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attributes (***Principle 1: Structure and composition of forest ecosystem are maintained***); functional attributes (***Principle 2: Forest ecosystem function is maintained***); and disturbance aspects (***Principle 3: Disturbance sign should be under control***). The criteria and indicators were appropriately rephrased and added under each principle. At the end of this phase, the revision set of C&I was generated. In addition, remarking that there is a new adding indicator named "number of digging hole" which is suggested from consensus of local team in the Criterion 1 (*To limit human disturbance*) of Principle 3 (*Disturbance sign should be under control*). This indicator represents the site-specific of human disturbance according to harvesting activities of local people. Assessing and monitoring this indicator will reflect harvesting intensity of some NTFPs. After the revision process, C&I consist of 3 principles, 7 criteria, and 41 indicators as showed in Table 4.3.

Table 4.3 The revision set of criteria and indicators

Principle 1: Structure and composition of forest ecosystem are maintained
Criterion 1.1: To maintain landscape heterogeneity
Indicator 1.1.1: Areal extent of each patch/vegetation type to total forest area
Indicator 1.1.2: Number of patches/vegetation type per unit area
Indicator 1.1.3: Largest patch size/vegetation type
Indicator 1.1.4: Number of gap
Indicator 1.1.5: Largest gap size
Indicator 1.1.6: Gap distribution pattern
Indicator 1.1.7: Average, minimum, and maximum distance between patches of the same cover type
Indicator 1.1.8: Area-weight patch/vegetation size
Criterion 1.2: To improve and maintain habitat heterogeneity
Indicator 1.2.1: Distribution in vertical stratification
Indicator 1.2.2: Percentage of canopy cover
Indicator 1.2.3: Frequency distribution of leaf size and shape
Indicator 1.2.4: Percentage of similarity of vegetation community
Criterion 1.3: To improve and maintain richness/diversity
Indicator 1.3.1: Species richness of vegetation
Indicator 1.3.2: Abundance of key stone species
Indicator 1.3.3: Abundance of nest of social bee
Indicator 1.3.4: Abundance of bird species
Indicator 1.3.5: Abundance of butterfly species
Criterion 1.4:To monitor population sizes and demographic structures of selected group
Indicator 1.4.1: Density and size class distribution of tree
Indicator 1.4.2: Height class distribution of sapling
Indicator 1.4.3: Percentage of sapling and seedling

Table 4.3 The revision set of criteria and indicators (continued)

Principle 2: Forest ecosystem function is maintained
Criterion 2.1: To conserve soil and water
Indicator 2.1.1: Frequency occurrence of detritivorous soil fauna of selected group
Indicator 2.1.2: Soil pH and conductivity
Indicator 2.1.3: Decomposition rate determines from leaf bag
Indicator 2.1.4: Quantity of leaf litters and small woody debris (under 10-cm diameter)
Indicator 2.1.5: Abundance of epiphytic species
Indicator 2.1.6: Abundance of epiphytic mosses
Indicator 2.1.7: Abundance of herbaceous bole climbers
Indicator 2.1.8: Abundance of amphibian species
Indicator 2.1.9: Percentage of ground cover
Indicator 2.1.10: Soil nutrient contents
Indicator 2.1.11: Frequency occurrence of soil erosion
Criterion 2.2: To improve and maintain yield and forest products
Indicator 2.2.1: Basal area of tree
Indicator 2.2.2: Above ground biomass of tree
Indicator 2.2.3: Number of species removed from the forest (for sale/subsistence use)
Indicator 2.2.4: Quantity of certain species harvested from the forest
Principle 3: Disturbance sign should be under control
Criterion 3.1: To limit human disturbances
Indicator 3.1.1: Number of stumps
Indicator 3.1.2: Frequency occurrence of charcoals/burned logs
Indicator 3.1.3: Frequency occurrence of fire
Indicator 3.1.4: Frequency occurrence of garbage/wastes
Indicator 3.1.5: Number and distance of walkways/trails in forest area
Indicator 3.1.6: Number of digging hole

4.3 PHASE II: FILTERING AND TESTING INITIAL SET OF CRITERIA AND INDICATORS

During this step, the experimental plots were set up under the scientific methodology in the context of ecology. Standard methods to gather the parameters that reveal to each C&I were used. Team members were accustomed to the scientific method and learned that how to measure the parameters of each indicators. Some parameters of indicators, which cannot be gathered in the experimental plots will be discussed later in the desk exercise processes and/or gathered by questionnaires.

Step I: General filter

Scoring and ranking were used in general filter. After the field experiment, each team members were asked to score to each indicator following the 0-5 score method and score 0 or 1 for the Importance/Priority in scoring method as showed in Table 4.4. The numeric nine-point scale was assigned for indicator ranking in ranking method as showed in Table 4.5. Participants were encouraged to express their opinions in a consensus without divulging their score to other members.

Table 4.4 Analysis of score of indicators

C&I	Mean				Mean*	Importance/ Priority
	Relate to goal	Understandable/ Practical	Precision	Cost-effective		
Principle 1						
Criterion 1.1						
I 1.1.1	0	0	0	0	0	0
I 1.1.2	0	0	0	0	0	0
I 1.1.3	0	0	0	0	0	0
I 1.1.4	0	0	0	0	0	0
I 1.1.5	0	0	0	0	0	0
I 1.1.6	0	0	0	0	0	0
I 1.1.7	0	0	0	0	0	0
I 1.1.8	0	0	0	0	0	0
Criterion 1.2						
I 1.2.1	4	3	3	4	3	1
I 1.2.2	3	4	3	4	3	1
I 1.2.3	1	0	1	0	0	0
I 1.2.4	3	2	3	2	2	1
Criterion 1.3						
I 1.3.1	5	5	4	4	4	1
I 1.3.2	1	0	0	0	0	0
I 1.3.3	5	5	4	4	4	1
I 1.3.4	5	5	4	4	4	1
I 1.3.5	5	4	4	4	4	1
Criterion 1.4						
I 1.4.1	4	4	4	3	3	1
I 1.4.2	5	5	4	4	4	1
I 1.4.3	5	4	3	3	3	1
Principle 2						
Criterion 2.1						
I 2.1.1	4	3	3	4	3	1
I 2.1.2	2	3	3	2	2	1
I 2.1.3	2	4	3	3	3	0
I 2.1.4	4	5	4	4	4	1
I 2.1.5	2	3	3	3	2	1
I 2.1.6	1	1	1	1	1	0
I 2.1.7	2	3	4	3	3	1
I 2.1.8	5	5	5	5	4	1
I 2.1.9	4	3	3	3	3	1
I 2.1.10	0	0	0	1	0	0
I 2.1.11	4	4	4	4	4	1

Table 4.4 Analysis of score of indicators (continued)

C&I	Mean				Mean*	Importance/ Priority
	Relate to goal	Understandable/ Practical	Precision	Cost-effective		
Criterion 2.2						
I 2.2.1	4	2	3	2	3	1
I 2.2.2	2	1	2	1	1	0
I 2.2.3	5	5	4	4	4	1
I 2.2.4	5	3	3	3	3	1
Principle 3						
Criterion 3.1						
I 3.1.1	5	5	4	3	4	1
I 3.1.2	5	5	4	3	4	1
I 3.1.3	5	5	4	3	4	0
I 3.1.4	4	5	5	5	4	1
I 3.1.5	0	0	0	1	0	0
I 3.1.6	5	5	5	5	4	1

* Calculate from all score of participants and round up/down (see Appendix, Table A1)

Table 4.5 Analysis of rank of indicators

C&I	Rank			Summation	Mean	SD	Relative weight
	Participant 1	Participant 2	Participant 3				
Principle 1							
Criterion 1.1							
I 1.1.1*	1	1	1	3	1	0.00	13
I 1.1.2*	1	1	1	3	1	0.00	13
I 1.1.3*	1	1	1	3	1	0.00	13
I 1.1.4*	1	1	1	3	1	0.00	13
I 1.1.5*	1	1	1	3	1	0.00	13
I 1.1.6*	1	1	1	3	1	0.00	13
I 1.1.7*	1	1	1	3	1	0.00	13
I 1.1.8*	1	1	1	3	1	0.00	13
Criterion 1.2							
I 1.2.1	7	8	8	23	8	0.58	40
I 1.2.2	5	6	7	18	6	1.00	31
I 1.2.3*	1	1	1	3	1	0.00	5
I 1.2.4	4	5	5	14	5	0.58	24
Criterion 1.3							
I 1.3.1	9	9	9	27	9	0.00	28
I 1.3.2*	2	2	2	6	2	0.00	6
I 1.3.3	8	8	7	23	8	0.58	23
I 1.3.4	7	6	6	19	6	0.58	19
I 1.3.5	8	8	7	23	8	0.58	23
Criterion 1.4							
I 1.4.1	6	6	7	19	6	0.58	29
I 1.4.2	8	7	7	22	7	0.58	34
I 1.4.3	8	8	8	24	8	0.00	37

Table 4.5 Analysis of rank of indicators (continued)

C&I	Rank			Summation	Mean	SD	Relative weight
	Participant 1	Participant 2	Participant 3				
Principle 2							
Criterion 2.1							
I 2.1.1	7	8	7	22	7	0.58	13
I 2.1.2	4	3	3	10	3	0.58	6
I 2.1.3*	6	6	5	17	6	0.58	10
I 2.1.4	8	8	7	23	8	0.58	14
I 2.1.5	3	3	4	10	3	0.58	6
I 2.1.6*	2	2	1	5	2	0.58	3
I 2.1.7	3	2	2	7	2	0.58	4
I 2.1.8	7	7	8	22	7	0.58	13
I 2.1.9	9	8	8	25	8	0.58	15
I 2.1.10*	1	1	2	4	1	0.58	2
I 2.1.11	9	8	8	25	8	0.58	15
Criterion 2.2							
I 2.2.1	7	6	7	20	7	0.58	25
I 2.2.2*	3	3	3	9	3	0.00	11
I 2.2.3	9	9	8	26	9	0.58	33
I 2.2.4	8	8	8	24	8	0.00	30
Principle 3							
Criterion 3.1							
I 3.1.1	9	9	9	27	9	0.00	21
I 3.1.2	8	7	6	21	7	1.00	17
I 3.1.3*	8	7	6	21	7	1.00	17
I 3.1.4	8	8	7	23	8	0.58	18
I 3.1.5*	1	3	3	7	2	1.15	6
I 3.1.6	9	9	9	27	9	0.00	21

* Considered to be omitted

From the results of scoring and ranking as showed in Table 4.4 and Table 4.5, respectively the following observation can be noted:

1. There were given a medium to high mean score (2-5) of the indicators that Accepted to further analysis (given score = 1 of Importance/Priority) and the indicators that rejected to further analysis (given Importance/Priority score = 0) that also given a low mean score (0-1). The exception was for indicator 2.1.3 (*Decomposition rate determines from leaf bag*) and 3.1.3 (*Frequency occurrence of fire*) (Table 4.4) as described after this.

