Diversity of understorey at Singkil Swamp Wildlife Reserve

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Abstract. Singkil Swamp Wildlife Reserve (SSWR) is the only conservation area in the coastal lowlands of Aceh as well as habitat of protected large mammals and migratory birds. Many publications related to Singkil swamp biodiversity have been published; however the understory communities were not studied. Understory communities are important part of peat swamp ecosystem. This study aimed to calculate the understory diversity and distribution using quadrat method. Nine sites were selected and 25 2m by 2m plots were established in each sites. All understorey species within plot were identified and measured their coverage. Overall, 134 species in 42 families were recorded which the community diversity in each site was categorized as moderate and high. Araceae was recorded as richest family (14 species), followed by Orchidaceae (10 species) and Annonaceae (8 species). Subsequently, there are 17 families (40.5%) categorized as very scare family which each family only contains 1 species. It means the vulnerability of the last family group is very high due to the ecosystem disturbance. Some invasive alien species were found at disturbed areas. Therefore, the pristine peat swamp ecosystem is needed to conserve as well as the disturbed area is needed to restore based on scientific approaches.

1. Introduction
Until 1990s, the Singkil swamp was remaining pristine tropical forested wetland at west southern of Aceh and the area has high biodiversity [1]. Rijksen et al. [2] stated that Singkil swamp is a habitat for many species of endemic fish and peat swamp forest ecosystem in Singkil swamp is very important for the productivity of coastal fisheries in the western part of Aceh. According to the assessment [1, 2], the Singkil swamp was designated as conservation area, namely the Singkil Swamp Wildlife Reserve (SSWR) in 1998 by Indonesia government. More than 83% of the SSWR area is peat land and covered by pristine and secondary peat swamp forests (PSFs) [3].

The SSWR has an important role in the conservation of biodiversity and its ecosystem, especially coastal peat swamp forest (PSF) ecosystems and other related ecosystems, such as mangroves, littorals and estuarine [3-5] as well as habitat for threatened extinction and large mammals, water birds, herpetofauna (reptiles and amphibians) and others [1, 3, 4, 6, 7]. Wich et al. [8] reported that the SSWR had highest density of Sumatran orangutan (SOU) population. It means, the SSWR is a key habitat of SOU as critically endangered species [9]. Coastal forested wetland has important role in protecting coastal resources from natural disaster, such as tsunami [4] and high resiliency level after disturbance [5, 10-12] Therefore, the SSWR needs to be maintained and managed properly.

Several researches on biodiversity of the SSWR were done after 1998 [4-8]. The conservation area had very rich tree species [4, 7] as well as high bird species both local and migratory species [6, 7]. To date, there is no data of lower plant both their diversity and distribution. Hence, the understorey
communities are important in PSF ecosystems [13], this study aimed to calculate the understorey diversity and distribution in the SSWR.

2. Materials and Methods

2.1. Research period and study site
Field survey was done from 7th June to 14th July 2017. The 9 sampling sites have been established and distributed at south, mid and north of the SSWR area, namely Singkil (S1-S3), Runding (R1-R3) and Trumon (T1-T3). A 1 ha plot was established in each site. By nested and systematic sampling method, a 25 m x 2m of subplot was set up in each plot [14-17].

2.2. Data collection and analyses
All understorey vegetations within subplot were identified and measured the cover percentage. Understorey identifications were based on Onrizal [18]. Saito and Atobe classification (19) was used to analyze the percentage of understorey coverage. Diversity indices were used to know the plant diversity. Due to individual of each species measured in floral survey, the species diversity was calculated based on Shannon-Winner index (Shannon’s; $H'$) [17]. The evenness index ($E$) [20] was used to know the degree of species evenness in each plot.

3. Results and Discussions

3.1. Species richness and distribution
Overall, 134 species in 42 families (Appendices 1) were recorded which the community diversity in each site was categorized as moderate and high. Species richness of understorey within plot varied from 19-43 species (Figure 1). The three rich plots were R2 (43 species), S3 (35 species) and S1 (34 species) while three poor plots were T2 (19 species), T1 (21 species) and S2 (23 species).

