Journal Of Biology Education Research (JBER)
Vol 6(1) 2025 | ISSN: 2774-7859
DOI: 10.55215/jber.v6.i1.23
https://journal.unpak.ac.id/index.php/jber

Analysis of Understory Vegetation in the Pusat Suaka Satwa Elang Jawa Area

Aip Muhamad Irpan[1*], Suci Siti Latifah, Dina Dyah Saputri, Muhamad Alfieansyah, Najla Nurul Amalia

[1]Universitas Pakuan, Bogor, Indonesia

**Email: aif.irpan@unpak.ac.id*

Received: 18 Desember 2024 Revised: 15 Februari 2025 Accepted: 10 Maret 2025

Abstract

Understory vegetation is the basic vegetation of the forest which can include grasses, shrubs, herbs and ferns which make an important contribution to ecological function and biodiversity. It contributes to nutrient cycling, soil stabilization, and forest regeneration. This study aims to analyze the structure of vegetation composition and diversity of understory plants in the Pusat Suaka Satwa Elang Jawa (PSSEJ). The research method uses square transects by determining the research location by purposive sampling. In each square transect, a plot measuring 2.5 m x 2.5 m was made. The number of plots made was 36 plots. The understory plants found were identified by cross-checking with the iNaturalist, PlantNet, Picture This - Plant identifier identification applications. Based on the results of the study, 52 species were found spread across 50 genera and 27 families. The dominant families are the Poaceae and Solanaceae families. The highest importance value index of *Pseudechinolaena polystachya* from the Poaceae family. The understory plant diversity index with a moderate category. It can be concluded that high species abundance does not always correlate with high INP values.

Keywords: diversity; importance value index; PSSEJ; understory vegetation; vegetation analysis

INTRODUCTION

Indonesia is one of the countries with the largest biodiversity in the world or also known as megabiodiversity. This biodiversity includes flora and fauna spread throughout Indonesia (Ramadona *et al*., 2021; Masriana *et al*., 2023; Nisa *et al.*, 2024). Forests in Indonesia are known for their high biodiversity, which includes various types of vegetation, including understory plants that have important ecological roles (Mahesa *et al.*, 2023; Nur & Chairul, 2024). One of the conservation areas that has a fairly high diversity of understory plants is the forest area of the Pusat Suaka Satwa Elang Jawa (PSSEJ) which consists of three types of forest constituents, namely homogeneous, transitional, and natural forests. The PSSEJ forest area is an area under the management of biodiversity conservation of Gunung Halimun Salak National Park which functions as a center for education and conservation of animals, especially eagles. This research does not discuss the Javan Hawk. Instead, it explores the flora side by analyzing the vegetation in the PSSEJ forest area.

Undergrowth is a plant community on the ground floor that grows covering the soil of the forest area with a stratum height of up to 1 m (Felsmann *et al*., 2018; Naemah *et al*., 2020). Undergrowth in the stratification arrangement occupies layer D, with a height of less than 4.5 m and a stem diameter of about 2cm, undergrowth is annual biennial, perennial and its distribution pattern occurs randomly, clumped / grouped and evenly distributed (Destaranti *et al*., 2017). Undergrowth is a type of basic vegetation found under forest stands except tree saplings which includes herbs, shrubs, grasses and ferns (Ali *et al*., 2022; Nur & Chairul, 2024). Understory plants are an important component in maintaining the balance of forest ecosystems because they contribute to soil stability, retain moisture, and serve as habitat for various organisms (Sulfayanti *et al*., 2023). In addition, understory plants also have a role in nutrient cycling and provide indicators of the stability of forest ecosystems (Naemah *et al*., 2020; Li *et al*., 2022). Deng *et al.* (2023) state that understory vegetation provides a variety of important ecological services, including contributing to carbon sequestration, helping to reduce greenhouse gas emissions while participating in overall nitrogen and nutrient cycle dynamics. The presence of understory vegetation positively impacts biodiversity resources, creates a microclimate on the forest floor, maintains soil fertility, prevents soil erosion through soil surface stabilization and reduction of stormwater runoff (Song *et al.*, 2020; Wardhani *et al*., 2020). However, despite the significant role of understory plants, research on the composition and structure of understory vegetation in the PSSEJ forest area is still very limited.

The composition and diversity of understory or forest floor vegetation is strongly influenced by various environmental factors, such as light intensity, elevation, rainfall, and soil type (Su *et al*., 2019; Hardini *et al.*, 2021). Management of understory vegetation is critical in maintaining forest health and productivity because understory vegetation plays an important role in shaping the species composition and structure of future forests, which carries economic and ecological significance (Seidel *et al.*, 2021). Therefore, research on understory vegetation composition and structure is essential to understand how ecosystem dynamics work and to provide information for subsequent conservation strategizing efforts (Hayati *et al.*, 2021). Based on this description, it is necessary to conduct research related to the analysis of understory vegetation in the PSSEJ forest area. This research aims to analyze the composition and structure of understory vegetation in the PSSEJ area. The results of the research are expected to be a reference for ecosystem management and conservation in the area and provide insight into the role of understory plants in supporting the sustainability of forest ecosystems.

