas and generally tolerates full sunlight. Therefore, during the flowering season, all branches produce flowers because the flowering process is greatly influenced by sunlight. The distribution of growth stages in plot 2 can be seen in Figure 4.

Based on the figure 4, the distribution of growth stages in plot 2 forms clustered patterns, with the growth stages of trees and seedlings tending to cluster, especially with seedlings growing more abundantly beneath the canopy of their parent trees. The limited dispersal of seeds causes many seeds from parent plants to fall directly and grow around the parent tree. The clustered distribution pattern indicates the presence of a plant species, indicating to find similar plants, as individuals tend to gather and seek environmental conditions suitable for their needs.

The physical condition of the environment plays a significant role in determining the distribution of a plant. This can be observed in both figures above, showing that the growth stages of Kasa in plot 2 are found to be fewer compared to plot 1. This is because plot 2 has a location that tends to be closed and densely packed with other plant species, leading to competition for nutrients, sunlight intensity, and steeper slopes compared to plot 1. The difference in growing conditions will result in significant differences in an organism. According to Ramadanil and Grisnayanti [24], every population is influenced by the structure and number of individuals with unsettled movements. This affects the population distribution pattern in a given area. This is due to the instinct of individuals or species to seek out suitable living environments for that species.

4. Conclusions

The potential regeneration of *Castanopsis Acuminatissima* Blume in the Kalaena Nature Reserve area indicates the number of seedlings < saplings < poles > trees. The regeneration potential of Castanopsis is influenced by the seedling and tree growth phases. In the seedling phase, the regeneration potential of Castanopsis falls into the category of very good, while the tree phase falls into the productive category despite its low density due to environmental factors and the characteristics of parent trees. However, the sapling and pole phases fall into the category of very poor. The growth rates found are seedlings 2,808 individuals, saplings 11 individuals, poles 5 individuals, and trees 39 individuals. The growth pattern of Castanopsis exhibits both scattered and clustered distribution.

Author Contributions

W: conceptualization, software, investigation, writing—review and editing; **HAK**: supervision, conceptualization, methodology and software; **AP**: collecting and analyzing the data, and writing the scripts; **UBP**: writing—review and editing

Conflicts of interest

The authors declare in writing this article there is no conflict of interest.

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