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Determination of Keystone Species that Influences the Diversity of Birds Species in the Land of Reclamation and Revegetation of Post-Coal Mining

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Abstract

Restoration of biodiversity is one of the successful assessments in the ecological restoration efforts on reclamation and revegetation land. The objective of this study is to determine the relationship between fauna diversity and role of vegetation as a producer. The selected fauna included bird species and the selected vegetation included the fast growing plant of revegetation as well as the lower vegetation growing among the staple crops. The analysis used was DCCA for sub-factor of bird species, shrub species and vegetation role clusters as fauna food producers. The result of the analysis shows that the highest Index Shannon in H_4 (*Sengon-rambutan*) habitat and in H9 habitat (Oil Palm) is 2.33, while the lowest index is in H_1 that is only one bird species. The species richness from the lowest to the highest is in H_1 (*Akasia-plantan* [-]), H_{10} (*Ponds* [0.6]), H_5 (*Trembesi-johar* [0.86]), H_6 (*Karamunting-shrubs* [0.95]), H11 (Fern-Rice [1.36]), H7 (*Sengon-karamunting* [1.85]), H_2 (*Akasia-karamunting* [1.94]), H_8 (Rubber [2.01]), H_9 (Oil Palm [2.30]), and H_4 (Sengon-rambutan [2.33]). H_6 and H_{11} have a better visible kind of richness than the P3 & P8 factors. H_5 is more closely influenced by P_2 factor. H_2, H_7 and H_9 are strongly influenced by P_6 and P_7, H_8 and H_3 are strongly influenced by P_4 and are weakly affected by P_2 and P_1. H_4 is strongly influenced by P_1 and less influenced by P_4.

Keywords: Birds diversity; Index Shannon.

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1. Introduction

Coal mining business mostly uses forest area as its concession area. Forests that have the function of protection, production, biodiversity, and social have changed their function as a source of economic income of the country. Mining has a greatly significant impact on individuals and species populations at the mine site in which they must move to another forest site [1]. After the land is mined, the company is required to reclaim and revegetate the concession area in accordance with the status of the land area. If the concession area is a forest area, it will be returned to forest again. One of the functions of forest area is to be a biodiversity habitat. The restoration of biodiversity is one of the most successful assessments of ecological restoration efforts.

The initial step in the efforts to restore the diversity is by identifying the factors that influence the increase of the diversity. According to [2], there is a relationship between biodiversity and productivity. The diversity of communities is due to niche diversification occupied by species, and this diversification will further increase community productivity as resource exploitation becomes more effective.

The hypothesis developed was the energy transfer factor from vegetation to fauna, and in this case, the most basic factor is the role of vegetation as a source of basic food for fauna. The role of vegetation is described as a function of production, starting from leaves that can be consumed by fauna (insects, mammals), flowers and nectar that can be consumed by insects, birds, and bats, fruits that can be consumed by fauna (fruit bats, fruit birds, and mammals), and litter that can be utilized by soil macrofauna.

Based on these problems and hypotheses, research on the relationship between fauna diversity and vegetation role as producer is required. The selected fauna was bird species and the selected vegetation included the fast growing plant of revegetation as well as the shrubs growing among the staple crops.

2. Research Method

2.1. Research location and time

The location of the research selected as a case study was the coal company of PT. X in Sangasanga City containing post-mining land of reclamation and 5-year revegetation with 6 main plant species as the representatives of habitat types (Acacia-Plantan, Acacia-Karamunting, Sengon-Karamunting, Sengon-Rambutan, Trembesi-Johar, Karamunting-shrub) and 5 habitats of land around the area used as comparison (Teak, Rubber, Oil Palm, Pond, Fern-Rice). The research was conducted from March 1, 2015 to August 31, 2015.

2.2. Field data collection method

Data collection of plant and wildlife communities (birds) was conducted by direct observations and measurement at the location of the post-mining land. Plant community data were collected through a survey using a pathway method, i.e. by observing vegetations in 20x20 m^2, 10x10 m^2, 5x5 m^2 and 2x2 m^2 plots to obtain the highest value of biodiversity of shrubs (Fig. 1). Furthermore, the value of the width is used in assessing the percentage of the spread of each type of shrubs, by dividing the width into 100 parts, and the percentage of width for each type of shrubs was calculated. Identification of plant species was conducted using the reference of [3]. Sampling data collection of wildlife (birds) took place at the vegetation sampling site. The method used is mist nest as well as direct observations of the visible birds. Identification of bird species was carried out using the reference of [4]. There were 3 samples chosen purposively by considering the vegetation observation data. In each sample point, data retrieval was conducted for 3 times, and the duration of data retrieval for each replication was 1 week of observation.