METHOD

The research was conducted in December 2023 in the forest area of the Pusat Suaka Satwa Elang Jawa (PSSEJ) which is under the management of biodiversity conservation of Mount Halimun Salak National Park. The object of this research is the understory plants that are classified in the habit / form of life in the form of grass, shrubs, herbs and ferns. The research location is at 800 - 1,100 masl with coordinates latitude -6.718094 and longitude 106.767071 to latitude -6.771983 and longitude 106.807661. This research is an exploratory study with a description analysis research design. Data collection was carried out using the transect method with the determination of the observation location by purposive sampling. The research location is divided into 3 observation stations, namely: homogeneous, transitional, and natural forest. At each observation station, 3 quadratic transects measuring 20m x 20m were made and within each transect, 3 plots measuring 2.5m x 2.5m were made. A total of 9 quadratic transects and 36 plots were made. After that, observations were made on all understory plant species in all plots. The species identification process was carried out by repeated cross-checks using the iNaturalis, PlantNet, and PictureThis - Plant Identifier applications, and the understory identification book (Karyati & Adhi, 2018). In addition, measurements of environmental factors were also carried out, namely measuring air temperature using a thermometer, air humidity using a hygrometer, and the amount of light intensity using a lux meter. The results of the identification of understory plants were then analyzed to determine the vegetation composition of the Dominant and Co-Dominant Families using the following formula:

$$\text{Famili Dominan and Co-Dominan} = \frac{\textit{Number of Individuls Families}}{\textit{Total number of Individuals Families}} \; x \; 100\%$$

A dominant family is defined as having a percentage value greater than 20%, while co-dominant families have a percentage value between 10% and 20% (Jhonston & Gilman, 1995). Vegetation structure needs to be known using several vegetation characteristics, namely density, frequency and importance of each species. Vegetation structure analysis refers to Naharuddin (2018) which can be seen in the following formula:

a. Density (D) = $\frac{Number\ of\ individuals\ of\ a\ Species}{Plot\ Area\ (m^2)}$

b. Relative Density (RD) = $\frac{Density\ of\ Area}{Density\ of\ all\ species}\ x\ 100\%$

c. Frequency (F) = $\frac{The\ number\ of\ plots\ occupied\ by\ a\ species}{Total\ Number\ of\ a\ plot}$

d. Relative Frequency (RF) = $\frac{a\ species\ Frequency}{Frequency\ of\ All\ Species}\ x\ 100\%$

e. Important Value Indeks (IVI) of understory vegetation = RD + RF

RESULT AND DISCUSSION

Based on the research conducted in the PSSEJ area, data on the composition and structure of understory vegetation was obtained, as described in the following sections. The composition of understory plants found in the PSSEJ forest includes 27 families, 50 genera, 52 species, and 3,783 individuals. Further details can be seen in Table 1.

Table 1. Top 10 family in the PSSEJ area

Familia	Genus	Species	∑ Individul	Persentase	Information
Poaceae	4	4	1499	39,62	**
Solanaceae	3	3	1173	31,01	**
Rubiaceae	1	1	229	6,05	
Melastomataceae	2	2	122	3,22	
Araceae	3	3	105	2,78	
Acanthaceae	2	2	85	2,25	
Piperaceae	2	2	79	2,09	
Asteraceae	6	6	78	2,06	
Thelypteridaceae	1	2	61	1,611	
Vitaceae	1	2	60	1,59	

Information: **) = Dominan Family

Based on Table 1, it was found that the understory vegetation in the PSSEJ area was dominated by the Poaceae family with a composition of 39.62%, and the Solanaceae family with a composition of 31.01%. The Poaceae and Solanaceae families are categorized as dominant families because they have a percentage above 20%. This is in accordance with the opinion of Solfiyeni *et al*. (2023) who have categorized the family of their findings above 20% as the dominant family. A family is said to be dominant if the percentage value is > 20%, and a family is said to be co-dominant if the percentage value is 10-20%. The dominant family and co- dominant family are obtained from the percentage ratio of the number of individuals of a family to the number of individuals of the entire family. The characteristics of the research site in the PSSEJ area are in the form of forests that are divided into three areas, namely homogeneous forests, transitional forests and natural forests. Homogeneous forests and transitional forests have been affected by human activities, homogeneous forests in the PSSEJ area are very open forests with only *Pinus mercusii* standing structures. There are differences in the families found because of the environmental factors that influence them. The existence of Poaceae family species is influenced by several environmental parameters. Nasution & Siregar (2024) stated that the dominance pattern of understory plant families can vary greatly. This depends on forest type, succession stage, and environmental conditions. Environmental factors such as temperature and light intensity strongly influence the distribution of understory species (Kermavnar *et al.*, 2022; Ibrahim *et al*., 2024). A good temperature for the growth of Poaceae family species ranges from 19-27^{o}C with an optimum temperature of 23℃ (Arisandi *et al.*, 2015). Based on the measurement of environmental data at the research site, the average temperature was 24.4℃ which is close to the optimum point, and the average light intensity was 240.5%. Altitude is also one of the factors determining diversity and dominance. However, in this study, it was not a limiting factor for the presence of Poaceae family species. The altitude of the study site ranged from 800 - 1100 meters above sea level. In general, Poaceae family species can live at altitudes ranging from 1 - 2,700 meters above sea level.