![Species richness of understorey within each plot at the Singkil Swamp Wildlife Reserve](image)

Figure 1. Species richness of understorey within each plot at the Singkil Swamp Wildlife Reserve

Araceae was recorded as richest family (14 species), followed by Orchidaceae (10 species) and Annonaceae (8 species). On the other hand, there are 17 families (40.5%) categorized as very scarce family which each family only contains 1 species (Appendices 1). It means that the SSWR is very high vulnerable to loss many family due to ecosystem disturbance both natural and anthropogenic factors [4, 21, 22].

At the disturbance area within the SSWR (T1 and T2), some alien and invasive species were found in the conservation area, such as *Mimosa pigra* and *Mikania micrata*. These plants are rapidly
spreading and can push the native plants of the region [21, 23]. Therefore, some defoliation treatments [21, 24] are needed to erase the alien and invasive species from the SSWR.

3.2. Diversity indices

The species diversity of each plot in the SSWR varied from 2.50 to 3.11 (Figure 1). Almost plots were categorized moderate diversity \((2.0 \leq H' < 3.0)\) and 2 plots (S1 and S3) were categorized high diversity. Subsequently, all plots were classified as high evenness degree \((E > 0.75)\) that it means there is no species dominated in each plot. This is supported by coverage distribution of each understorey species where most of the species (72\%) had been distributed with class of A (coverage \(\leq 5\%\)) (Figure 3). This condition could be happen because of a balanced competition between species, both to space and nutrients [22, 25-28].

![Figure 2. Species diversity \((H')\) and evenness (E) within each plot in the Singkil Swamp Wildlife Reserve](image)

![Figure 3. Coverage distribution of understorey species in the Singkil Swamp Wildlife Reserve](image)

4. Conclusions and Recommendations

The SSWR had high diversity of understorey vegetation (134 species in 42 families). Based on coverage distribution, none species is very dominance. However, about 40.5 % of family were categorized as a very scare family due to the family has only 1 species where the families is very vulnerable to loss if disturbances are occurred in the conservation area. Subsequently, the some alien
and invasive species were invaded the conservation area. Therefore, the properly management is need to maintain the biodiversity at the SSWR as well as some restoration activities are required to recover the ecosystem and to erase the alien and invasive species.

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**Acknowledgments**

Author thanks to USAID’s LESTARI Project for funding this research and BKSDA Aceh for supporting the fieldwork.

Appendices 1: Number of understorey species within each family in the Singkil Swamp Wildlife Reserve

| No. | Family       | No. of Species |
|-----|--------------|---------------|
| 1.  | Annonaceae   | 8             |
| 2.  | Apocynaceae  | 5             |
| 3.  | Araceae      | 14            |
| 4.  | Araliaceae   | 2             |
| 5.  | Arecaceae    | 6             |
| 6.  | Aspleniaceae | 3             |
| 7.  | Blechnaceae  | 2             |
| 8.  | Commelinaceae| 3             |
| 9.  | Compositae   | 1             |
| 10. | Convolvulaceae| 1            |
| 11. | Cyparaceae   | 6             |
| 12. | Davalliaceae | 2             |
| 13. | Dilleniaceae | 2             |
| 14. | Dioscoreaceae| 2             |
| 15. | Dryopteridaceae| 1          |
| 16. | Fabaceae     | 1             |
| 17. | Gleicheniaceae| 1            |
| 18. | Hypoxidiaceae| 1             |
| 19. | Leguminosae  | 3             |
| 20. | Lindsaeaceae | 1             |
| 21. | Lomariopsidaceae| 1         |
| 22. | Loranthaceae | 1             |
| 23. | Lycopodiaceae| 1             |
| 24. | Lygodiaceae  | 1             |
| 25. | Marattiaceae | 1             |
| 26. | Melastomataceae| 4          |
| 27. | Menispermaeae| 3             |
| 28. | Mimosaceae   | 1             |
| 29. | Nepenthaceae | 6             |
| 30. | Nephrolepidaceae| 2          |
| 31. | Ophioglossaceae| 1            |
| 32. | Orchidaceae  | 10            |
| 33. | Pandanaceae  | 7             |
| 34. | Piperaceae   | 1             |
| 35. | Plagiogyriaceae| 1           |
| 36. | Poaceae      | 3             |
| 37. | Polypodiaceae| 7             |
| 38. | Pteridaceae  | 4             |
| 39. | Rubiaceae    | 3             |
| 40. | Tectariaceae | 3             |
| 41. | Thelypteridaceae| 1         |
| 42. | Zingiberaceae| 3             |
| 43. | [Undet]      | 4             |
|     | Total        | 134           |