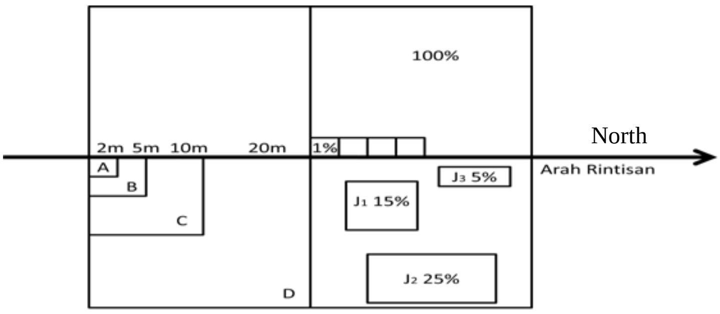

Figure 1: The shape and size of the observation plots of inventory of vegetation growing under (shrub)

2.3. Cluster data for analysis

Data collection was conducted in reclamation and revegetation of post-coal mining land, with multivariate data approach divided into the grouping of: 1) the habitat type and the habitat type observed included the 6 revegetation areas of post-coal mining land with monoculture plants and 5 community cultivation areas adjacent to the mine site. The habitat types include Acacia-Plantan, Acacia-Karamunting, Sengon-Karamunting, Sengon-Rambutan, Trembesi-Johar, and Karamunting-shrub. The habitat type of the cultivation areas include Teak, Rubber, Oil Palm, Ponds, and Fern-Rice; 2) the environmental factor, and the influencing environmental factor is divided into P_{1-n} (producers of edible plants for fauna [plants & litter]); 3) the parameters, number of presence of bird species, and species of shrub.

2.4. Data analysis

Efforts to identify the criteria of recommended plant species and indicators of restoration of the function of protected forest as habitat for flora fauna biodiversity were constructed using the multivariate analysis approach. A multivariate analysis approach for the indicator of the restoration of habitat function used the hyper Detrend Cannonical Correspondence Analysis (hDCCA) by [5]. The use of hDCCA method aims to determine the relationships in the form of graphs and to reveal the maximum information of a data matrix with the environmental factors simultaneously. The data matrix comprises the main plant species of revegetation as a sample (x) and a maximum of 3 sub-environments (y) i.e. B_{1-n} (bird species), S_{1-n} (shrub), F_{1-n} (food chain level), P_{1-n} (edible plants for fauna). The richness of types was calculated using the Shannon-Weaver richness index [6] by the following formula:

$$H' = -\Sigma p_i.\ln(p_i)$$

$$= -\sum\left(\frac{n_i}{N}\right).\ln\left(\frac{n_i}{N}\right)$$

H' notation denotes the diversity index of Shannon, p_i is the proportion of individuals found in the species of the i-th, n_i is the number of individual species of the i-th, and N is the total number of individuals of all species found.

3. Result and Discussion

3.1. Result

The results of the field data collection for bird species in each habitat type are presented in Table 1 in which 38 species of birds were found from the 11 habitat types, and the percentages of their presence in each habitat varied. As many as 13 bird species were found in the oil palm garden, and only 1 species was found in Acacia-plant habitat. For plant species of shrub, the habitat types are presented in Table 2 in which 21 species of shrubs were found in the 11 habitat types and the percentages of presence of each habitat varied. As many as 13 plant species were found in the habitats of Sengon-karamunting and Sengon-rambutan and two species were found in pond habitat.