The data in Table 1 shows Poaceae and Solanaceae as the top two dominant families in the study site. The dominance of the Poaceae family indicates that species from this family have high adaptability to environmental conditions in the PSSEJ area. The Poaceae family is a group of grasses that have adapted to a variety of extreme environmental conditions, from the coldest regions to the equatorial hot regions, from lowland areas to the highest elevations where plants can still grow, so Poaceae are known as cosmopolitan plants because they can grow in various parts of the world. Poaceae are highly adaptable plants and play an important role in showing dominance in various plant communities (Gramineae *et al*., 2024; Campbell, 2025). The global distribution of Poaceae across different climates reflects variation in functional traits that determine stress tolerance and phenology (Wingler & Sandel, 2023). In addition, diverse reproductive strategies ranging from self-pollination to cross-pollination through *self- incompatibility* mechanisms and their *dioecious* nature (Vanani *et al*., 2020). The pattern of pollination and dispersal that occurs by wind is a factor that triggers the dominance of Poaceae. In general, the Poaceae family has a very important role, namely its function as an erosion control at the foot of rainforest cliffs. The Poaceae family is a very large number of plants, around 10,000-12,000 species or around 24% of the earth's total vegetation (Vanani *et al*., 2020; Campbell, 2025).

Several botanical families consistently appear as major components of forest floor vegetation in various ecosystems. Poaceae (grass family) often appears as one of the most dominant families in the forest floor layer, especially in disturbed or open forest areas. Several studies have identified Poaceae as the main component of the dominant family of understory or forest floor vegetation. Purnomo *et al*. (2017) documented 10 Poaceae species among 60 species of seed plants from 18 plant families in a restoration forest area. Understory vegetation generally consists of members of the Poaceae, Cyperaceae, Araceae, and Asteraceae families, especially in open places, roadsides, river banks, forest floors, and agricultural land (Supriyati & Ariyanti, 2024). Behera *et al*. (2023) noted that Poaceae, Fabaceae, Asteraceae, Malvaceae, and Acanthaceae were the dominant herbaceous species families along the disturbance gradient.

Apart from the Poaceae family, one of the dominant families found in the PSSEJ Area is the Solanaceae family. Solanaceae have been observed to thrive in more open areas and forest gaps associated with high luminosity and natural regeneration processes (Viveiros *et al.*, 2021). Solanaceae families can show particular dominance in disturbed or transitional habitats, i.e. areas affected by human activities such as livestock grazing and agriculture (Martínez-Orea *et al.*, 2024). This is in accordance with the characteristics shown by the research site in the PSSEJ forest area, where homogeneous forests and transitional forests have been affected by human activities. Moreover, the homogeneous forest of the PSSEJ area is a category of forest that has been opened due to the influence of the opening of the *camping ground* area.

In contrast to the results of this study, Nasution & Siregar (2024) stated that in general, Cyperaceae, Asteraceae, and ferns (a group of ferns) represent the dominant taxonomic groups in understory forest vegetation across different forest types. In certain ecological contexts, such as shaded forest floors at low elevations, Cyperaceae often dominate the ground layer alongside Pteridophyta (ferns) (Li *et al.*, 2022). Asteraceae has been documented as the dominant family with 17 species recorded (Yazdanshenas *et al.*, 2019). In unprotected vegetation, Asteraceae along with Poaceae were found to have the highest representation with 4 species each (Malav *et al.*, 2023). Arecaceae also contributes significantly to forest floor vegetation in certain forest ecosystems especially in tropical and subtropical regions. Arecaceae along with Poaceae and Cyperaceae were found to be the dominant families in floodplains and riverbanks below 1,000 m elevation (Wingler & Sandel, 2023). Forest understory vegetation can show different patterns of family distribution and dominance in different ecosystems. The distribution of these families can vary according to land use patterns and the presence of forest disturbance also affects family distribution. The dominance patterns of certain families reflect the ecological adaptation of these plant groups to the specific conditions found in the understory environment, as family dominance patterns can vary greatly depending on forest type, successional stage, and environmental conditions (Nasution & Siregar, 2024). These patterns are not static but change with changing environmental conditions to create dynamic understory communities. The species found at the study site have different life forms. Among them are herbs, grasses, shrubs, and ferns as shown in Figure 1.