2. Consider the mean score, ranking results, and Importance/Priority (accepted/rejected to further evaluation) the indicators those considered to be omitted were:

For Principle 1 (***Structure and composition of forest ecosystem are maintained***); Criterion 1.1 (*To maintain landscape heterogeneity*), all members exhibited the same evaluation that all indicators were assigned as "not applicable criteria or indicator" (score = 0). In addition, weakly importance (rank = 1) were assigned to all indicators in this criterion. Team members suggested that all indicators under Criterion 1.1, at this time, did not prior to be conducted for their management practices. From the study found that Nong Meg-Nong Hee are considered as a small-scale area and classified to the secondary dry dipterocarp forest. Forest areas were covered with sparsely distributed trees and crown cover of each stands which more or less broken and rarely continuous, thus creating numerous canopies opening. Forest areas are quite homogeneously according to no other forest type or other ecosystem type found in forest area. In addition, all indicators under Criterion 1.1 which intend to quantify the heterogeneity of landscape pattern (Krummel et al., 1987; O'neill et al., 1988; Turner and Gardner, 1991; Gustafson and Parker, 1992; Gustafson et al., 1994 cited in Stork, et al., 1997; McGarigal and Cushman, 2002) need the specific techniques and equipment to analyze, thus they were considered to be not applicable at this forest management level. Therefore, all indicators under this criterion were rejected.

For Principle 1; Criterion 1.2; I 1.2.3 (*Frequency distribution of leaf size and shape*) was assigned "not applicable criteria or indicator" (score = 0) and its relative weight (5) assigned to the lowest rank compared to other indicators under the same criterion and team consensus did not accept it for further evaluation (Importance/Priority = 0). Even though it could be identified leaf size and shape of tropical litter fall but it was difficult to categorize them into the different guilds such as pioneer guild as can be done in the area that has low species diversity like the temperate zone. Moreover, adaptation of leaf size and shape according to environmental stress and diseases require a long period of time.

For Principle 1; Criterion 1.3; I 1.3.2 (*Abundance of key stone species*) was assigned "not applicable criteria or indicator" (score = 0) and was assigned to the lowest rank compared to other indicators under the same criterion and team did not accept it for further evaluation (Importance/Priority = 0). This indicator is difficult to understand and to put into practice and also not cost-effective one. Concept of keystone species is still questionable and to identify keystone species need further specific study (Mills, Soulé, and Doak, 1993; Folke, et al. 1993; Stork, et al., 1997; Simberloff, 1998; Piraino and Fanelli, 1999).

For Principle 2; Criterion 2.1; I 2.1.10 (*Soil nutrient contents*) and of Principle 3; Criterion 3.1; I 3.1.5 (*Number and distance of walkway/trail in forest area*) were assigned "not applicable criteria or indicator" (score = 0) and its relative weight (2, and 6, respectively) was assigned to the lowest rank compared to other indicator under the same criterion and the team did not accept them for further evaluation (Importance/Priority = 0). Because of analyzing nutrient contents in soil need a special knowledge and costly and according to the pattern of cultural forest utilities, road or trail patterns are complex and occurred throughout forest area. To measure these indicators was considered a troublesome work and was considered to be costly. However, for I 3.1.5, there was another indicator can be substituted to use such as I 2.1.9 (*Percentage of ground cover*) that could represent the impact of walkway or trail on ground vegetation. However, it could be noted that there were some indicators those were not assigned the mean score = 0 but team did not accept for further evaluation. There were:

For Principle 2; Criterion 2.1; I 2.1.3 (*Decomposition rate determines from leaf bag*) was assigned "acceptable" (score = 3). Even though its relative weight (10) did not assign to the lowest rank but it was rejected for further evaluation (Importance/Priority = 0). Field observation found that decomposing activities of termites was highly significant and very fast (say approximately 50 days after buried). Leaf litters and litter bag were lost according to decomposing and human activities. Moreover, too little of litter mass (compare to 1 kg of initial weight) was left for weighting with field weighting meter. However, there was I 2.1.1 (*Frequency occurrence of detritivorous soil fauna of selected group*) which is timely and indirectly correlated to litter mass lost (Crossley and Hoglund 1962; Seastedt, 1984) which considered from local team as the substitution. Anyway, the average rank of this indicator was 6 (considered as important one) in this case this indicator might be taken back to the C&I list.

For Principle 2; Criterion 2.1; I 2.1.6 (*Abundance of epiphytic mosses*) was assigned "extremely weak performance or strongly unfavorable" (score = 1) compare to other indicator under the same criterion and was rejected for further evaluation (Importance/Priority = 0). Because this indicator might not be suitable in xeric forest like dry dipterocarp forest and there was no data available to measure. Epiphytic mosses are commonly found in densely hydric forest like evergreen forests.

For Principle 2; Criterion 2.2; I 2.2.2 (*Above ground biomass of tree*) was assigned the mean score = 1 but its relative weight (11) was the lowest rank and was rejected for further evaluation (Importance/Priority = 0). At this moment for the team members, although it is a useful indicator but calculating procedure with the complex biomass allometric equation need a computer spreadsheet program such as Microsoft office excels which cannot be conducted by themselves. Moreover, cutting tree will not permit in this area according to the regulation rules and harvesting activities are no longer pole removal or logging operation for charred burning. Thus, at this time, this indicator was not necessary to be conducted. Furthermore, above ground biomass of tree can calculate directly from dbh and basal area datasets (Ogawa et al., 1965) which already assigned in I 2.2.1 (*Basal area of tree*) under Criterion 2.2 (*To improve and maintain yield and forest products*). Thus, using the easier and more practically indicators should be suitable.

For Principle 3; Criterion 3.1; I 3.1.3 (*Frequency occurrence of fire*) was assigned the mean score = 4 and its relative weight (17) was not the lowest rank, because it refer to measure the same human impact as I 3.1.2 (*Frequency occurrence of charcoals/burned log*s). However, the latter was easier to observe, and it was better to use as a pre-cautious indicator. Again, the average rank of this indicator was 7 (considered as very strongly important). However, there was no sign of fire occurred in the experimental plots but sign of charred around the forest edge outside the plots.

At the end of this step, some indicators were omitted from the list. Thus, the final set of C&I consisted of 3 principles, 6 criteria, and 25 indicators as showed in Table 4.6.

Table 4.6 Set of criteria and indicators after Phase I: General filter

Principle 1: Structure and composition of forest ecosystem are maintained
Criterion 1.2: To improve and maintain habitat heterogeneity
Indicator 1.2.1: Distribution in vertical stratification
Indicator 1.2.2: Percentage of canopy cover
Indicator 1.2.4: Percentage of similarity of vegetation community
Criterion 1.3: To improve and maintain richness/diversity
Indicator 1.3.1: Species richness of vegetation
Indicator 1.3.3: Abundance of nest of social bee
Indicator 1.3.4: Abundance of bird species
Indicator 1.3.5: Abundance of butterfly species
Criterion 1.4:To monitor population sizes and demographic structures of selected group
Indicator 1.4.1: Density and size class distribution of tree
Indicator 1.4.2: Height class distribution of sapling
Indicator 1.4.3: Percentage of sapling and seedling
Principle 2: Forest ecosystem function is maintained
Criterion 2.1: To conserve soil and water
Indicator 2.1.1: Frequency occurrence of detritivorous soil fauna of selected group
Indicator 2.1.2: Soil pH and conductivity
Indicator 2.1.4: Quantity of leaf litters and small woody debris (under 10-cm diameter)
Indicator 2.1.5: Abundance of epiphytic species
Indicator 2.1.7: Abundance of herbaceous bole climbers
Indicator 2.1.8: Abundance of amphibian species
Indicator 2.1.9: Percentage of ground cover
Indicator 2.1.11: Frequency occurrence of soil erosion
Criterion 2.2: To improve and maintain yield and forest products
Indicator 2.2.1: Basal area of tree
Indicator 2.2.3: Number of species removed from the forest (for sale/subsistence use)
Indicator 2.2.4: Quantity of certain species harvested from the forest
Principle 3: Disturbance sign should be under control
Criterion 3.1: To limit human disturbances
Indicator 3.1.1: Number of stumps
Indicator 3.1.2: Frequency occurrence of charcoals/burned logs
Indicator 3.1.4: Frequency occurrence of garbage/wastes
Indicator 3.1.6: Number of digging hole

Step II: Fine filter

The set of C&I from Step I was fine filtered in the Analytic Hierarchy Process called pairwise comparisons. Again, team members were asked to fill the quantitative score to each indicator under each criterion following the numeric nine-point scale individually but freely and openly discuss their opinions to other members. Another desirable feature of pairwise comparisons is that its degree of inconsistency of each criterion relative to each judgment (C.I.) can be measured. The analysis of pairwise comparisons of indicators was showed in Table 4.7.