Table 1: Cluster data of habitat types and bird species found

Habitat	Bird species found (%)
1. Acasia-plantan	B_1(100)
2. Acasia-karamunting	B_2 (26.5), B_3(8.8), B_4(11.8), B_5(17.6), B_6(2.9), B_7 (8.8), B_8(8.8), B_9(14.7)
3. Sengon-karamunting	B_7(10.7), B_{10}(14.3), B_{11}(25), B_{12}(7.1), B_{13}(7.1), B_{14}(14.3), B_{15}(21.4)
4. Sengon-rambutan	B_1(4.3), B_3(15.2), B_4 (15.2), B_8 (8.7), B_{11} (10.9), B_{16}(6.5), B_{17}(2.2), B_{18}(10.9), B_{19}(6.5), B_{20} (4.3), B_{21}(2.2), B_{22}(13.0)
5. Trembesi-johar	B_4(9.1), B_{15}(27.3), B_{23}(63.6)
6. Karamunting-semak	B_1(30), B_2(60), B_{15}(10)
7. Teak	B_5 (25), B_7(18.8), B_{24} (31.3), B_{25}(6.3), B_{26}(6.4), B_{27}(12.5)
8. Rubber	B_8(14.8), B_{13}(3.7), B_{15}(18.5), B_{20}(25.9), B_{24}(7.4), B_{28}(7.4), B_{29}(11.1), B_{30}(7.4), B_{31}(3.7)
9. Oil Palm	B_2(18.2), B_5(9.1), B_7(11.4), B_8(2.3), B_{15}(2.3), B_{21}(2.3), B_{24}(4.5), B_{26}(20.5), B_{32}(11.4), B_{33}(4.5), B_{34}(4.5), B_{35}(6.8), B_{36}(2.3)
10. Pond	B_{27}(66.7), B_{36}(33.3)
11. Fern-rice	B_1(42.3), B_2(23.1), B_7(3.8), B_{26}(19.2), B_{27}(11.5)

Description: B_1 (*Lonchura malacca*), B_2 (*Pycnonotus goiavier*), B_3 (*Dicaeum concolor*), B_4 (*Aethopyga mystacalis*), B_5 (*Pygnonotus aurigaster*), B_6 (*Aplonis panayensis*), B_7 (*Treror vernans*), B_8 (*Pycnonotus *erythrophthalmos*), B_9 (*Meiglyptes tukki*), B_{10} (*Cuculus saturates*), B_{11} (*Aeghitina viridissima*), B_{12} (*Chalcophaps indica*), B_{13} (*Batrachostomus stellatus*), B_{14} (*Aethopyga eximia*), B_{15} (*Lanius schach*), B_{16} (*Lonchura fuscans*), B_{17} (*Dicaeum concolor*), B_{18} (*Nectarinia sperata*), B_{19} (*Orthotomus atrogularis*), B_{20} (*Prinia flavicentris*), B_{21} (*Otus matananensis*), B_{22} (*Pnoepyga pusilla*), B_{23} (*Picoides moluccensis*), B_{24} (Stachyris maculata), B_{25} (*Caprimulgus indicus*), B_{26} (*Geopelia striata*). B_{27} (*Merops viridis*), B_{28} (*Pachychepala hypoxantha*), B_{29} (*Rhipidura javanica*), B_{30} (*Orthotomus ruficeps*), B_{31} (*Orthotomus sericeus*), B_{32} (*Arachnothera longirostra*), B_{33} (*Cisticola juncidis*), B_{34} (*Treron curvirostra*), B_{35} (*Streptopelia chinensis*), B_{36} (*Alcedo meninting*), B_{37} (*Acridotheres javanicus*), B_{38} (*Prinia familiaris*)

Table 2: Cluster data of habitat types and shrub species found

Habitat	Shrub species found (%)
1. Acasia-plantan	S_{10}(8.3), S_{11}(15) , S_{12}(74.7), S_{15}(2)
2. Acasia-karamunting	S_1(20.3), S_2(17.3), S_3(24), S_5(12.3), S_6(2), S_7(1.7), S_8(5.7), S_9(1.7), S_{12}(7.7), S_{13}(2.7), S_{14}(2.7), S_{15}(2)
3. Sengon-karamunting	S_1(21), S_2(2), S_3(40.3), S_4(2), S_5(1), S_6(1.7), S_7(1.7), S_8(8), S_9(2.7), S_{10}(1.7), S_{12}(11.3), S_{13}(5), S_{14}(1.7)
4. Sengon-rambutan	S_1(5.3), S_2(13.3), S_3(7), S_6(8.3), S_7(2), S_8(21), S_9(7.3), S_{10}(9), S_{12}(7.7), S_{13}(9.3), S_{14}(1.7), S_{18}(4), S_{21}(4)
5. Trembesi-johar	S_{10}(31), S_{12}(46.7), S_{13}(4.3), S_{14}(17), S_{15}(1)
6. Karamunting-semak	S_{10}(11.3), S_{11}(9.3), S_{12}(45), S_{14}(21), S_{15}(13.3)
7. Teak	S_1(3.7), S_2(8), S_3(58.7), S_{10}(7), S_{11}(10), S_{12}(12), S_{15}(0.7)
8. Rubber	S_4(11.3), S_6(3.3), S_9(9), S_{10}(10.7), S_{11}(8), S_{12}(17), S_{14}(18), S_{15}(5.7), S_{19}(17)
9. Oil Palm	S_1(2), S_2(3.7), S_3(33.3), S_{16}(34.3), S_{17}(13.7), S_{20}(13)
10. Pond	S_{11}(83.3), S_{14}(16.7)
11. Fern-Rice	S_1(3.3), S_2(4), S_3(21.7), S_{11}(2.3), S_{16}(68.7)