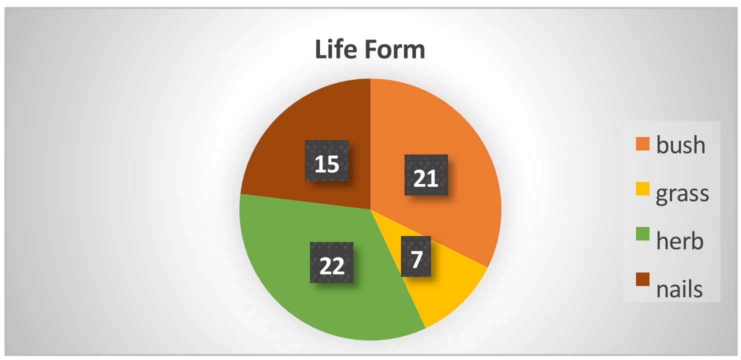

Figure 1. Living forms of undergrowth in the PSSEJ area.

The composition of forest floor vegetation (understory vegetation) can show different patterns in various forest ecosystems (Deng *et al.*, 2023). The most herbaceous understory was found in the research location of the PSSEJ forest area. This is due to the fact that the research location is quite humid and also the light intensity is not so high, while the least understory was found to come from the fern habitat. Studies show that in tropical ecosystems, herbs contribute about 30% of total species richness (André *et al.*, 2023). In tropical forests, herbaceous plants usually account for 14%-40% of all vascular plant species, and the proportion of shrubs also shows a high proportion in tropical forests than in temperate forests (Deng *et al.*, 2023). The composition and diversity of forest floor vegetation are strongly influenced by various environmental factors. Site conditions, which include light availability, soil nutrients, moisture content, and substrate diversity, play an important role in determining the abundance and diversity of forest floor flora (Su *et al.*, 2019). Forest canopy structure and composition can significantly affect light penetration and litter quality, thereby impacting the forest floor environment. For example, diverse canopy species can create environmental heterogeneity, which promotes the coexistence of more forest floor species compared to monoculture environments (Groote *et al.*, 2017). Abiotic factors, such as moisture, temperature, rainfall, wind and soil properties, in addition to physiographic conditions such as slope and elevation also influence forest floor vegetation (Maciel-Nájera *et al.*, 2021). These factors determine plant growth patterns and diversity, which affect local and regional plant communities. In addition, topographic variations can alter the microclimate and resource availability under the canopy, further affecting the composition and diversity of species in the understory. Comparing different forest types exhibiting different abiotic and biotic conditions provides valuable insights into the ecological factors controlling the vegetation diversity of the herbaceous layer (Kermavnar *et al*., 2022). The structure of understory vegetation in an area is seen from its importance, where the importance value is obtained from the total relative density and relative frequency. The highest important value for understory vegetation is 85.87%. Further details can be seen in Table 2.

Table 2. Ten highest important value indexes in the PSSEJ forest area

Species	Family	RD%	RF%	IVI	Inf
Pseudechinolaena polystachya	Poaceae	42,94	42,94	85,87	Grass
Salpichroa origanifolia	Solanaceae	33,60	33,60	67,20	Shrub
Spermacpce remota Lam.	Rubiaceae	6,56	6,56	13,12	Grass
Clidemia hirta	Melastomataceae	3,49	3,49	6,99	Shrub
Philodendron davidsonii	Araceae	3,01	3,01	6,02	Herb
Strobilanthes attenuata	Acanthaceae	2,43	2,43	4,87	Shrub
Piper aduncum	Piperaceae	2,26	2,26	4,53	Herb
Acmella oleracea	Asteraceae	2,23	2,23	4,47	Herb
Thelypteris dentata	Thelypteridaceae	1,75	1,75	3,49	Fern
Cissus discolor Blume	Vitaceae	1,72	1,72	3,44	Shrub

Information:
Grass: ■ Shrub: ■ Herb: ■ Fern: □

Based on the results in Table 2, it can be seen that in the research locations that have been carried out in the PSSEJ area, the lower plants that have the highest relative density are *Pseudechinolaena polystachya* species with a value of 42.94% followed by *Salpichroa origanifolia* from Solanaceae at 33.60%. Density values can illustrate that species with high density values have large adjustment patterns in their environment. This shows that the species *Pseudechinolaena polystachya* has a high adjustment pattern at the research site, because the number of individuals of the species is most dominant and many compared to other species. In accordance with the opinion of Nugroho *et al.* (2021) which states that a high relative density value indicates that the species has the largest population size compared to other species in the community.