Table 4.7 Analysis of pairwise comparisons

C&I	Pairwise comparisons (relative weight)			Average relative weight (w)	SD
	Participant 1	Participant 2	Participant 3		
Principle 1					
Criterion 1.2					
I 1.2.1	67	62	67	65 (1)	2.62
I 1.2.2	23	22	23	23 (2)	0.39
I 1.2.4	10	16	10	12 (3)	3.01
C.I.	0.07 (7%)	0.08 (8%)	0.07 (7%)		
Criterion 1.3					
I 1.3.1	58	63	58	60 (1)	3.13
I 1.3.3	20	16	19	18 (2)	2.21
I 1.3.4	7	7	7	7 (4)	0.24
I 1.3.5	15	14	17	15 (3)	1.47
C.I.	0.05 (5%)	0.03 (3%)	0.03 (3%)		
Criterion 1.4					
I 1.4.1	10	11	10	10 (3)	0.57
I 1.4.2	28	26	25	27 (2)	1.71
I 1.4.3	62	63	65	64 (1)	1.69
C.I.	0.06 (6%)	0.03 (3%)	0.01 (1%)		
Principle 2					
Criterion 2.1					
I 2.1.1	11	12	13	12 (4)	0.97
I 2.1.2	5	4	6	5 (6)	1.07
I 2.1.4	11	8	11	10 (5)	1.60
I 2.1.5	3	3	3	3 (7)	0.33
I 2.1.7	2	2	3	2 (8)	0.27
I 2.1.8	15	21	12	16 (3)	4.64
I 2.1.9	25	21	23	23 (2)	2.19
I 2.1.11	28	29	29	29 (1)	0.50
C.I.	0.15 (15%)	0.12 (12%)	0.15 (15%)		
Criterion 2.2					
I 2.2.1	6	7	6	6 (3)	0.49
I 2.2.3	64	59	58	60 (1)	3.08
I 2.2.4	30	34	37	34 (2)	3.27
C.I.	0.08 (8%)	0.01 (1%)	0.07 (7%)		
Principle 3					
Criterion 3.1					
I 3.1.1	56	52	45	51 (1)	5.37
I 3.1.2	14	16	15	15 (3)	1.19
I 3.1.4	6	7	7	7 (4)	0.77
I 3.1.6	25	25	33	27 (2)	4.78
C.I.	0.09 (9%)	0.07 (7%)	0.08 (8%)		

Based on Table 4.7, the average relative weights (*w*) of pairwise comparisons were sufficiently differentiated in term of magnitude that can be served as a basis for prioritizing indicators under each criterion. However, the prioritizing order of indicators did not fully reflect their ecological importance, but reflect the order of concern in local team's perception. The priority of each indicator under each criterion can be described as follow:

Principle 1 (*Structure and composition of forest ecosystem are maintained*)

Criterion 1.2 (*To improve and maintain habitat heterogeneity*): The ranks of priority were I 1.2.1 (*Distribution in vertical stratification*), I 1.2.2 (*Percentage of canopy cover*), and I 1.2.4 (*Percentage of similarity of vegetation community*) which assigned following the average relative weights of pairwise comparisons (65, 23, and 12, respectively).

Criterion 1.3 (*To improve and maintain richness/diversity*): The ranks of priority were I 1.3.1 (*Species richness of vegetation*), I 1.3.3 (*Abundance of nest of social bee*), I 1.3.5 (*Abundance of butterfly species*), and I 1.3.4 (*Abundance of bird species*) which assigned following the average relative weights of pairwise comparisons (60, 18, 15, and 7, respectively).

Criterion 1.4 (*To monitor population sizes and demographic structures of selected group*): The ranks of priority were I 1.4.3 (*Percentage of sapling and seedling*), I 1.4.2 (*Height class distribution of sapling*), and I 1.4.1 (*Density and size class distribution of tree*) which assigned following the average relative weights of pairwise comparisons (64, 27, and 10, respectively).

Principle 2 (*Forest ecosystem function is maintained*)

Criterion 2.1 (*To conserve soil and water*): The ranks of priority were I 2.1.11 (*Frequency occurrence of soil erosion*), I 2.1.9 (*Percentage of ground cover*), I 2.1.8 (*Abundance of amphibian species*), I 2.1.1 (*Frequency occurrence of detritivorous soil fauna of selected group*), I 2.1.4 (*Quantity of leaf litters and small woody debris (under 10-cm diameter)*), I 2.1.2, I 2.1.5 (*Abundance of epiphytic species*), and I 2.1.7 (*Abundance of herbaceous bole climbers*) that assigned following the average relative weights of pairwise comparisons (29, 23, 16, 12, 10, 5, 3, and 2, respectively).

Criterion 2.2 (*To improve and maintain yield and forest products*): The ranks of priority were I 2.2.3 (*Number of species removed from the forest (for sale/subsistence use)*), I 2.2.4 (*Quantity of certain species harvested from the forest*), and I 2.2.1 (*Basal area of tree*) which assigned following the average relative weights of pairwise comparisons (60, 34, and 6, respectively).

Principle 3 (*Disturbance sign should be under control*)

Criterion 3.1 (*To limit human disturbances*): The ranks of priority were I 3.1.1 (*Number of stumps*), 3.1.6 (*Number of digging hole*), I 3.1.2 (*Frequency occurrence of charcoals/burned logs*), and I 3.1.4 (*Frequency occurrence of garbage/wastes*) which assigned following the average relative weights of pairwise comparisons (51, 27, 15, and 7, respectively).

It was noted that only the (In)Consistency index (C.I.) of the team judgments in Criterion 2.1 of Principle 2 (15%, 12%, and 15%, respectively) were slightly higher than 10% (the threshold acceptable level) (Mendoza et al., 1999). This is because of it might be least comfortable the number of one-on-one judgments that are needed to be made with the pairwise comparisons method compared to ranking and scoring method. However, there was no significant difference from the threshold level of C.I. and to eliminate the inconsistency was outside the scope of this study. Even though there was relatively high variance or standard deviation in some indicators among the team judgments, the priority rank of relative weight of pairwise comparisons of them showed significant discrimination. The final set of C&I arranged in the priority rank of relative weight of pairwise comparisons were showed in Table 4.8.

Table 4.8 Priority rank of criteria and indicators

Principle 1: Structure and composition of forest ecosystem are maintained
Criterion 1.2: To improve and maintain habitat heterogeneity
Indicator 1.2.1: Distribution in vertical stratification
Indicator 1.2.2: Percentage of canopy cover
Indicator 1.2.4: Percentage of similarity of vegetation community
Criterion 1.3: To improve and maintain richness/diversity
Indicator 1.3.1: Species richness of vegetation
Indicator 1.3.3: Abundance of nest of social bee
Indicator 1.3.5: Abundance of butterfly species
Indicator 1.3.4: Abundance of bird species
Criterion 1.4:To monitor population sizes and demographic structures of selected group
Indicator 1.4.3: Percentage of sapling and seedling
Indicator 1.4.2: Height class distribution of sapling
Indicator 1.4.1: Density and size class distribution of tree
Principle 2: Forest ecosystem function is maintained
Criterion 2.1: To conserve soil and water
Indicator 2.1.11: Frequency occurrence of soil erosion
Indicator 2.1.9: Percentage of ground cover
Indicator 2.1.8: Abundance of amphibian species
Indicator 2.1.1: Frequency occurrence of detritivorous soil fauna of selected group
Indicator 2.1.4: Quantity of leaf litters and small woody debris (under 10-cm diameter)
Indicator 2.1.2: Soil pH and conductivity
Indicator 2.1.5: Abundance of epiphytic species
Indicator 2.1.7: Abundance of herbaceous bole climbers
Criterion 2.2: To improve and maintain yield and forest products
Indicator 2.2.3: Number of species removed from the forest (for sale/subsistence use)
Indicator 2.2.4: Quantity of certain species harvested from the forest
Indicator 2.2.1: Basal area of tree
Principle 3: Disturbance sign should be under control
Criterion 3.1: To limit human disturbances
Indicator 3.1.1: Number of stumps
Indicator 3.1.6: Number of digging hole
Indicator 3.1.2: Frequency occurrence of charcoals/burned logs
Indicator 3.1.4: Frequency occurrence of garbage/wastes

4.4 ASSESSING C&I IN EXPERIMENTAL PLOTS

The assessment of indicators was annually conducted during 2002 and 2003. Data set in 2002 was proposed as the first baseline, the following set that conduct later will be compared to the baseline.