Description: S_1 (*Clidemia hirta*), S_2 (*Ageratum conyzoides*), S_3 (*Melastoma malabatricum*), S_4 (*Dendrocnide stimulans*), S_5 (*Rubus moluccanus*), S_6 (*Blumea riparia*), S_7 (*Piper aduncum*), S_8 (*Solanum torvum*), S_9 (*Carallia brachiata*), S_{10} (*Mimosa pudica*), S_{11} (*Scleria puspurascens*), S_{12} (*Imperata cylindrica*), S_{13} (*Centotheca lappacea*), S_{14} (*Echinocloa colonum*), S_{15} (*Paspalum conjugatum*), S_{16} (*Nephrolepis falcata*), S_{17} (*Gleichenia linearis*), S_{18} (*Selaginella willdenovii*), S_{19} (*Microlepia speluncae*), S_{20} (*Heterongonium pinnatum*), S_{21} (*Eugenia sephalantha*)

From the results of data d in Table 2, the percentage of domination for each species was grouped and calculated into the types of producer (edible for fauna). The types of producer (edible for fauna) explain that plants act as a producer that can be a source of food for fauna, starting from leaves, flowers, fruits, seeds, to the easiness of litter to be decomposed by macrofauna and utilized by fauna. The division of producer types into P_1 (*Tree-Leaf*) i.e. the leaves of staple crop revegetation, P_2 (*Tree-Flower*) i.e. the flower and its nectar from the staple crop revegetation, P_3 (*Tree-Seed/fruit*) i.e. seeds and fruits from staple crop revegetation, P_4 (*Tree-Litter*) i.e. the litter of the staple crop revegetation, P_5 (*Shrub-Leaf*) i.e. the leaf of the shrub species found, P_6 (*Shrub-Flower*) i.e. flower and nectar of the shrub species found, P_7 (Shrub- Seed/Fruit) i.e. seeds and fruits of the shrub type found, P_8 (Shrub-litter) i.e. litter of the type of shrub found. The results of the calculation of grouping for each type of producer are presented in Table 4.

Table 3: *Cluster* data of habitat types and producer types (*edible* for fauna)

Habitat	**Tipe produsen (%)**
1. Acasia-plantan	P_2(40) , P_3(40) , P_5(1) , P_6(0.8) , P_7(1.6) , P_8(16.7)
2. Acasia-karamunting	P_2(40) , P_3(40) , P_5(4) , P_6(5.3) , P_7(4.7) , P_8(6.1)
3. Sengon-karamunting	P_1(26.7) , P_2(26.7) , P_4(26.7) , P_5(3.7) , P_6(5) , P_7(4.7) , P_8(6.5)
4. Sengon-rambutan	P_1(26.7) , P_2(26.7) , P_4(26.7) , P_5(2.9) , P_6(6.5) , P_7(4.8) , P_8(5.8)
5. Trembesi-johar	P_2(26.7) , P_4(26.7) , P_5(26.7) , P_6 (3.6), P_7(3.5) , P_8(12.9)
6. Karamunting-semak	P_2(40) , P_4(40) , P_5(6) , P_6(3.5) , P_7(2.8) , P_8(13.1)
7. Teak	P_5(20.9) , P_6(20.3) , P_7(23.3) , P_8(35.6)
8. Rubber	P_2(40) , P_4(40) , P_5(2.8) , P_6(4.6) , P_7 (3.9), P_8(8.7)
9. Oil Palm	P_1(20) , P_2(20) , P_3(20) ,P_4(20) , P_5(2.8) , P_6(4.6) , P_7(3.9) , P_8(8.7)
10. Pond	P_5(27.8) , P_6(5.6) , P_7 (33.3), P_8(33.3)
11. Pern-Rice	P_5(42.4) , P_6(7.3) , P_7 (8), P_8(42.4)