Table 2 shows that the plant that has the highest relative frequency is the species *Pseudechinolaena polystachya* with a value of 42.94%. The distribution of a species can be known through its frequency value. Frequency is used as a vegetation parameter that can show the distribution or distribution of plant species in the ecosystem. Relative frequency can describe the level of species distribution in various plants, with a high relative frequency having a more even distribution in the research area (Sari *et al*., 2018; Rawana *et al*., 2023). This is possible considering that *Pseudechinolaena polystachya* has the characteristics of living in clumps and forming expanses so that the level of distribution and relative frequency in the understory vegetation community is relatively high. Although it has not been able to describe the distribution pattern (Powo, 2025). Therefore, if the relative frequency of *Pseudechinolaena polystachya* species is high, it indicates that this species is found in many research plots, making this species the most widespread among other species found in the research site.

The highest Index of Importance for understory plants in the PSSEJ forest area was *Pseudechinolaena polystachya* from the Poaceae family with an index of importance of 85.87%. This was followed by *Salpichroa origanifolia* from Solanaceae with an index of importance of 67.20%. The high index of importance of each species is because it has the highest relative density value (Uno, 2013). Asrianny *et al.* (2019) stated that the high index of importance value of a species is caused by a large density and frequency that is evenly distributed throughout the research area. Hidayat *et al.* (2017)

states that the index of importance of a plant species is one of the parameters that can describe the role of a species in a community. The presence of a plant species in an area shows good adaptation to its habitat. Species that have a high index of importance also have considerable tolerance to environmental conditions. The index of importance value can be used as a measure of the dominance of a species in an area. The species that has the highest index of importance value means that it has the most important role in the area (Ali *et al*., 2022). According to Taufikurrahman & Junaedi (2017) *Pseudechinolaena polystachya* species can grow in an environment that has an average air temperature of 20.06°C, 80.82% air humidity. This is not so different from the temperature at the research location which is 24.4°C, which means that the temperature supports this species to breed at this research location. The results of the study in table 2 also show that there are no species from the dominant herbaceous group. This is indicated by the absence of species that have index of importance value more than 50%, index of importance value *Philodendron davidsomii* 6.02%, index of importance value *Piper aduncum* 4.53%, index of importance value *Alcmella oleracea* 4.47%. Whereas the abundance or richness of species from the herbaceous group (Asteraceae) is higher than Poaceae. This means that high species abundance does not always have a high index of importance value. High species abundance was not always followed by a high index of importance value.

CONCLUSION

Based on the results of research on vegetation analysis in the forest area of the Javan Eagle Sanctuary Center (PSSEJ), 52 species were found spread across 50 genera and 27 families. The dominant families are the Poaceae and Solanaceae families. The highest importance value index of the *Pseudechinolaena polystachya* plant from the Poaceae family is 85.87%. The diversity index of understory plants is 1.53 with a moderate category. The highest Importance Value Index (INP) value for forest floor vegetation is *Pseudechinolaena polystachya* from the Poaceae family with an INP of 85.87%. It can be concluded that high species abundance does not always correlate with high INP values. This research is useful for the global, especially researchers because it can be a reference in the management and conservation of ecosystems in this area as well as providing insight into the role of lower-level plants in supporting the sustainability of forest ecosystems.

REFERENCES

Ali, H., Naemah, D., & Nugroho, Y. (2022). Analisis Vegetasi Tumbuhan Bawah Di Sekitar Tegakan Aren (Arenga pinnata Merr). *Jurnal Sylva Scienteae*, *5*(1), 41–47. https://doi.org/10.20527/jss.v5i1.5045

André, T., Moulatlet, G. M., Almeida, T. E., Alverga, P. P. de P., Boelter, C. R., Drucker, D. P., da SILVA, J. G., Linares-Palomino, R., Lopes, M. A., Magalhães, J. L. L., Manzatto, A. G., Mews, H. A., de Siuza MOLL, I. E., Mortati, A. F., da PAIXÃO, E. C., Quintero-Vallejo, E., Andel, T. van, Silveira, M., Storck-Tonon, D., … Costa, F. R. C. (2023). HERBase: A collection of understorey herb vegetation plots from Amazonia. *Acta Amazonica*, *53*(2), 114–121. https://doi.org/10.1590/1809-4392202203150

Arisandi, R., Dharmono, & Muchyar. (2015). Keanekaragaman Spesies Familia Poaceae di Kawasan Reklamasi Tambang Batubara PT Adaro Indonesia Kabupaten Tabalong. *Seminar Nasional XII Pendidikan Biologi FKIP UNS 2015*, *16*(1), 733–739.