During the field visit, the final set of C&I was tested in 25 experimental plots. The forest characteristics in the context of species compositions of vegetation were also examined to be used as the databases for further management plan of this cultural forest (see Appendix A, Table A5-A10). The composition of vegetation in Table 4.9 suggested that this forest could be categorized as dry dipterocarp forest with 45 families and 3 unknown species and 45 families and 2 unknown species in 2002 and 2003, respectively. Rubiaceae had the highest number of species in both 2002 and 2003 (15, and 13 species, respectively) but most of them were in seedling stratum (h < 1.3 m). At the forest floor level (h < 1.3 m), Graminae (*Arundinaria pusilla* (Chevalier & A. Camus) Nguyen) were dominant species. During 2002-2003, there were no significant difference in number of tree (dbh ≥ 10 cm) and sapling (dbh < 10 cm and h ≥ 1.3 m) (591, and 609, and 1,540, and 1,527, respectively). This is because plants increase in dbh size but there were no seedling (h < 1.3 m class) can grow bigger to be sapling (dbh < 10 cm and h ≥ 1.3 m class). The only class that was varied in number was seedling stratum (h < 1.3 m class). Most of them were Graminae, Euphorbiaceae, and Zingiberaceae. As because of some indicators aimed to measure the interesting group, vegetation were classified into family classification. In this study, the word "selected group" referred to the top-five families that have highest importance value index. Importance value index was used to determined dominant trees in sampling area. The highest top-five dominance of tree families in 2002-2003 were Dipterocarpaceae, Burseraceae, Mimosoidae, Connaraceae, and Caesalpinioidae, respectively (Table 4.10). Like the other dry dipterocarp forest, Dipterocarpaceae was the most dominant family (Sahunaru and Dhanmmanoda, 1995). In this IVI rank, Caesalpinioidae had the greatest of species composition of 5 species while Buseraceae, Minosoidae, and Connaraceae had the least of species composition of 1 species. Species composition of tree stratum (dbh ≥ 10 cm) in each family of top-five dominance was showed in Table 4.11.

Table 4.9 Vegetation composition of Nong Meg-Nong Hee cultural forest (in Family)

No.	Family	2002					2003				
		Tree dbh ≥ 10cm	Sapling dbh < 10, h ≥ 1.3m	Seedling h < 1.3m	No. of stem	No. of species	Tree dbh ≥ 10cm	Sapling dbh < 10, h ≥ 1.3m	Seedling h < 1.3m	No. of stem	No. of species
1	Acanthaceae	0	0	4	4	1	0	0	3	3	1
2	Anacardiaceae	26	19	20	65	5	27	23	55	105	4
3	Annonaceae	0	4	91	95	4	0	7	57	64	3
4	Apocynaceae	0	1	0	1	1	0	1	0	1	1
5	Asparagaceae	0	0	2	2	1	0	0	39	39	1
6	Bignoniaceae	14	25	299	338	2	14	26	246	286	2
7	Bombacaceae	24	7	30	61	1	26	13	60	99	1
8	Burseraceae	58	27	48	133	1	58	23	14	95	1
9	Caesalpinioideae	47	110	268	425	7	47	121	248	416	6
10	Celastraceae	0	2	19	21	1	0	5	20	25	1
11	Combretaceae	0	0	3	3	1	0	0	4	4	2
12	Connaraceae	58	109	683	850	1	60	114	258	432	1
13	Dilleniaceae	0	0	1	1	1	0	0	74	74	1
14	Dipterocarpaceae	198	140	514	852	4	203	154	494	851	5
15	Ebenaceae	2	63	307	372	3	2	58	279	339	4
16	Elaeocarpaceae	0	6	90	96	1	0	6	101	107	1
17	Erythroxylaceae	0	0	50	50	1	0	0	19	19	1
18	Euphorbiaceae	7	42	1324	1373	8	7	40	577	624	8
19	Flacourtiaceae	10	32	111	153	2	10	23	83	116	2
20	Hypericaceae	0	16	65	81	1	0	19	44	63	2
21	Irvigiaceae	2	4	2	8	1	2	2	2	6	1
22	Labiatae	9	212	354	575	3	9	201	173	383	2
23	Lauraceae	3	33	216	252	1	3	28	165	196	1
24	Lecythidaceae	1	0	3	4	1	1	0	3	4	1
25	Leeaceae	0	0	438	438	1	0	1	122	123	1
26	Lythraceae	1	18	23	42	1	1	20	25	46	1

Table 4.9 Vegetation composition of Nong Meg-Nong Hee cultural forest (in Family) (continued)

No.	Family	2002					2003				
		Tree dbh ≥ 10cm	Sapling dbh < 10, h ≥ 1.3m	Seedling h < 1.3m	No. of stem	No. of species	Tree dbh ≥ 10cm	Sapling dbh < 10, h ≥ 1.3m	Seedling h < 1.3m	No. of stem	No. of species
27	Melastomataceae	0	117	579	696	1	0	104	394	498	1
28	Meliaceae	4	4	41	49	2	4	6	29	39	2
29	Mimosoidae	66	231	161	458	1	71	240	171	482	1
30	Moraceae	2	6	11	19	2	2	6	20	28	3
31	Myrtaceae	0	0	5	5	1	0	0	1	1	1
32	Ochnaceae	0	10	253	263	1	0	12	133	145	1
33	Papilionoideae	9	8	40	57	4	9	9	26	44	4
34	Rhamnaceae	1	26	3	30	2	1	16	8	25	2
35	Rubiaceae	32	154	1864	2050	15	33	159	1184	1376	13
36	Rutaceae	1	1	66	68	3	1	1	41	43	3
37	Sapindaceae	2	16	28	46	3	3	16	30	49	2
38	Sterculiaceae	0	57	582	639	2	0	40	336	376	3
39	Strychnaceae	3	6	44	53	1	3	8	48	59	1
40	Symplocaceae	0	3	1	4	1	0	1	0	1	1
41	Thymelaeaceae	0	9	5	14	1	0	2	0	2	1
42	Tiliaceae	8	19	76	103	2	9	16	90	115	3
43	Compositae	0	0	288	288	1	0	0	405	405	1
44	Graminae	0	0	2348	2348	1	0	0	3995	3995	1
45	Zingiberaceae	0	0	320	320	1	0	0	2035	2035	1
46	Unknown 1	2	0	0	2	1	2	0	0	2	0
47	Unknown 2	0	0	12	12	1	0	0	0	0	1
48	Unknown 3	1	3	14	18	1	1	6	19	26	1
		591	1540	11706	13837	103	609	1527	12130	14266	102

[a] Per sampling area (1 ha)
[b] Per sampling area (2,500 m^2)

Table 4.10 Ranking of trees (dbh ≥ 10 cm) families following IVI

No.	Family	2002				2003			
		Relative			IVI	Relative			IVI
		Density	Frequency	Dominance		Density	Frequency	Dominance	
1	Dipterocarpaceae	33.50	12.02	31.50	77.02	33.33	11.79	31.46	76.58
2	Burseraceae	9.81	9.62	17.58	37.01	9.52	9.43	17.25	36.20
3	Mimosoidae	11.17	9.13	6.97	27.28	11.66	9.43	7.31	28.40
4	Connaraceae	9.81	8.65	7.08	25.54	9.85	8.49	7.02	25.37
5	Caesalpinioideae	7.95	9.13	7.61	24.69	7.72	8.96	7.56	24.24
6	Anacardiaceae	4.40	7.21	4.91	16.53	4.43	7.08	4.86	16.37
7	Bignoniaceae	2.37	4.33	1.67	8.37	2.30	4.25	1.70	8.24
8	Bombacaceae	4.06	6.73	6.52	17.32	4.27	7.08	6.53	17.88
9	Ebenaceae	0.34	0.96	0.23	1.53	0.33	0.94	0.23	1.51
10	Euphorbiaceae	1.18	2.88	0.67	4.74	1.15	2.83	0.68	4.66
11	Flacourtiaceae	1.69	1.92	1.16	4.77	1.64	1.89	1.19	4.72
12	Irvigiaceae	0.34	0.96	0.21	1.51	0.33	0.94	0.20	1.48
13	Labiatae	1.52	3.37	0.84	5.72	1.48	3.30	0.86	5.64
14	Lauraceae	0.51	0.96	0.37	1.84	0.49	0.94	0.44	1.87
15	Lecythidaceae	0.17	0.48	0.34	0.99	0.16	0.47	0.34	0.97
16	Lythraceae	0.17	0.48	0.09	0.74	0.16	0.47	0.08	0.72
17	Meliaceae	0.68	1.44	1.20	3.32	0.66	1.42	1.16	3.23
18	Moraceae	0.34	0.96	0.82	2.12	0.33	0.94	0.80	2.07
19	Papilionoideae	1.52	4.33	3.23	9.08	1.48	4.25	3.12	8.84
20	Rhamnaceae	0.17	0.48	0.07	0.72	0.16	0.47	0.07	0.71
21	Rubiaceae	5.41	7.21	4.07	16.70	5.42	7.08	4.15	16.65
22	Rutaceae	0.17	0.48	0.33	0.98	0.16	0.47	0.32	0.95
23	Sapindaceae	0.34	0.96	0.20	1.50	0.49	1.42	0.27	2.18
24	Strychnaceae	0.51	0.96	0.26	1.73	0.49	0.94	0.27	1.71
25	Tiliaceae	1.35	3.37	1.36	6.08	1.48	3.77	1.44	6.69
26	Unknown 1	0.34	0.48	0.60	1.42	0.33	0.47	0.59	1.39
27	Unknown 3	0.17	0.48	0.10	0.75	0.16	0.47	0.09	0.73
		100.00	100.00	100.00	300.00	100.00	100.00	100.00	300.00

* Calculated from dbh ≥ 10 cm

Table 4.11 Species composition of trees (dbh ≥ 10 cm) in top-five IVI ranking

IVI rank	Family	Species
1	Dipterocarpaceae	
		Dipterocarpus obtusifolius Teijsm. ex Miq.
		Dipterocarpus tuberculatus Roxb.
		Shorea obtusa Wall.
		Shorea siamensis Miq.
2	Burseraceae	
		Canarium subulatum Guill.
3	Mimosoidae	
		Xylia xylocarpa (Roxb.) Taub. var. *kerri* Nieselsen
4	Connaraceae	
		Ellipanthus tomentosus Kurz var. *tomentosus*
5	Caesalpinioideae	
		Acrocarpus fraxinifolius Wight ex Arn.
		Bauhinia malabarica Roxb.
		Erythrophleum succirubrum Gagnep.
		Senna garretiana (Craib) Irwin & Barneby
		Sindora siamensis Teijsm & Miq. var. *maritima* K. & S.S. Larsen
		Sindora siamensis Teijsm. ex Miq. var. *siamensis*

Forest ecosystem integrity of Nong Meg-Nong Hee cultural forest was assessed via all indicators under their principle and criteria in the experimental plots during 2002-2003. The results of each indicator assessment were described in the order of their principle and criteria.