Description: P_1 (*Tree-Leaf*), P_2 (*Tree-Flower*), P_3 (*Tree-Seed/fruit*), P_4 (*Tree-Litter*), P_5 (*Shrub-Leaf*), P_6 (*Shrub-Flower*), P_7 (*Shrub-Seed/fruit*), P_8 (*Shrub-Litter*)

Table 4: Data on the richness of the bird types in each habitat

Habitat	**Indeks of species richness (Shannon)**
1. Acasia-plantan	-
2. Acasia-karamunting	1.94
3. Sengon-karamunting	1.85
4. Sengon-rambutan	2.33
5. Trembesi-johar	0.86
6. Karamunting-semak	0.99
7. Teak	1.43
8. Rubber	2.01
9. Oil Palm	2.30
10. Pond	0.64
11. Fern-Rice	1.39

The analysis of species richness of bird species (Shannon index) is presented with histogram in Figure 2. The highest Shannon index of 2.33 is in H_4 (Sengon-rambutan) and H_9 habitats (Oil Palm), while the lowest index is in H_1 i.e. only one bird species. The species richness from the lowest to the highest is H_1 (Akasia-plantan [-]), H_{10} (Pond [0.6]), H_5 (Trembesi-johar [0.86]), H_6 (Karamunting-shrub) [0.95]), H_{11} (Fern-Rice [1.36]), H_7 (Sengon-karamunting [1.85]), H_2 (Akasia-karamunting [1.94]), H_8 (Rubber [2.01]), H_9 (Oil Palm [2.30]), and H_4 (Sengon-rambutan [2.33]).

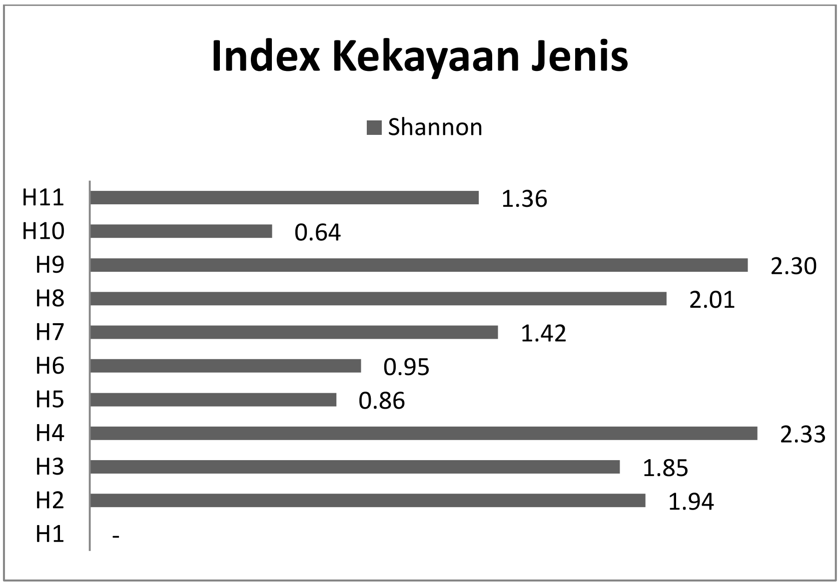

Figure 2: Histogram of species richness of birds in each tree habitat type

Description: H_1 (Acasia-plantan), H_2 (Acasia-karamunting), H_3 (Sengon-karamunting), H_4 (Sengon-rambutan), H_5 (Trembesi-johar), H_6 (Karamunting-semak), H_7 (Teak), H_8 (Rubber), H_9 (Oil Palm), H_{10} (Pond), H_{11} (Fern-Rice)