Asrianny, A., Paweka, C. B., Achmad, A., Oka, N. P., & Achmad, N. S. (2019). Komposisi Jenis Dan Struktur Vegetasi Hutan Dataran Rendah Di Kompleks Gunung Bulusaraung Sulawesi Selatan. *Perennial*, *15*(1), 32–41. https://doi.org/10.24259/perennial.v15i1.6793

Behera, M. C., Sahoo, U. K., Mohanty, T. L., Prus, P., Smuleac, L., & Pascalau, R. (2023). Species Composition and Diversity of Plants along Human-Induced Disturbances in Tropical Moist Sal Forests of Eastern Ghats, India. *Forests*, *14*(10), 1–25. https://doi.org/10.3390/f14101931

Campbell. (2025). *Biologi*.

De Groote, S. R. E., van Schrojenstein Lantman, I. M., Sercu, B. K., Dekeukeleire, D., Boonyarittichaikij, R., Smith, H. K., De Beelde, R., Ceunen, K., Vantieghem, P., Matheve, H., De Neve, L., Vanhellemont, M., Baeten, L., de la Peña, E., Bonte, D., Martel, A., Verheyen, K., & Lens, L. (2017). Tree species identity outweighs the effects of tree species diversity and forest fragmentation on understorey diversity and composition. *Plant Ecology and Evolution*, *150*(3), 229–239. https://doi.org/10.5091/plecevo.2017.1331

Deng, J., Fang, S., Fang, X., Jin, Y., Kuang, Y., Lin, F., Liu, J., Ma, J., Nie, Y., Ouyang, S., Ren, J., Tie, L., Tang, S., Tan, X., Wang, X., Fan, Z., Wang, Q. W., Wang, H., & Liu, C. (2023). Forest understory vegetation study: current status and future trends. *Forestry Research*, *3*(6), 1–23. https://doi.org/10.48130/FR-2023-0006

Destaranti, N., Sulistyani, S., & Yani, E. (2017). Struktur Dan Vegetasi Tumbuhan Bawah Pada Tegakan Pinus Di Rph Kalirajut Dan Rph Baturraden Banyumas. *Scripta Biologica*, *4*(3), 155–160. https://doi.org/10.20884/1.sb.2017.4.3.407

Felsmann, K., Baudis, M., Kayler, Z. E., Puhlmann, H., Ulrich, A., & Gessler, A. (2018). Responses of the structure and function of the understory plant communities to precipitation reduction across forest ecosystems in Germany. *Annals of Forest Science*, *75*(1), 1–18. https://doi.org/10.1007/s13595-017-0681-7

Gramineae, P., Area, K., Izzati, K. Al, Efendi, M. H., & Purwati, N. (2024). Analisis Karakteristik Morfologi Famili Poaceae (Gramineae) di Kawasan Lembuak Kebon , Kecamatan Narmada Kabupaten Lombok Barat. *Bioindikator: Jurnal Biologi Dan Pendidikan Biologi*, *1*(1), 20–31.

Hardini, D. K., Istiana, D., & Awaludin, M. T. (2021). *Keanekaragaman Reptilia (Ordo Squamata) di Pusat Suaka Satwa Elang Jawa, Taman Nasional Gunung Halimun Salak*. *4*, 508–520.

Hayati, S. D., Bramasta, D., Kamala, N., & Basrowi, M. (2021). Floristic Composition and Vegetation Structure in The Edge Forest, Mount Ciremai National Park, West Java. *Jurnal Sumberdaya HAYATI*, *7*(1), 17–24. https://journal.ipb.ac.id/index.php/sumberdayahayati

Hidayat, M., Laiyanah, Silvia, N., Putri, Y. A., & Marhamah, N. (2017). Analisis Vegetasi Tumbuhan Menggunakan Metode Transek Garis di Hutan Seulawah Agam Pulo Kemukiman Lamteuba Kabupaten Aceh Besar. *Prosiding Seminar Nasional Biotik*, 85–91.

Ibrahim, Y., Gurnita, Suwandi, P., & Karima, E. (2024). Diversity of Broadleaf Undergrowth Plants in the Pananjung Pangandaran Nature Reserve Area, West Java. *BIO Web of Conferences*, *91*, 1–6. https://doi.org/10.1051/bioconf/20249101026

Jhonston, M., & Gilman, M. (1995). Tree population Studies in Low-diversity Forest, Guyana. I. Floristic Composition and Stand Structure. In *Biodiversity & Conservation Aims and Scope*.

Karyati, & Adhi, M. A. (2018). Jenis-Jenis Tumbuhan Bawah di Hutan Pendidikan Fakultas Kehutanan Universitas Mulawarman. In *Mulawarman University Press. Samarinda*.