Principle 1: Structure and composition of forest ecosystem are maintained
Criterion 1.2: To improve and maintain habitat heterogeneity

Indicator 1.2.1: Distribution in vertical stratification

Table 4.12 Distribution in vertical stratification of vegetation

	Vertical class (m)															
	2002								2003							
	1.3-2.5	%	3-6.5	%	7-10.5	%	>10.5	%	1.3-2.5	%	3-6.5	%	7-10.5	%	>10.5	%
Number of stem	782	37	706	33	460	22	183	9	541	25	875	41	534	25	186	9

Plant height normally used as a criterion in life-form classification. It also gives a certain idea of stratification or layering in forest community (Müller-Dombois and Ellenberg, 1974). The recognition of more or less continuous layers of vegetation on the basis of height differences is a structural approach to vegetation description and is inherent life-form classification (Goldsmith and Harrison, 1976).

From Table 4.12, vertical layer of vegetation was defined into 4 classes. Height class distribution showed a high number in small height class and decrease in a bigger class. The middle height class was continuously fulfilling the bigger height class that known as the building or pole phase (Whitmore, 1975). The 3-6.5 m and 7-10.5 m height class showed a greater increase in number from 706 (33%) and 460 (22%) individuals to 875 (41%) and 534 (25%) individuals in the later year. However, the 1.3-2.5 m height class decrease in number of individuals from 782 (37%) to 541 (25%) in the following year. This because some of seedlings ($h < 1.3$ m) could not established to fulfill the upper height class in the later year (see Table 4.9).

Furthermore, in the 1.3-2.5 m height class, Labiatae, Melastomataceae, Mimosoidae, and Sterculiaceae showed a highly decline in number from 75, 93, 76, and 65 individuals to 22, 49, 49, and 40 individuals, respectively in the later year

(Figure 4.1). In the 3-6.5 m height class, Dipterocarpaceae, Melastromataceae, and Minosoidae showed a highly increase in number from 80, 24, and 114 individuals to 103, 54, and 152 individuals, respectively in the later year (Figure 4.2). In the 7-10.5 m height class, Labiatae and Mimosoidae showed a highly increase in number from 13 and 87 individuals to 38 and 102 individuals, respectively (Figure 4.3). In the highest class (h > 10.5 m class), only Dipterocarpaceae was found increasing (1 stem) in the following year (Figure 4.4).

