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Vegetation Degradations of Wildlife Sanctuary Danau Pulau Besar Danau Bawah Siak District Riau Province

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Abstract: ***Wildlife Sanctuary of Danau Pulau Besar Danau Bawah is surrounded by a forest conservation area of timber industrial estates and villages inhabited by indigenous peoples where their lives are very dependent on the forest. The consequence of these conditions is that forest degradation is quite serious as the encroachment of trees and forest conversion practices to agriculture and plantations. This study aims to gain estimation on forest encroachment and total loss of trees resulting in a decline in floristic diversity in this region. Data collection on forest encroachment map using satellite imagery analysis was done by using Supervised Classification technique. The area assessed is conservation forest areas which has been encroached upon or degraded areas. Vegetation data were collected by using the plot method that illustrates the potential, type, density values, dominance of vegetation and its importance value index. The results of extensive analysis of vegetation encroachment illustrated the potential value of forest degradation rate. Conservation forests area was degraded up to± 2,339.73 in hectare or 8.29% of the total area, while the estimated loss due to the encroachment of trees during the period 1998 to 2012 reached 550,819.24 m3 or equal to 39,344.23 m3 trees per year, or 3,278.69 m3 per month and 109.29 m3 per day.***

Keyword: Vegetation Degradation of Forests, Forest Conservation, illegal logging

1. Introduction

Geographically forest conservation Danau Pulau Besar/Danau Bawah lies between 0°35'- 0°45' North latitude and 102°10' - 102°19' east longitude. This area is largely composed of peat swamp forest. Peat bogs occupy hollows between the two great rivers, can be shallow peat thickness of 0.5-1 m, and peat are 1-2 m thick and deep and very deep peat, the flow of water from acidic peat swamp forests and colored black or reddish with a low diversity fauna [1].

Conservation forests with an area 28,237.95 ha, is surrounded by a forest concession management concession Plant Industry of ± 150,000 ha, in the concession licensing are residential communities that depend on forests. The indigenous people have long interacted with the environment in and around the forest and has long use forest resources for generations.

The dependence of forest communities on forest resources, to meet the needs of life, is the cause of the pressure on forests [2]. Forest had been converted into agricultural land, plantations and settlements without regard to sustainability. People who depend on forest resources assume that the development and operation of logging and plantation concessions always associated with arbitrariness and the declining quality of their lives, distrust to the government and the concessions company continue to grow [3].

People's dependence on forest products and the breakdown of public access to forest areas, which were controlled by licensing concessions company, cause pressure on the conservation of forest area. This done by the community to meet the needs of the economy. This research aims to know the degradation rate of forest vegetation and to estimate the size of encroachment which caused in decreasing of forest resource in this area.

2. Material and Method

2.1. The Research Time and Place

This research was conducted in conservation forests of Danau Pulau Besar Danau Bawah Wildlife Sanctuary and starts on Februari 2013 until Februari 2014. The study area was located between plantation, forest conservation and villages (Fig. 1).

The area around the conservation-forest area of Danau Pulau Besar/Danau Bawah Wildlife Sanctuary has 1,977.20 mm of rainfall per year. According to the climate division Kappen, this area is groupped into tropical rain climate with Alfa type and monthly rainfall greater than 60 mm. The temperature of the hottest month was higher than 22°C (BMKG Pekanbaru, 2013).

The conservation-forest of Danau Pulau Besar/Danau Bawah Wildlife Sanctuary has a relatively flat topography. The landscape of this area is the expanse of lowland with the natural peat swamp forest vegetation almost in all parts of the area.The slope of this region range between 0% - 8%. Hydrologic system can be divided into streams, that are natural, and channels. The flowing pattern at the meeting point between the natural and channel flow is strongly

influenced by the drainage of channel system. Some rivers found in this area are Sungai Sejuk, Sungai Rasau and Sungai Rawa. Water entering the lake through rivers, channel and seepage from the surrounding area.