The results of *hDCCA* analysis on staple cop species of revegetation as a sample of habitat (x) and 3 sub-environments (y) i.e. B_{1-n} (bird species), S_{1-n} (shrub species), P_{1-n} (edible plant producer for fauna) are presented in Figure 3. To identify factors affecting species richness in each habitat, the Shannon index analysis should be correlated with the hDCCA analysis result. H_1 has the lowest Shannon richness index due to the factor of the producer type in the habitat, causing no bird species to be interested in coming to find feed or foraging. H_{10} (pond) is the second lowest due to the influence of producer factor, and it is slightly influenced by the factors of P_5 (shrub-leaf) and P_8 (shrub-litter). H_6 (karamunting-shrub) and H_{11} (fern-rice) have better species richness as seen from the factor of P_3 (tree-seed/fruit) affecting H_6 (karamunting-shrub); in addition, the factors of P_3 (tree-seed/fruit) and P_8 (shrubs-litter) affect H_{11} (fern-rice). H_5 (trembesi-johar) is more closely influenced by P_2 factor (tree-flower). H_2 (acasia-karamunting), H_7 (teak) and H_9 (oil palm) are strongly influenced by P_6 factor (shrub-flower) but have the least influence of P_7 (shrub-seed/fruit). H_8 (rubber garden) and H_3 (sengon-karamunting) are strongly influenced by P_4 (staple crop-litter) but weakly affected by P_2 (tree-flower) and P_1 (tree-leaf). H_4 (sengon-rambutan) is strongly influenced by P_1 (tree-leaf) and has less influence of P_4 (tree-litter).

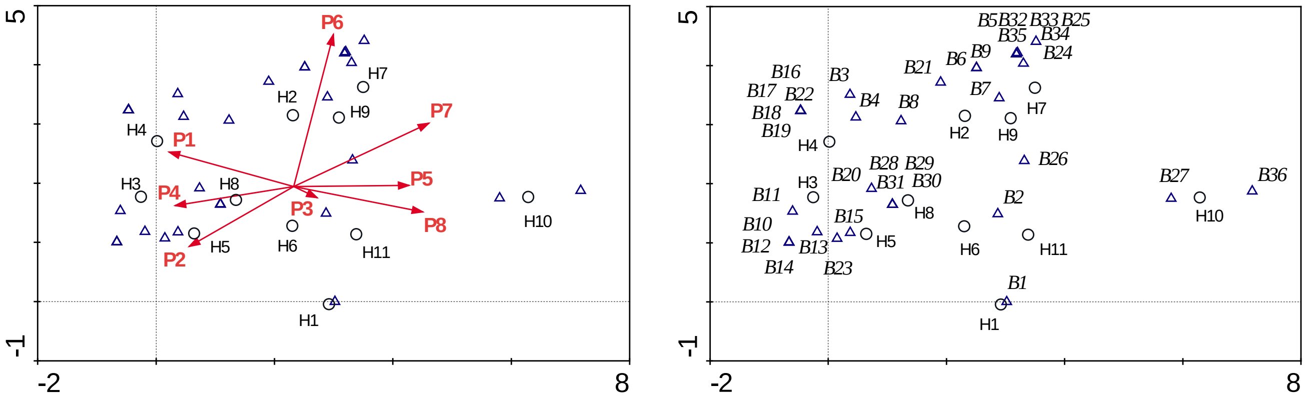

Figure 3: Results of hCCA analysis on bird species, producer type, and shrub species

Description: H_1 (Akasia-plantan), H_2 (Akasia-karamunting), H_3 (Sengon-karamunting), H_4 (Sengon-rambutan), H_5 (Trembesi-johar), H_6 (Karamunting-semak), H_7 (Kebun Jati), H_8 (Kebun Karet), H_9 (Kebun Sawit), H_{10} (Tambak), H_{11} (Pakis-Padi), P_1 (*Tanaman pokok-Daun*), P_2 (*Tanaman pokok-Bunga*), P_3 (*Tanaman pokok-Biji/Buah*), P_4 (*Tanaman pokok-Seresah*), P_5 (*Semak-Daun*), P_6 (*Semak-Bunga*), P_7 (*Semak-Biji/Buah*), P_8 (*Semak-Seresah*), B_1 (*Lonchura malacca*), B_2 (*Pycnonotus goiavier*), B_3 (*Dicaeum concolor*), B_4 (*Aethopyga mystacalis*), B_5 (*Pygnonotus aurigaster*), B_6 (*Aplonis panayensis*), B_7 (*Treror vernans*), B_8 (*Pycnonotus erythrophthalmos*), B_9 (*Meiglyptes tukki*), B_{10} (*Cuculus saturates*), B_{11} (*Aeghitina viridissima*), B_{12} (*Chalcophaps indica*), B_{13} (*Batrachostomus stellatus*), B_{14} (*Aethopyga eximia*), B_{15} (*Lanius schach*), B_{16} (*Lonchura fuscans*), B_{17} (*Dicaeum concolor*), B_{18} (*Nectarinia sperata*), B_{19} (*Orthotomus atrogularis*), B_{20} (*Prinia flavicentris*), B_{21} (*Otus matananensis*), B_{22} (*Pnoepyga pusilla*), B_{23} (*Picoides moluccensis*), B_{24} (Stachyris maculata), B_{25} (*Caprimulgus indicus*), B_{26} (*Geopelia striata*). B_{27} (*Merops viridis*), B_{28} (*Pachychepala hypoxantha*), B_{29} (*Rhipidura javanica*), B_{30} (*Orthotomus ruficeps*), B_{31} (*Orthotomus sericeus*), B_{32} (*Arachnothera longirostra*), B_{33} (*Cisticola juncidis*), B_{34} (*Treron curvirostra*), B_{35} (*Streptopelia chinensis*), B_{36} (*Alcedo meninting*), B_{37} (*Acridotheres javanicus*), B_{38} (*Prinia familiaris*).