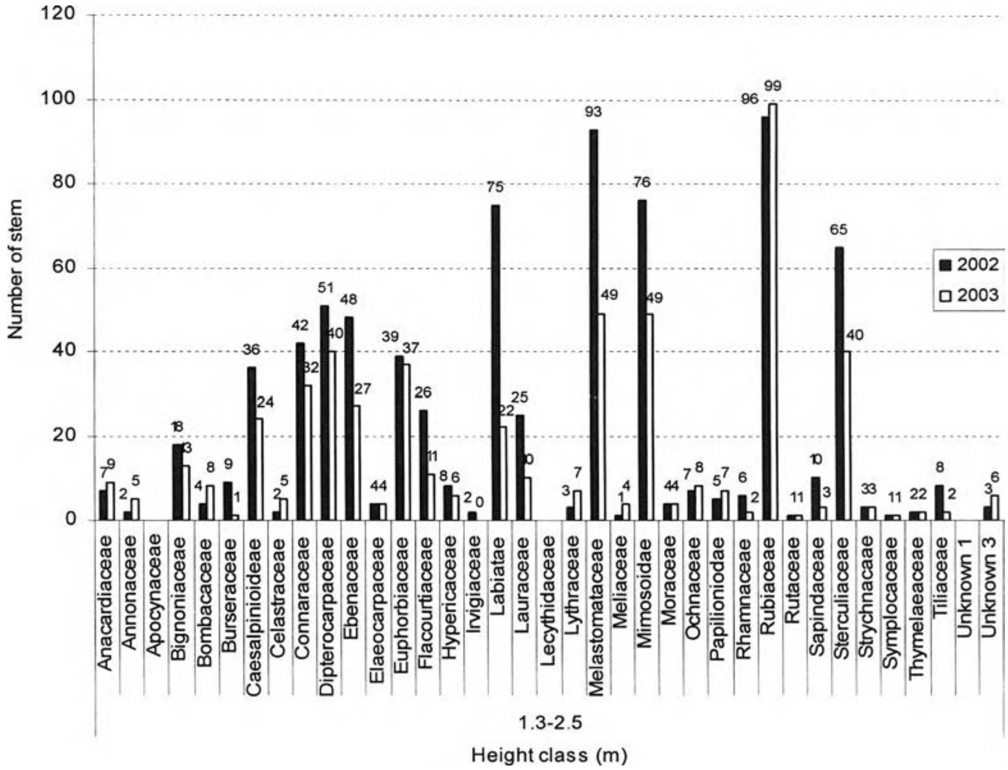

Figure 4.1 The 1.3-2.5 height class of vertical stratification

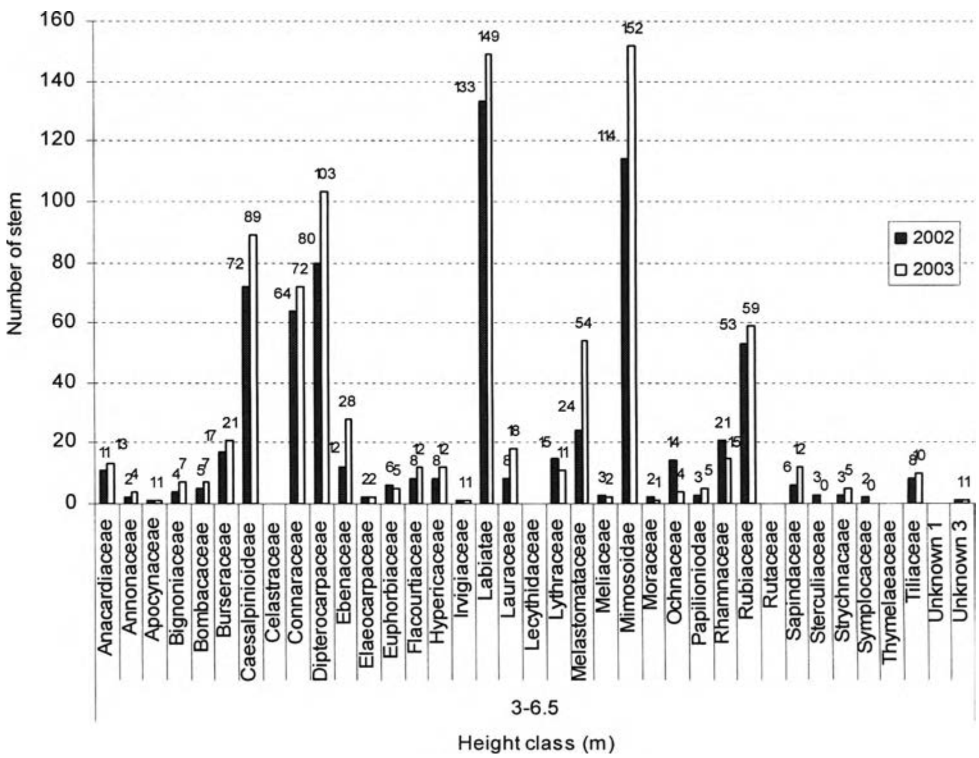

Figure 4.2 The 3-6.5 height class of vertical stratification

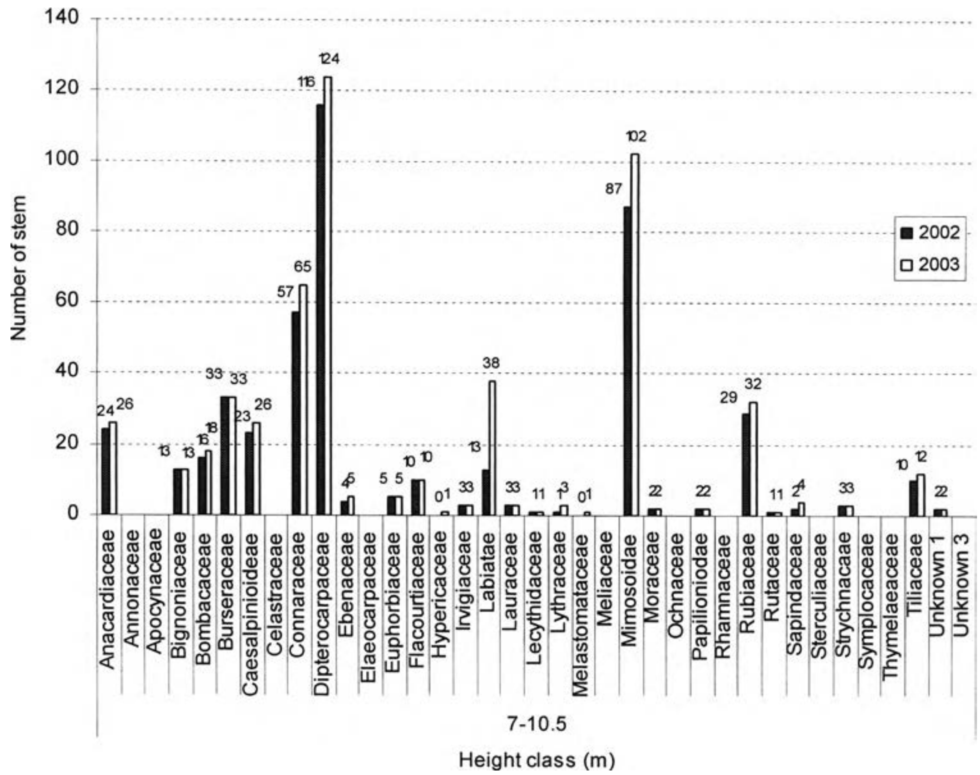

Figure 4.3 The 7-10.5 height class of vertical stratification

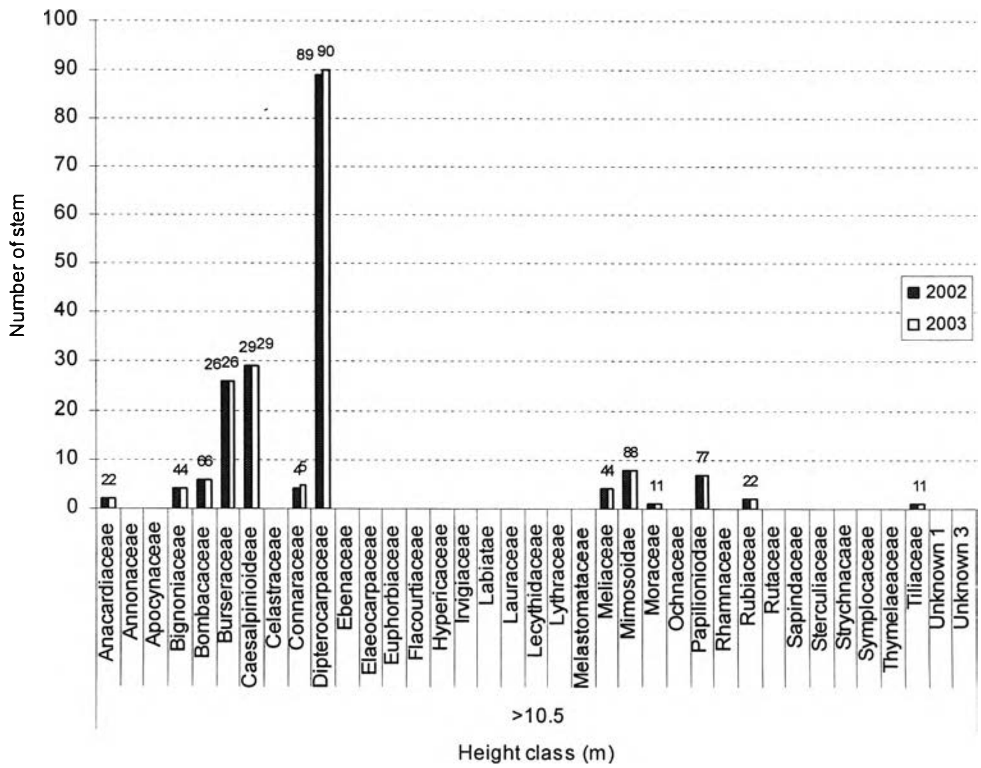

Figure 4.4 The >10.5 height class of vertical stratification

Indicator 1.2.2: Percentage of canopy cover and Indicator 1.2.4: Percentage of similarity of vegetation community

Table 4.13 Canopy cover, richness, and similarity of vegetation species

No.	Indicators parameters	Mean ± SD	
		2002	2003
1	% canopy cover :per 40 m	58.50 ± 16.75	66.66 ± 18.26
2	Richness: Magalef richness index	6.12 ± 1.16	5.74 ± 1.18
3	% similarity of vegetation community :Sorensen index	85.66 ± 3.55	

As showed in Table 4.13, there was no intensive disturbance to tree canopy found in this area. Thus, tree canopy showed upward trend over time. There was increasing of canopy cover from 58.50 ± 16.75 % to 66.66 ± 18.26 % in 2002 and 2003, respectively. However, secondary dry dipterocarp forest was characterized by the sparsely distributed trees and crown cover of each stand which was more or less broken and rarely continuous, thus creating numerous canopies opening (Nilroung, 1986; Dhanmanonda, 1988; Chaimongkol, 1989).

There was only slightly different in species composition from year to year. Percentage of similarity based on Sorensen similarity index compare between 2002 and 2003 showed a high similarity of species composition (85%). This suggested that almost of dry dipterocarp species recruited from coppice and root sucker, thus there were slightly different in term of species composition.

Criterion 1.3: To improve and maintain richness/diversity

Indicator 1.3.1: Species richness of vegetation

Richness index are base on the relationship between number of species (S) and the total number of individuals observed (N) which also increase with increasing of sample size (Ludwig and Reynolds, 1988). In this case, sample size was equal but there was dramatically increase number of individuals only a few species. Thus, from Table 4.13, species richness of vegetation decrease in the later year because there was a significantly increase in number of Graminae and Zingiberaceae from 2,348 to 3,995 and 320 to 2,035, respectively from 2002 to 2003. Thus, the value of richness index of Magalef was decreased from 6.12 ± 1.16 to 5.74 ± 1.18 in 2002 and 2003, respectively.

Indicator 1.3.3: Abundance of nest of social bee

In 2002, nest of *Apis florea* was once found in area adjacent to the experimental plots but in the following year it was collected by local villager. Bee species are recognized as pollinator of many flowering plants. However, most of dry dipterocarp dominant species are regenerated by re-sprout from coppice, seed, and root suckers (Washrinrat, 2000).

For Indicators 1.3.3 Abundance of nest of social bee, there was the population of bee (*Apis florea*) observed in plot area and the nest of social bee was rarely found in the area outside experimental plot, but there was no nest of bee found in experimental plots. Honey from bee has economic value and also medicinal value for local people. The recruitment of bees in forest area could be flavored for forest ecosystem itself and also for local people.

Indicator 1.3.5: Abundance of butterfly species

There were many different butterfly species found in experimental plots. Local people realized the importance role of butterfly as the pollinator in supporting plant diversity and try to identify the difference of various species of butterfly. Although it can be identified butterfly species from their different color but some confusing could happen with the species that have different color between male and female. In this study, butterfly species were caught and identified. A number of butterfly species found in both years were almost the same (21 and 23 species respectively) but species compositions were different. The differences in species composition might be the result of the difference of surveying time and the difficulty to catch some species with the spoon-net in the rambling forest (Table 4.14).

Indicator 1.3.4: Abundance of bird species

Different bird species could be found along the line transects of experimental plots and only visible species were recorded. Field observation and secondary data from previous study were compared. From Table 4.15, 37 and 41 species were found in 2002 and 2003 respectively compared to 65 species in the study of Walai Rukhavej Botanical Research Institute (1998) as showed in Appendix A, Table A14. The species abundance in this study and the previous study are different because the difference of observation area and frequency of observation.

Table 4.14 Abundance of butterfly species

No.	2002		No.	2003	
	Common name	**Scientific name**		**Common name**	**Scientific name**
1	Lemon Emigrant	*Catopsillia pomona*	1	The Lemon Emigrant	*Catopsillia pomona*
2	Leopard Lacewing	*Cethosia cyane*	2	The Leopard Lacewing	*Cethosia cyane*
3	Common Mine	*Chilasa clytia*	3	CommonMine	*Chilasa clytia*
4	Burmese Raven	*Chilasa mahadeva*	4	The Burmese Raven	*Chilasa mahadeva*
5	Tricolor Pied Flat	*Coladenia indrani*	5	Tricolor Pied Flat	*Coladenia indrani*
6	Pain tiger	*Danaus chrysippus*	6	Plain Tiger	*Danaus chrysippus*
7	Common Tiger	*Danaus genutia*	7	Common Tiger	*Danaus genutia*
8	Painted Jezebel	*Delias hyparete*	8	Painted Jezebel	*Delias hyparete*
9	Small Grass Yellow	*Eurema brigitta*	9	Common Grass Yellow	*Eurema hecabe*
10	Common Grass Yellow	*Eurema hecabe*	10	Common Jay	*Graphium doson*
11	Yellow Orange Tip	*Ixias pyrene*	11	Spotted Zebra	*Graphium megarus*
12	Grey Pansy	*Junonia atlites*	12	Yellow Orange Tip	*Ixias pyrene*
13	Lemon Pansy	*Junonia lemonias*	13	Grey Pansy	*Junonia atlites*
14	Common sailor	*Neptis hylas*	14	Psyche	*Leptosia nina*
15	The Nigger	*Orsotriaena Medus*	15	Common sailor	*Neptis hylas*
16	Lime Butterfly	*Papilio demoleus*	16	Banded Swallowtail	*Papilio demolion*
17	Great Mormon	*Papilio memnon*	17	Great Mormon	*Papilio memnon*
18	Long-banded Silverline	*Spindasis lohita*	18	Black and White Helen	*Papilio nepherus*
19	Golden Birdwing	*Troides aeacus*	19	Long-banded Silverline	*Spindasis lohita*
20	Wanderer	*Valeria valeria*	20	Golden Birdwing	*Troides aeacus*
21	Tiny Grass Blue	*Zizula hylax*	21	Yellow Grassy Tiger	*Parantica aspasia*
			22	Wanderer	*Valeria valeria*
			23	Tiny Grass Blue	*Zizula hylax*