The water which were enter Danau Pulau Besar comes from Sungai Sejuk. Meanwhile, the water from Sungai Air Sejuk and Sungai Rasau, which is the outlet of Danau Pulau Besar, will go into Danau Bawah. Based on geospatial analysis, included in the watershed area of Rawa are the conservation-forest area of Danau Pulau Besar/Danau Bawah at the upstream and Sungai Rawa Village at the downstream.

2.2. Research Material

The data was collected by searching method which cover the map of study area, identification of plant species encountered, and measuring the extent of illegal logging by using image-satellite analysis. The analysis of satellite imagery maps was conducted using Supervised Classification technique and the data were processed using ER Mapper version 6.4 and ArcGIS 9.3 software [4]. Supervised Classification technique is a classification of pixel value based on the the pixel value of sample areas with known object types and spectral values. This technique was used to determine the appearance of difference segmented-area or region [5].

Satellite images which were used were a combination of Landsat imagery 5, 4, 2 bands issued by the National Institute of Aeronautics and Space (Space agency) from 1998 until 2012 and acquired in 2013. Area which was assessed with this technique is the conservation-forest area which observed as an open area or the area that has been cleared or degraded. Therefore, the size of forest area persector that have been degraded will be known.

In order to determine the condition of a forest area, things that should be taken into account is the stand density, species dominance, important value, and the stand volume of the species that were found in forest area. Data collection was carried out using purposive sampling technique. The plot was established on the area that are considered most representative to the condition of the forest area [6].

The plot was set in the conservation- forest of Danau Pulau Besar/Danau Bawah with coordinates $102^0$17'27.893 "E and $0^0$39'10.655" N. The plot made was an observation point with the size of 20m x 20m for tree. For tree level, the data record included species, diameter at breast height and tree height. Inside the sample plots were established sub sample plots with size 10m x 10m for the pole level. The data recorded were species, diameter at breast height, and plant height. Inside the sample sub-plot, the observations also conducted to a saplings and seedlings level with 5m x 5m and 2m x 2m size, respectively. The plot design can be seen in Figure 2 and 3.

Figure 3 shows the sub-plots that were in the plot, where A is a plot to plant seedlings with the size of 2m x 2m, B is a plot to plant saplings with the size of 5m x 5m, C is a plot to a small-trees plant with size 10m x 10m, and D is a plot to a tree-plant species with a size of 20m x 20m [7].

The data obtained from each sample plot, were used to calculate the density, frequency, dominance, importance value, and the volume of tree stand. This was conducted to find out the condition of forests, species diversity, density value, and the potential value of floristic [8]. Important value was calculated using Mueller and Elleberg formula [9].

$$RF = (\text{frequency of species } i / \text{sum frequencies of all species}) \times 100, \quad (1)$$

$$RD = (\text{number of individuals of species } i / \text{total number of individuals}) \times 100, \quad (2)$$

$$RDo = (\text{total basal area for species } i / \text{total basal area of all species}) \times 100, \quad (3)$$

$$RDi \text{ (relative diversity)} = (\text{number of species } i \text{ in family species } i / \text{total number of species}) \times 100. \quad (4)$$

$$IVI = RDi + RF + RDo \quad (5)$$

Calculating the volume of a tree to describe the potential of a forest area was conducted using the calculation of basal area and calculating the volume of a tree [10].

Stage 1. Calculate the diameter of the tree trunk

$$D = K / \pi \quad (6)$$

D = diameter of the trunk (cm), K = circumference of the tree trunk, and π = constants pi (3.1415)

Stage 2. Calculate the basal area

$$G = 1/4\ \pi.\ D^2 \quad (7)$$

G = tree basal area (cm^2), D = diameter of the trunk (cm), π = constants pi (3.1415)

Stage 3. Calculate the volume of trees

$$V = 1/4\ \pi.\ D^2.\ t.\ f \quad (8)$$

V = volume of trees (m3), D = diameter of the trunk (cm), π = constants pi (3.1415), t = height of the tree, the form factor, f = correction factor (0.7)