3.2. Discussion

There is a positive relationship between habitat diversity and the number of tree species and species diversity association, such as birds [7]. Environmental diversity or landscapes provide niche, food and sources of protection to determine the magnitude of species diversity [8]. In this study, 38 species of birds were found on the revegetation & reclamation land on the 5th year, and the increased structure is expected to increase species diversity. The research conducted by [9] found 70 species in the post-gold mining area in the 10th year, and this condition is predicted to continue to change toward the composition commonly found in natural forests. [9] state that there are wide variations of leaves, grasses and shrubs that can support bird population in a deciduous forest. The highest species richness (3.86) was found in this kind of area when compared to that in bush habitat (3.86), conifer forest (3.22), and cultivation area (3.17). The key factor influencing the choice of habitat includes the searches for feed (foraging), food sources and competition [11]. Feed search and feed sources are affected by habitat structure [12, 13]. Bird diversity strongly interacts with complex structures [14], but it does not apply to exotic plants such as *Acacia mangium*. For example, habitat H_1 (Acacia-plants) has a low diversity of bird species; however, in habitat H_2 (Acacia-karamunting), the shrubs have a significant effect on the increase in bird species diversity. It is assumed that the transfer of energy into the food chain from H_1 through the availability of feed is very small. H_1 only provides flowers edible for birds; in contrast, H_2 is additionally affected by P_6 (shrub-flower) and P_7 (shrub-seed/fruit). It is assumed that vegetation structure affecting diversity is seen from the use of vegetation in this structure. Higher vegetation utilization will have a significant effect on the diversities of birds and other faunas. The increased diversity of species utilized by fauna within the forest structure will affect diversity. Some tree-level plants used by birds include *Vitex pubscens* (Verbenaceae), *Alstonia angustiloba* (Apocynaceae), *Ficus grossularioides* (Moraceae), *Anthocephalus chinensis* (Rubiaceae), *Trema tormentosa* (Cannabaceae), *Dillenia suffruticosa* (Dilleniaceae), Macaranga dan Mallotus (Euphorbiaceae) [15, 16, 17]. The species that attract birds and bats [16] include Trema, Mallotus and Macaranga throughout the season. Ficus also attracts frugivore to enter the forest structure [18]. The second factor that influences biodiversity is the increase of forest biomass as it becomes older [19]. In the case of habitat in *Acacia mangium* (H_1) the increase of forest biomass has no significant effect on the diversity of birds, but it is suspected that the fauna species (birds) have not been able to adapt to *A. mangium*. The leaves of *A. mangium* cannot be consumed by insects because they contain high tannins, and its litter that is still difficult to be decomposed by macrofauna soil. Therefore, the increased biomass in *A. mangium* has no impact on the increase of bird diversity. In the habitat represented by Teak plants (*Tectona grandis*), although the leaves cannot be decomposed by the majority of fauna, in a certain season (leaf falling), there are some insects/caterpillars that can utilize the litter/teak leaves. It is suspected that fauna is more adaptable to Teak species than it is to *A. mangium*.

5. Conclusion & Recommendation

5.1. Conclusion

The role of vegetation as a source of feed or foraging in the food chain is one of the causes of diversity of fauna (birds). It is assumed that if more energy is transferred in the form of feed to fauna, diversity will be increased. The transporter of energy from plant to fauna is more influenced by insects because insectivore birds are found to dominate in the succession of the 5^{th} year.

5.2. Recommendation

The need for appropriate species selection to accelerate the return of diversity of fauna species (birds) into the habitat. The selection of these species is mainly related to the needs of forage (fauna).