Table 4.15 Abundance of bird species

No.	2002		No.	2003	
	Scientific name	Common name		Scientific name	Common name
1	*Acridotheres javanicus*	White-vented Myna	1	*Accipiter badius*	Shikra
2	*Acridotheres tristis*	Common Myna	2	*Acridotheres javanicus*	White-vented Myna
3	*Aegithina tiphia*	Common Iora	3	*Acridotheres tristis*	Common Myna
4	*Athene brama*	Spotted Owlet	4	*Aegithina tiphia*	Common Iora
5	*Aviceda leuphotes*	Black Baza	5	*Athene brama*	Spotted Owlet
6	*Celeus brachyrus*	Rufous Woodpecker	6	*Aviceda leuphotes*	Black Baza
7	*Centropus sinensis*	Greater Coucal	7	*Celeus brachyrus*	Rufous Woodpecker
8	*Copsychus saularis*	Oriental Magpie-Robin	8	*Centropus sinensis*	Greater Coucal
9	*Coracias benghalensis*	Indian Roller	9	*Chrysomma sinense*	Yellow-eyed Babbler
10	*Corvus macrorhynchos*	Large-billed Crow	10	*Copsychus saularis*	Oriental Magpie-Robin
11	*Culicicapa javanica*	Grey-headed Flycatcher	11	*Coracias benghalensis*	Indian Roller
12	*Cypsiurus balasiensis*	Asian Palm-Swift	12	*Corvus macrorhynchos*	Large-billed Crow
13	*Dicrurus macrocercus*	Black Drongo	13	*Culicicapa javanica*	Grey-headed Flycatcher
14	*Eudynamys scolopacea*	Common Koel	14	*Cypsiurus balasiensis*	Asian Palm-Swift
15	*Ficedula parva*	Red-throated Flycatcher	15	*Eudynamys scolopacea*	Common Koel
16	*Geopelia striata*	Zebra Dove	16	*Ficedula parva*	Red-throated Flycatcher
17	*Glareola maldivarum*	Oriental Pratincole	17	*Geopelia striata*	Zebra Dove
18	*Glaucidium cuculodes*	Asian Barred Owlet	18	*Glareola maldivarum*	Oriental Pratincole
19	*Hirundo rustica*	Barn Swallow	19	*Glaucidium cuculodes*	Asian Barred Owlet
20	*Hypothuymis azurea*	Black-naped Monarch	20	*Hirundo rustica*	Barn Swallow
21	*Lonchura punctulata*	Scaly-breasted Munia	21	*Hypothuymis azurea*	Black-naped Monarch
22	*Luscinia calliope*	Siberian Rubythroat	22	*Lonchura punctulata*	Scaly-breasted Munia
23	*Merops orientalis*	Green Bee-eater	23	*Luscinia calliope*	Siberian Rubythroat
24	*Oriolus chinensis*	Black-naped Oriole	24	*Merops orientalis*	Green Bee-eater
25	*Orthotomus sutorius*	Common Tailorbird	25	*Oriolus chinensis*	Black-naped Oriole
26	*Passer flaveolus*	Plain-backed Sparrow	26	*Orthotomus sutorius*	Common Tailorbird
27	*Phylloscopus inornatus*	Inornate Warbler	27	*Passer flaveolus*	Plain-backed Sparrow
28	*Phylloscopus schwarzi*	Radde's Warbler	28	*Phylloscopus inornatus*	Inornate Warbler
29	*Prinia inornata*	Plain Prinia	29	*Phylloscopus plumbeitarsus*	Two-barred Warbler
30	*Pycnonotus aurigaster*	Sooty-headed Bulbul	30	*Phylloscopus schwarzi*	Radde's Warbler
31	*Pycnonotus blanfordi*	Streak-eared Bulbul	31	*Picoides macei*	Fulvous-breasted Woodpecker
32	*Pycnonotus finlaysoni*	Stripe-throated Bulbul	32	*Prinia inornata*	Plain Prinia
33	*Saxicola torquata*	Stonechat	33	*Pycnonotus aurigaster*	Sooty-headed Bulbul
34	*Streptopelia chinensis*	Spotted Dove	34	*Pycnonotus blanfordi*	Streak-eared Bulbul
35	*Streptopelia tranquebarica*	Red Turtle-Dove	35	*Pycnonotus finlaysoni*	Stripe-throated Bulbul
36	*Sturnus nigricollis*	Black-collared Starling	36	*Saxicola torquata*	Stonechat
37	*Turnix suscitator*	Barred Buttonquail	37	*Streptopelia chinensis*	Spotted Dove
			38	*Streptopelia tranquebarica*	Red Turtle-Dove
			39	*Sturnus nigricollis*	Black-collared Starling
			40	*Timalia pileata*	Chestnut-capped Babbler
			41	*Turnix suscitator*	Barred Buttonquail

Criterion 1.4: To monitor population sizes and demographic structures of selected group

Indicator 1.4.3: Percentage of sapling and seedling

As mentioned above, "selected group" in this study mean to the top-five dominant of IVI families. Percentage of sapling and seedling of IVI top-five ranking families compare to entire family were examined. The percentage of sapling of IVI group increased from 40 % to 43 % in 2002 to 2003, respectively while sapling of all families showed downward trend because there were some of sapling recruit to the tree stratum but only small number of seedling can recruit to the sapling stratum. The percentage and the number of seedling decreased from 14% to 10% in 2002 and 2003, respectively (Table 4.16). Decreasing of percentage of seedling (h < 1.3 m) of IVI group in 2003 because seedling of Dipterocarpaceae usually re-sprouts from the old stumps and root suckers (Washrinrat, 2000). Thus, many seedlings were probably died off by searching activities (walking and scratching) of mushroom collectors. However, for all families, seedlings increase because proportion number of Zingiberaceae and Graminae were dramatically increased (see Table 4.9).

Table 4.16 Percentage of sapling and seedling of selected group

Group	2002		2003	
	dbh < 10, h ≥ 1.3m	h < 1.3m	dbh < 10, h ≥ 1.3m	h < 1.3m
IVI top-five family	617	1,674	652	1,185
All families	1,540	11,706	1,527	12,130
Percentage (%)	40	14	43	10

Indicator 1.4.2: Height class distribution of sapling

According to field observation, height of sapling increased about 0.5-1.0 m per year. Four height classes of sapling were defined for this study. Number of individuals in all height class increase in the later year except in 1.3-2.5 m height class (780 and 539 in 2002 and 2003, respectively) (Table 4.17). Only number of Burseraceae increases in the lowest class (1.3-2.5 m), but decrease in the 3-5.5 m height class (Figure 4.5). In the highest class (> 9 m), only Mimosoidae and Connaraceae were increased of 3 and 2 individuals, respectively in 2003. Moreover, there was no stem of Burseraceae present in the highest height class.

Table 4.17 Distribution in each height class of sapling of selected group

dbh < 10, h ≥ 1.3m (IVI group)	Height class (m)															
	2002								2003							
	1.3-2.5	%	3-5.5	%	6-8.5	%	> 9	%	1.3-2.5	%	3.5.5	%	6-8.5	%	> 9	%
Number of stems	780	51	580	38	172	11	8	1	539	35	699	46	276	18	13	1

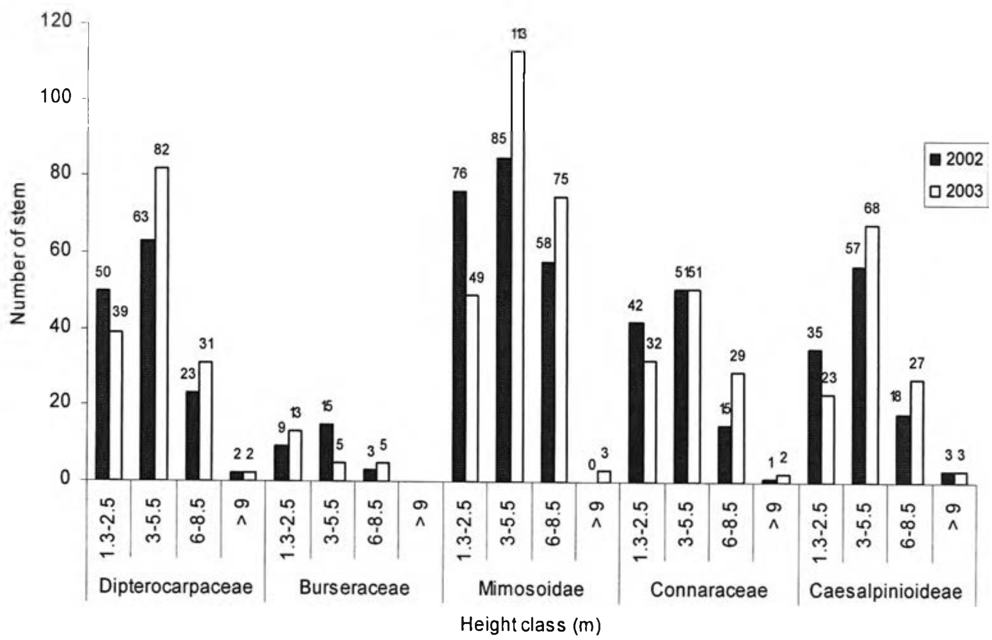

Figure 4.5 Height class distribution of selected group of sapling

Indicator 1.4.1: Density and size class distribution of tree

Density is the count of number of individuals of a particular species per unit area. It is usually to count the number of individuals within a series of quadrats or plots, calculating the average number of individuals relative to quadrats used, from the total sample (Goldsmith and Harrison, 1976; Müller-Dombois and Ellenberg, 1974).

All families in this group increase in number of individuals from 2002 to 2003. Dipterocarpaceae and Mimosoidae were the first and second dominant families, while Caesalpinioidae was the lowest density in both years (Table 4.18).