Estimation of the amount of potential loss of trees in cubication was calculated as follow:

$$\text{Estimation of the sum of the trees lost} = \text{the size of illegal logging x potential of logging per ha} \quad (9)$$

$$\text{Estimation of the sum of trees lost per year} = \text{sum of trees lost / duration of illegal logging} \quad (10)$$

$$\text{Estimation of trees lost per month} = \text{sum of trees lost per year / 12 months} \quad (11)$$

$$\text{Estimation of trees lost per day} = \text{sum of trees lost per month / 30 days} \quad (12)$$

3. Result

3.1. The Extensive of Illegal Logging

The results of supervised classification analysis showed that the vast amount of forest degradation that occurs as a result of illegal logging on forests conservation was ± 2,339.73 ha. of the overall conservation area which is ± 28,237.95 ha or 8.28%. The extent of this damage is obtained from the overlay map of satellite images in time series from 1998 until 2012.

The encroachment size of forest conservation showed a trends of enhancement. This is a serious pressure on the environment and biodiversity functions of conservation forest. The time series accumulation of encroachment on forest conservation area based on supervised classification data is presented at Table.1

The enhancement trends of encroachment can be seen in Figure 4 in which the area of encroachment is increasing year after year. From equation Y = 3E-13e0.155x, it has been seen the enhancement trends of encroachment from year to year so it can be predicted widespread encroachment in the coming years.

3.2 The Potential Value of Forest Vegetation

The area which was chosen as the plot through the analysis of the map, is an area that still has a good stand-density which was showed with its important value. This has been done to get the density value of vegetation that can represent the entire conservation-forest area. The density values obtained was benchmarked as a climax forest where the forest environment is going well.

Species density, frequency, dominance index, importance value, and timber potential-value of all sampling plot were consider as the reference in rehabilitation of a conservation forest, especially in areas that already degraded, encroached, and areas that had been occupied by the community. Observations which were carried out on 25 plots, restricted to ≥ 20 cm in diameter for the class of trees, and 10-20 cm for class of pole showed the variation of distribution of plant species. Important value in the whole plot for the class of trees can be seen in Table 2.

Shorea avalis has the highest important value in the tree class of all sampling plots, this indicated that Shorea avalis was dominant. This was also indicated by the value of the relative density, relative dominance and relative frequency (Table 2). The results of the collection and processing of data obtained from the plot of samples for the class of pole with a diameter of 10-20 cm can be seen in Table. 3. Within diameter class of 10-20 cm, the species with the highest important value was Shorea platycarpa. This value is correlated with the high value of relative density, relative dominance and relative frequency (Table 3).

4. Discussion

The result of calculation on timber potential of diameter class of ≥ 20 cm was 120.71 m3/ha, meanwhile timber potential for diameter class of 10-20 cm was 114.71 m3/ha. The important value index for each tree species range between 1.92 (*Santria tomentosa*) to 30.5 (*Shorea platycarpa*). This value indicated that Shore platycarpa has more important role in ecosystem compared to the other tree species. Furthermore, Santria tomentosa was revealed has no significant role in conservation forest.

The calculation of the volume of trees in the plot describes the condition of overall of forest conservation area where the potential value of the plot is used as a parameter estimate the value of trees lost due to illegal logging. By comparison, the potential value of floristic in peat swamp forest in the province of Central Kalimantan and Riau Province with new potential calculation result on peat swamp forest in the Kalimantan Tengah Province as many as 151 tree or 97.90 m3/ha whereas in peat swamp forest in Riau Province as much as 119 trees or 185.50 m3/ha [11].

While the results of the inventory of the existence of the vegetation on the Island Lake conservation forest area of the Lake bottom, note that the total number of plant species that are found as many as 116 types of plants consisting of 88 species of trees, 26 types of plants under and 2 types of aquatic plants. Plant species of tree in the family Dipterocarpaceae are dominant [12].