References

[1] Buehler, D.A., M.J. Welton, T.A. Beachy. “Predicting cerulean warbler habitat use in the Cumberland Mountains of Tennessee.” Journal of Wildlife Management, 2006, vol. 70, pp. 1763-1769,

[2] Darwin. Tropical Nature and Other Essays. on Tropical Nature, and other essay. ed: Wallace, A. R.,

1878, pp. 353

[3] Ngatiman & M. Budiono. Jenis-jenis gulma pada hutan tanaman dipterokarpa di Kalimantan Timur. Dinas Kehutanan Kalimantan Timur, Bogor, 2007, pp. 103.

[4] Mackinnon, J., K. Phillipps, B. van Ballen. Burung-burung di Sumatera, Jawa, Bali dan Kalimantan. Birdlife International, 1992, pp. 400.

[5] Ter Braak, C.J.F. & P. Smilauer. Canoco reference manual and user's guide to canoco for windows. Ithaca: Microcomputer Power, 1998, pp. 110.

[6] Krebs, C.J. 1989. "Ecological Methodology" in Statistics and partitioning of species diversity, and similarity among multiple communities, 1st ed. vol. 76. R.H. Lande, Ed. New York: Oikos, 1996, pp. 5–13.

[7] Balaž, M., M. Balažova. "Diversity and abundance of bird communities in three mountain forest stands: effect of the habitat heterogeneity." Pol Journal Ecology, vol. 60, pp. 629-634, 2012.

[8] Batary, P., S. Fronczek, C. Normann, C. Scherber, T. Tscharntke. "How do edge effect and tree species diversity change bird diversity and avian nest survival in Germany's largest deciduous forest?." Forest Ecology Management, vol. 319, pp. 44-50, 2014.

[9] Boer, C. "Keragaman avifauna pada lahan bekas tambang emas PT Kelian Equatorial Mining, Kutai Barat Kalimantan Timur." Jurnal Managemen Hutan Tropika, vol. 15(2), pp. 54-60, 2009.

[10] Singh, R., D.N. Kour, F. Ahmad, D.N. Sahi. "Species diversity, relative abundance and habitat use of the bird communities of Tehsil Chenani, District Udhampur, Jammu and Kashmir, India." Indian Journal. L. Science, vol. 2(2), pp. 81-90, 2013.

[11] Terborgh, J. Habitat selection in Amazonian birds. In: Cody, M.L. (Ed.), Habitat Selection in Birds. Academic Press, Inc., Orlando, 1985, pp. 311–338.

[12] Peh, K.S.H., J. de Jong, N.S. Sodhi, S.L.H. Lim, C.A.M. Yap. "Lowland rainforest avifauna and human disturbance: persistence of primar forest birds in selectively logged forests and mixed-rural habitats of southern Peninsular Malaysia." Biological Conservation, vol. 123, pp. 489–505, 2005.

[13] Edwards, D.P., F.A Ansell, A.H. Ahmad, R. Nilus, K.C. Hamer. "The value of rehabilitating logged rainforest for birds." Conservation Biology, vol. 23, pp. 1628–1633, 2009.

[14] Sheldon, F.H., A.R. Styring, P.A. Hosner. "Bird species richness in a Bornean exotic tree plantation: a long-term perspective." Biological Conservation, vol. 143: 399–407, 2010.

[15] Mitra, S. & F.H. Sheldon. "Use of an exotic tree plantation by Bornean lowland forest birds." Auk,

vol. 110, pp. 529–540, 1993.

[16] Kuusipalo, J., G. Adjers, Y. Jafarsidik, A. Otsamo, K. Tuomela, R. Vuokko. "Restoration of natural vegetation in degraded Imperata-Cylindrica grassland-understorey development in forest plantations." Journal of Vegetation Science, vol. 6, pp. 205-210, 1995.

[17] Otsamo, A. "Secondary forest regeneration under fast growing forest plantations on degraded Imperata cylindrica grasslands." New Forests, vol. 19, pp. 69–93, 2000.

[18] Zakaria, M. & M. Nordin. "Comparison of frugivory by birds in primary and logged lowland dipterocarp forests in Sabah, Malaysia." Tropical Biodiversity, vol. 5, pp. 1–9, 1998.

[19] Odum, E.P., 1969. Strategy of ecosystem development. Science. pp. 164-262.