Kermavnar, J., Kutnar, L., & Marinšek, A. (2022). Variation in floristic and trait composition along environmental gradients in the herb layer of temperate forests in the transition zone between Central and SE Europe. *Plant Ecology*, *223*(2), 229–242. https://doi.org/10.1007/s11258-021-01203-8

Li, N., Yu, F., Sack, D., Huang, Z., Tian, G., & Liu, S. (2022). Phytolith Assemblages as a Promising Tool for Quantitative Canopy Coverage Reconstruction in Subtropical Forests, China. *Frontiers in Plant Science*, *13*(912627), 1–18. https://doi.org/10.3389/fpls.2022.912627

Maciel-Nájera, J. F., González-Elizondo, M. S., Hernández-Díaz, J. C., López-Sánchez, C. A., Bailón-Soto, C. E., Carrillo-Parra, A., & Wehenkel, C. (2021). Influence of environmental factors on forest understorey species in Northern Mexico. *Forests*, *12*(9), 1–17. https://doi.org/10.3390/f12091198

Mahesa, S., Nerita, S., & Abizar, A. (2023). Pteridophyta in the Puncak Gaduang Area, Lubuk Basung, Agam Regency as a Learning Media for Plantae Materials. *Journal Of Biology Education Research (JBER)*, *4*(1), 42–50. https://doi.org/10.55215/jber.v4i1.5962

Malav, A., Dadhich, P., & Jaiswal, P. (2023). Comparative Study of Phytosociological Status of Herbs and Shrubs in Nanta Forest Region, Rajasthan, India. *Journal of Agriculture and Ecology Research International*, *24*(6), 83–99. https://doi.org/10.9734/jaeri/2023/v24i6564

Martínez-Orea, Y., Vázquez-Santos, Y., Castillo-Argöero, S., & Romero-Romero, M. A. (2024).

Assessing ecological traits of a secondary vegetation species in temperate forests of central mexico: A case study. *Botanical Sciences*, *102*(3), 812–827. https://doi.org/10.17129/botsci.3468

Masriana, S., Halang, B., & Mahrudin, M. (2023). Inventory of the Citrus in Barimbun Village, Tabalong District. *Journal Of Biology Education Research (JBER)*, *4*(2), 82–88. https://doi.org/10.55215/jber.v4i2.8692

Naemah, D., Rachmawati, N., & Pujawati, E. D. (2020). Keragaman Jenis Tumbuhan Bawah Hutan Rawa Gambut Di Kabupaten Banjar. *Jurnal Hutan Tropis*, *8*(3), 298–305. https://doi.org/10.20527/jht.v8i3.9630

Naharuddin, N. (2018). Komposisi Dan Struktur Vegetasi Dalam Potensinya Sebagai Parameter Hidrologi Dan Erosi. *Jurnal Hutan Tropis*, *5*(2), 134–142. https://doi.org/10.20527/jht.v5i2.4367

Nasution, N. A., & Siregar, E. S. (2024). The Diversity of Understorey Plants In Siranggas Wildlife Reserve, Pakpak Bharat District, North Sumatra. *Journal of Sylva Indonesiana*, *7*(02), 140–147. https://doi.org/10.32734/jsi.v7i02.14695

Nisa, H., Mahrudin, & Utami, N. H. (2024). Inventory of Epiphytic Ferns in Tanta Village, Tabalong District, South Kalimantan. *Journal Of Biology Education Research (JBER)*, *5*(1), 43–54.

Nugroho, Y., Supandi, Suyanto, Matatula, J., & Wirabuana, P. Y. A. P. (2021). Influence of understorey diversity on wildlife at the coal mining reclamation area in south kalimantan, indonesia. *Biodiversitas*, *22*(9), 3736–3742. https://doi.org/10.13057/biodiv/d220917

Nur, K. P. M., & Chairul. (2024). Analisis Vegetasi Tumbuhan Tingkat Pohon di Kawasan Geopark Silokek Kabupaten Sijunjung. *Bioscientist : Jurnal Ilmiah Biologi*, *12*(1), 421–432. https://doi.org/10.33394/bioscientist.v12i1.9231

Powo. (2025). *Pseudechinolaena polystachya (Kunth)*.

Purnomo, P., Sancayaningsih, R. P., & Wulansari, D. (2017). Spesies Tumbuhan Penyusun Vegetasi Lantai di Wilayah Restorasi Taman Nasional Gunung Merapi di Ngablak, Magelang, Jawa Tengah. *Journal of Tropical Biodiversity and Biotechnology*, *1*(2), 63–70. https://doi.org/10.22146/jtbb.15282

Ramadona, J. S., Fatiqin, A., & Azwar, F. (2021). Analisis Vegetasi Tumbuhan Bawah Lahan Terbakar Dibawah Tegakan Bambang Lanang (Michelia Champaca) di KHDTK Kemampo. *Prosiding Seminar Nasional Sanis Dan Teknologi Terapan*, *3*(1), 440–445.