5. Conclusion

The Conservation forests have been degraded as a result of encroachment that occur in the region. Extensive encroachment during the period 1998 to 2012 reached ± 2,339.73 in hectares or 8.29% of the whole area. The results of calculations on 25 plots found 38 species of trees are dominated by species of Shorea avalist for classification of trees and Shorea platycarpa for classification of poles.

The measurement results of potential of the tree on the overall of plots is 127 stems or 120.71 m3, whereas for the classification tree pole size is 564 stems or 114.71 m3. Estimates of lost trees over a period of 14 years of encroachment reached 550,819.24 m3, with estimated lose of trees per year is 39,344.23 m3, an estimated lose of trees per month is 3,278.69 m3 and the estimated lose of trees per day is 109.29 m3.

Encroachment of forest conservation by the community as a result of close of public access to forest resources that resulted in loss of livelihood of the people as beneficiaries of non-timber forest products. The close of public access to forest resources is as a result of forest plantation development by companies granted concessions of forest management for purposes industrial raw materials.

Government and the concessionaire suggested forming a community development organization forest farmer groups, through a pattern of social forestry. With the management of

intercropping together with the community in which the industrial plantations do integrated between forestry plants and agricultural plants. Thus eliminating dependence and pressure on the forest of conservation.

Needs to foster and cadre of community members who are in the farmers groups through agricultural extension services, forestry, and the environment is necessary so public awareness for environmental protections can be increased and become an awareness of himself and his family.

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Author Profile

Tri Handro Pramono, A student of environmental sciences doctoral program at Riau University, Indonesia. which is a graduate of Master MB-IPB Bogor Indonesia in 2008 and has also studied at the Faculty of Forestry of Gadjah Mada University Yogyakarta and graduated in 2000.

Bintal Amin, A professor of environmental sciences at Riau University, Indonesia also Dean of Faculty of Fisheries and Marine Sciences, Riau University, Indonesia.

Syafriadiman, A Professor Faculty of Fisheries and Marine Sciences, Riau University, Indonesia.

Radith Mahatma, Chairman of the Biology Department at Faculty of Mathematics and Natural Sciences, Riau University, Indonesia.

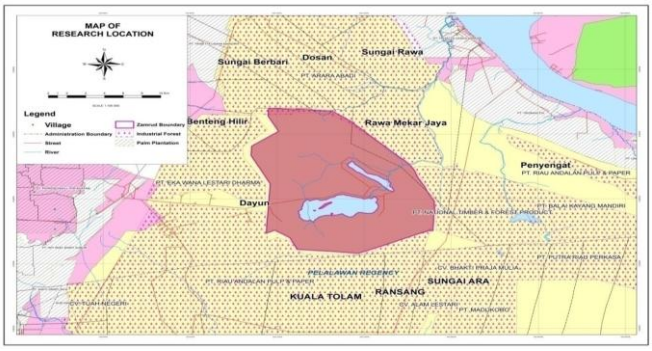

Figure 1: The research location

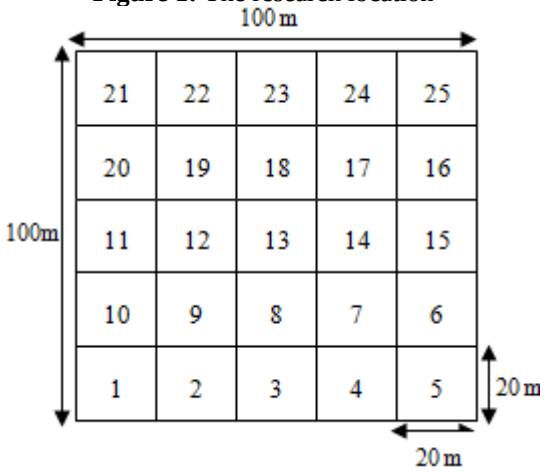

Figure 2: The design of sample plots

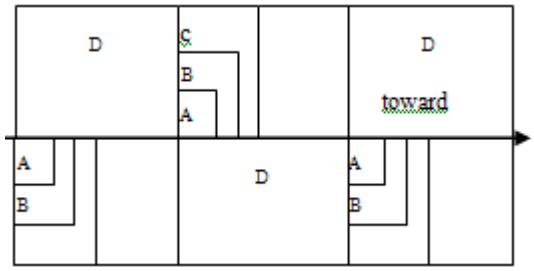

Figure 3: The design of the section sample Plots

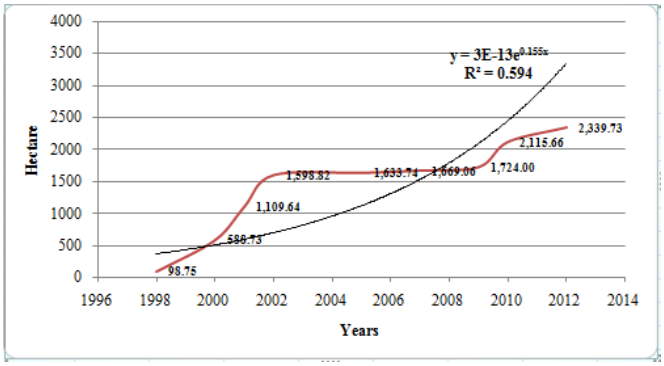

Figure 4: The increase in encroachment of Conservation forest Area

Table 1: Size of accumulation of encroachment on forest-conservation area

Year	Size of encroachment (hectare)	Accumulation (hectare)
1998	98.75	98.75
2000	489.98	588.73
2001	520.91	1.109.64
2002	489.18	1.598.82
2005	34.92	1.633.74
2007	35.32	1.669.06
2009	54.94	1.724.00
2010	391.66	2.115.66
2012	224.07	2.339.73