Rawana, Wijayani, S., & Masrur, M. A. (2023). Indeks Nilai Penting dan Keanekaragaman Komunitas Vegetasi Penyusun Hutan di Alas Burno SUBKPH Lumajang. *Jurnal Wana Tropika*, *12*(02), 80–89. https://doi.org/10.55180/jwt.v12i02.215

Sari, D. N., Wijaya, F., Mardana, M. A., & Hidayat, M. (2018). Analisis Vegetasi Tumbuhan Bawah dengan Metode Transek (Line Transect) di Kawasan Hutan Deudap Pulo Aceh Kabupaten Aceh Besar. *Prosiding Seminar Nasional Biotik*, *6*(1), 165–173.

Seidel, D., Annighöfer, P., Ammer, C., Ehbrecht, M., Willim, K., Bannister, J., & Soto, D. P. (2021). Quantifying understory complexity in unmanaged forests using tls and identifying some of its major drivers. *Remote Sensing*, *13*(8), 1–20. https://doi.org/10.3390/rs13081513

Solfiyeni, Hafizhah, R., & Gusmawarni, W. (2023). Vegetation Analysis of Sapling and Understorey Invaded by Invasive Alien Species (IAS) Bellucia pentamera Naudin in Lembah Harau Sanctuary. *Jurnal Sains Natural*, *13*(3), 115–125. https://doi.org/10.31938/jsn.v13i3.455

Song, L., Boithias, L., Sengtaheuanghoung, O., Oeurng, C., Valentin, C., Souksavath, B., Sounyafong, P., de Rouw, A., Soulileuth, B., Silvera, N., Lattanavongkot, B., Pierret, A., & Ribolzi, O. (2020). Understory limits surface runoff and soil loss in teak tree plantations of Northern Lao PDR. *Water*, *12*(9), 1–23. https://doi.org/10.3390/W12092327

Su, X., Wang, M., Huang, Z., Fu, S., & Chen, H. Y. H. (2019). Forest understorey vegetation: Colonization and the availability and heterogeneity of resources. *Forests*, *10*(11), 3–7. https://doi.org/10.3390/f10110944

Sulfayanti, R., Dirhamzah, D., & Nurindah, N. (2023). Analisis vegetasi tumbuhan bawah di Kawasan Hutan Konservasi Topidi Kecamatan Tinggimoncong Kabupaten Gowa. *Filogeni: Jurnal Mahasiswa Biologi*, *3*(1), 38–43. https://doi.org/10.24252/filogeni.v3i1.30813

Supriyati, H., & Ariyanti, N. A. (2024). The Diversity of Understory (Shrubs and Herbs) in the Kalikuning Area. *Biology, Medicine, & Natural Product Chemistry*, *13*(1), 159–163. https://doi.org/10.14421/biomedich.2024.131.159-163

Taufikurrahman, N., & Junaedi, D. (2017). Keanekaragaman dan komposisi tumbuhan epifit berpembuluh pada paku tiang (Cyathea spp.) di Kebun Raya Cibodas, Jawa Barat. *Prosiding Seminar Nasional Masyarakat Biodiversitas Indonesia*, *3*(3), 453–460. https://doi.org/10.13057/psnmbi/m030326

Uno, H. B. (2013). *Teori Motivasi dan Pengukurannya*. Bumi Aksara.

Vanani, F. R., Shabani, L., Sabzalian, M. R., Dehghanian, F., & Winner, L. (2020). Comparative physiological and proteomic analysis indicates lower shock response to drought stress conditions in a self-pollinating perennial ryegrass. *PLoS ONE*, *15*(6), 1–24. https://doi.org/10.1371/journal.pone.0234317

Viveiros, E., Francisco, B. S., López, A. M. T., Piña-Rodrigues, F. C. M., & da Silva, J. M. S. (2021). Drivers of Restoration Trajectory of a Community of Regenerant Plants: Natural Regeneration or Tree Seedling? *Floresta e Ambiente*, *28*(3), 1–13. https://doi.org/10.1590/2179-8087-FLORAM-2020-0082

Wardhani, F. K., Rofi'i, I., Kusumandari, A., Subrata, S. A., & Wianti, K. F. (2020). The Role of Undergrowth Species for Soil Fertility in Hutan Pangkuan Desa Pitu BKPH Getas. *Jurnal Manusia Dan Lingkungan*, *27*(1), 14–23. https://doi.org/10.22146/jml.49668

Wingler, A., & Sandel, B. (2023). Relationships of the competitor, stress tolerator, ruderal functional strategies of grass species with lifespan, photosynthetic type, naturalization and climate. *AoB PLANTS*, *15*(3), 1–10. https://doi.org/10.1093/aobpla/plad021

Yazdanshenas, H., Kalagar, M., & Toularoud, M. M. (2019). Understory plant species diversity of Asalem's forests, northern Iran. *Forestry Research and Engineering: International Journal*, *3*(2), 56–62. https://doi.org/10.15406/freij.2019.03.00078