Table 2: The Important Value Index per Tree Species with Diameter Class ≥ 20 cm

No	SPECIES		D	RDi (%)	Dominance	RDo (%)	F	RF (%)	IVI
	Name of Scientific	Family							
1	*Shorea avalis*	*Dipterocarpace*	12	9.45	7,013.60	8.48	0.44	8.87	26.80
2	*Shorea platycarpa*	*Dipterocarpace*	9	7.09	7,090.28	8.57	0.32	6.45	22.11
3	*Gonystylus bancanus*	*Thymelaeaceae*	7	5.51	5,873.64	7.10	0.28	5.65	18.26
4	*Melanorrhoea walihii*	*Anacardiaceae*	6	4.72	4,535.84	5.48	0.24	4.84	15.05
5	*Palaquium leiocarpum*	*Sapotaceae*	6	4.72	3,527.05	4.26	0.24	4.84	13.83
6	*Arthocarpus elasticus*	*Moraceae*	5	3.94	4,299.51	5.20	0.2	4.03	13.17
7	*Calophyllum soulattri*	*Guttiferae*	5	3.94	3,761.70	4.55	0.2	4.03	12.52
8	*Alstonia angustifolia*	*Apocynaceae*	5	3.94	3,507.40	4.24	0.2	4.03	12.21
9	*Xylopia fusca*	*Annonaceae*	5	3.94	2,687.84	3.25	0.2	4.03	11.22
10	*Tetramerista glabra*	*Tetrameristacea*	5	3.94	2,466.63	2.98	0.2	4.03	10.95
11	*Koompassia*	*Leguminosae*	4	3.15	3,507.48	4.24	0.16	3.23	10.62
12	*Litsea grandis*	*Lauraceae*	4	3.15	1,976.86	2.39	0.16	3.23	8.77
13	*Paratocarpus*	*Moraceae*	3	2.36	2,453.26	2.97	0.12	2.42	7.75
14	*Dyera lowii*	*Apocynaceae*	3	2.36	1,848.48	2.23	0.12	2.42	7.02
15	*Anisoptera marginata*	*Dipterocarpace*	3	2.36	1,791.60	2.17	0.12	2.42	6.95
16	*Diospyros marphylla*	*Ebenaceae*	3	2.36	1,777.05	2.15	0.12	2.42	6.93
17	*Myristica lowiana*	*Myristicaceae*	3	2.36	1,730.99	2.09	0.12	2.42	6.87
18	*Syzygium kiahii*	*Myristicaceae*	3	2.36	1,605.23	1.94	0.12	2.42	6.72
19	*Arthocarpus kemandu*	*Moraceae*	3	2.36	1,518.60	1.84	0.12	2.42	6.62
20	*Durio carinatus*	*Bombacaceae*	2	1.57	1,754.61	2.12	0.08	1.61	5.31
21	*Dialium patens*	*Leguminosae*	2	1.57	1,350.52	1.63	0.08	1.61	4.82
22	*Rhodamnia cineria*	*Myrtaeae*	2	1.57	1,343.44	1.62	0.08	1.61	4.81
23	*Camnosperma*	*Anacardiaceae*	2	1.57	1,221.26	1.48	0.08	1.61	4.66
24	*Garcinia nigrolineata*	*Guttiferae*	2	1.57	1,204.80	1.46	0.08	1.61	4.64
25	*Ganua motleyana*	*Sapotaceae*	2	1.57	1,153.41	1.39	0.08	1.61	4.58
26	*Tristaniopsis obovata*	*Myrtaceae*	2	1.57	1,139.17	1.38	0.08	1.61	4.56
27	*Dacryodes macrocarpa*	*Burseraceae*	2	1.57	1,070.36	1.29	0.08	1.61	4.48
28	*Heritiera spec*	*Sterculiaceae*	2	1.57	1,047.77	1.27	0.08	1.61	4.45
29	*Aglaia rubiginosa*	*Meliaceae*	2	1.57	1,007.44	1.22	0.08	1.61	4.41
30	*Cratoxylon arborescens*	*Hypericaceae*	2	1.57	993.52	1.20	0.08	1.61	4.39
31	*Shorea uliginosa*	*Dipterocarpace*	2	1.57	956.53	1.16	0.08	1.61	4.34
32	*Dillenia reticulta*	*Dilleniaceae*	2	1.57	870.94	1.05	0.08	1.61	4.24
33	*Vatica rassak*	*Dipterocarpace*	2	1.57	1,423.94	1.72	0.04	0.81	4.10
34	*Santria tomentosa*	*Burseraceae*	1	0.79	860.36	1.04	0.04	0.81	2.63
35	*Parastemon urophyllym*	*Rosaceae*	1	0.79	748.44	0.90	0.04	0.81	2.50
36	*Sapium discolor*	*Euphorbiaceae*	1	0.79	602.08	0.73	0.04	0.81	2.32
37	*Ficus* sp	*Moraceae*	1	0.79	534.86	0.65	0.04	0.81	2.24
38	*Cratoxyllum formosum*	*Hypericaceae*	1	0.79	471.63	0.57	0.04	0.81	2.16
	Total		127	100	82,728.15	100	4.96	100	300

Table 3: The Important Value per tree species diameter of class 10-20cm

No	SPECIES		D	RDi (%)	Dominance	RDo (%)	F	RF (%)	IVI
	Name of Scientific	Family							
1	*Shorea platycarpa*	*Dipterocarpacea*	56	9.93	11,553.98	10.38	0.5	10.22	30.53
2	*Melanorrhoea walihii*	*Anacardiaceae*	52	9.22	9,903.73	8.90	0.4	8.03	26.14
3	*Palaquium leiocarpum*	*Sapotaceae*	36	6.38	8,641.58	7.76	0.3	6.57	20.71
4	*Xylopia fusca*	*Annonaceae*	32	5.67	5,691.00	5.11	0.3	5.84	16.62
5	*Shorea avalis*	*Dipterocarpacea*	28	4.96	4,990.44	4.48	0.2	5.11	14.56
6	*Calophyllum soulattri*	*Guttiferae*	28	4.96	4,627.32	4.16	0.2	5.11	14.23
7	*Dillenia reticulta*	*Dilleniaceae*	24	4.26	5,516.32	4.95	0.2	4.38	13.59
8	*Dyera lowii*	*Apocynaceae*	24	4.26	4,803.27	4.31	0.2	4.38	12.95

9	*Shorea uliginosa*	*Dipterocarpacea*	20	3.55	4,339.44	3.90	0.2	3.65	11.09
10	*Litsea grandis*	*Lauraceae*	20	3.55	2,870.95	2.58	0.2	3.65	9.77
11	*Diospyros marphylla*	*Ebenaceae*	20	3.55	2,985.50	2.68	0.1	2.92	9.15
12	*Koompassia malaccensis*	*Leguminosae*	16	2.84	3,261.05	2.93	0.1	2.92	8.69
13	*Tetramerista glabra*	*Tetrameristaceae*	16	2.84	3,073.64	2.76	0.1	2.92	8.52
14	*Syzygium kiahii*	*Myristicaceae*	16	2.84	2,808.11	2.52	0.1	2.19	7.55
15	*Durio carinatus*	*Bombacaceae*	12	2.13	3,060.67	2.75	0.1	2.19	7.07
16	*Rhodamnia cineria*	*Myrtaeae*	12	2.13	2,708.68	2.43	0.1	2.19	6.75
17	*Garcinia nigrolineata*	*Guttiferae*	12	2.13	2,588.73	2.33	0.1	2.19	6.64
18	*Heritiera spec*	*Sterculiaceae*	12	2.13	2,522.86	2.27	0.1	2.19	6.58
19	*Dacryodes macrocarpa*	*Burseraceae*	12	2.13	2,400.36	2.16	0.1	2.19	6.47
20	*Vatica rassak*	*Dipterocarpacea*	12	2.13	2,267.36	2.04	0.1	2.19	6.35
21	*Tristaniopsis obovata*	*Myrtaceae*	8	1.42	2,220.91	1.99	0.0	1.46	4.87
22	*Myristica lowiana*	*Myristicaceae*	8	1.42	1,721.36	1.55	0.0	1.46	4.42
23	*Arthocarpus kemandu*	*Moraceae*	8	1.42	1,586.14	1.42	0.0	1.46	4.30
24	*Gonystylus bancanus*	*Thymelaeaceae*	8	1.42	1,516.14	1.36	0.0	1.46	4.24
25	*Paratocarpus venenosus*	*Moraceae*	8	1.42	1,466.82	1.32	0.0	1.46	4.20
26	*Anisoptera marginata*	*Dipterocarpacea*	8	1.42	1,423.94	1.28	0.0	1.46	4.16
27	*Camnosperma coriaceum*	*Anacardiaceae*	8	1.42	1,390.85	1.25	0.0	1.46	4.13
28	*Dialium patens*	*Leguminosae*	8	1.42	1,376.14	1.24	0.0	1.46	4.11
29	*Arthocarpus elasticus*	*Moraceae*	8	1.42	1,110.22	1.00	0.0	1.46	3.88
30	*Alstonia angustifolia*	*Apocynaceae*	4	0.71	1,223.09	1.10	0.0	0.73	2.54
31	*Parastemon urophyllym*	*Rosaceae*	4	0.71	1,033.77	0.93	0.0	0.73	2.37
32	*Ganua motleyana*	*Sapotaceae*	4	0.71	962.50	0.86	0.0	0.73	2.30
33	*Aglaia rubiginosa*	*Meliaceae*	4	0.71	962.50	0.86	0.0	0.73	2.30
34	*Sapium discolor*	*Euphorbiaceae*	4	0.71	893.77	0.80	0.0	0.73	2.24
35	*Cratoxylon arborescens*	*Hypericaceae*	4	0.71	763.95	0.69	0.0	0.73	2.13
36	*Cratoxyllum formosum*	*Hypericaceae*	4	0.71	534.86	0.48	0.0	0.73	1.92
37	*Santria tomentosa*	*Burseraceae*	4	0.71	534.86	0.48	0.0	0.73	1.92
Total			564	100	111,336.83	100	5.4	100	300