Table 4.18 Density of trees (dbh ≥ 10 cm) in order of the highest top-five rank of IVI

No.	Family	Density (stems ha^{-1})	
		2002	2003
1	Dipterocarpaceae	198	203
2	Mimosoidae	66	71
3	Connaraceae	58	60
4	Burseraceae	58	58
5	Caesalpinioideae	47	47
	Total	**427**	**439**

Size class distributions of trees (dbh ≥ 10 cm) of all top-five IVI families were typical of natural regeneration, with high stem counts in the smaller size classes (L-shape or reverse J-curve). Actually, the L-shape or reverse J- curve was showed as balance maintenance. This trend was usually showed in various primary forests in Thailand (Ogawa, 1961, 1965; Sahunaru et al., 1979; Nilroung, 1986; Sahunaru and Dhanmanonda, 1995; Bunyavejchewin, 1999). The exception was for Burseraceae that the distribution in size class did not show L-shape. Its trend showed low numbers the in smallest size due to poor survival from the sapling stratum to the tree stratum (see Table 4.9).

Moreover, in the last 3 biggest size classes (32.4-37.9 cm, 38-43.5cm, and > 43.5 cm), only Burseraceae was found and there were only 1 stem in each class in both years (Figure 4.6).

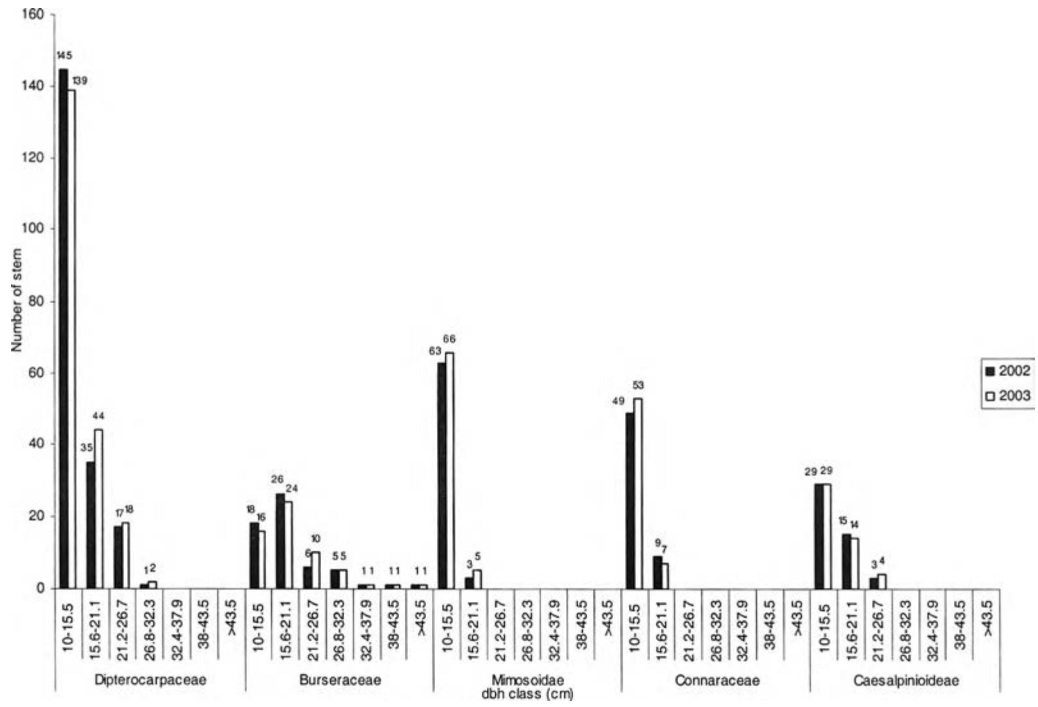

Figure 4.6 Dbh class of selected group of tree (dbh ≥ 10 cm)

Principle 2: Forest ecosystem function is maintained

Criterion 2.1: To conserve soil and water

Indicator 2.1.11: Frequency occurrence of soil erosion

There was no sign of soil erosion occurred in experimental plots but there was the sign of severe soil erosion which resulted of previous lateritic soil mine in the northwest of forest site . Anyway, there was no different of severe soil erosion sign around that area after 1-year observation. However, there were signs of soil erosion in forest area around Nong Hee reservoir that might be severe when heavily raining. This indicator could be used to track the change of erosion area so that it was selected as the first priority in this criterion.

Indicator 2.1.8: Abundance of amphibian species

There were 6 common species of amphibian found in the forest area. There was no different in species recorded which was compiled from the questionnaires. All of them were common and normally found in forest and nearby area in both years. Local people normally collect them for food and sale at the market place (Table 4.19).

Table 4.19 Abundance of amphibian species

No.	Local name	Common name	Scientific name
1	Aoung Pao	Truncated-snouted Burrowing Frog	*Glyphoglossus molossus*
2	Auong Yang	Painted Bullfrog	*Kaloula pulchra*
3	Kiad Cha Na	Common Puddle Frog	*Occidozyca lima*
4	Kiad Chig	Green-backed Frog	*Rana erythraea*
5	Kiad Ka Kum	Painted Chorus Frog	*Microhyla pulchra*
6	Kob Na	Rugose Frog	*Hoplobatrachus rugulosus*

Indicator 2.1.1: Frequency occurrence of detritivorous soil fauna of selected group

In this study, detritivorous soil fauna species of selected group referred to soil fauna that are visible (> 2 mm length) and easy for local people to observe and identified on soil surface in 1×1 m quadrat. Frequency occurrence refers to the distribution in an area. In this study, group of termites, earthworms, crickets, millipede, centipede, cockroach, beetles, snails, and woodlice were taken into account. The order of frequency occurrence of detritivorous soil faunas was different over time but there was a slightly different in frequency value. In this case, termite group was very common and well disperse throughout the plots, while snail group showed the poorest distribution in both 2002 and 2003 (Table 4.20). However, there were some studies showed the positive relation of abundance of detritivorous species to litter mass lost (Crossley and Hoglund 1962; Seastedt, 1984). The study that reveals the direct relation between frequency occurrence and the abundance of detritivorous soil faunas have to be further analyzed.

Table 4.20 Frequency occurrence of detritivorous soil fauna of selected group

No.	2002		2003	
	Selected group	Frequency	Selected group	Frequency
1	Termites	0.79	Termites	0.85
2	Wood lice	0.61	Beetles	0.69
3	Beetles	0.57	Wood lice	0.61
4	Crickets	0.50	Cockroach	0.59
5	Cockroach	0.43	Cricket	0.56
6	Millipede	0.38	Millipede	0.41
7	Centipede	0.26	Centipede	0.21
8	Earthworms	0.18	Earthworms	0.16
9	Snails	0.08	Snails	0.06
	Total	**3.80**	**Total**	**4.14**

Indicator 2.1.9: Percentage of ground cover, Indicator 2.1.4: Quantity of leaf litters and small woody debris (under 10-cm diameter), Indicator 2.1.2: Soil pH and conductivity

Table 4.21 Litter weight, percentage of ground cover, and soil pH and conductivity

No.	Indicators parameters	Mean ± SD	
		2002	2003
1	Litter weight : kg ha^{-1}	3,674.5.1 ± 42.81	3,414.1 ± 48.22
2	% ground cover :per 4 m^2	23.49 ± 13.34	29.58 ± 16.16
3	Soil pH :0-30 cm deep	5.59 ± 0.19	5.66 ± 0.11
4	Electric conductivity :0-30 cm deep (μ S m^{-1})	12.73 ± 2.92	11.34 ± 2.49

Leaf litters and small woody debris mean small branches leaves or small pieces of plants that accumulate on the ground (Tsai, 1974). Large pieces of plants such as stems, big branch, and fruits are not included. Quantity of collected litters can be measured by weighting of collected litters. Litters on the forest floor act as the input-output system for nutrients (Das and Ramakrishnan, 1985). Following Table 4.21, quantity of leaf litters and small woody debris were considered as a common quantity in dry tropical forest compared to 1,552-5,584 kg ha^{-1} of dry dipterocarp forest in Nakhon Ratchasima (Wachrinrat, 2000) and were considered as about one-third of 9,014 kg ha^{-1} of litter weight in natural dry evergreen forest (Thanee, 1997). Quantity of leaf litters decreased from 3,674 kg ha^{-1} to 3,414 kg ha^{-1} in 2002 and 2003, respectively. In the tropics, soil arthropods might be playing a significant role in the massive loss of a common substrate (Henegan et al., 1999). High abundance of detritivorous soil faunas may magnify the mineralization processes in soil (Lavelle et al., 1993; Gonza´lez and Zou, 1999). Feeding activities of soil faunas (e.g. termite group) on decay litters were reduced litter mass and, consequently, were returned the nutrients back to soil (Seastedt, 1984; Lussenhop, 1992). However, in this study could not directly indicate the relationship between frequency occurrence and the abundance of detritivorous soil fauna. Thus, there was no strong evident to conclude high frequency occurrence of detritivorous species were influent on litter mass lost. However, mushroom collection pattern (e.g. walking and scratching) of local people could be accelerated decomposition processes by breaking down the litter size (Wiegert and Murphy, 1970). Moreover, beyond the substrates quality, decomposition rate of litters was higher in older phase of secondary succession (Xuluc-Tolosa et al., 2003). Percentage of ground cover was increasing from 23.52 ± 13.35 to 29.61 ± 16.16 in 2002 and 2003, respectively. According to the higher of annual rainfall in the last 3 years, leaf shredding will decrease because of high relative humidity (Spain, 1984). The increasing of ground covers were consequently increasing of soil moisture and might be reduced soil electric conductivity and soil acidity. Soil pH showed slightly acidity in both years, which was the common phenomenon of soil in tropical dry forest (Handechanon, 1990; Popan, 2000; Wachrinrat, 2000).

Indicator 2.1.5: Abundance of epiphytic species, and Indicator 2.1.7: Abundance of herbaceous bole climbers

These indicators (I2.1.5 and I2.1.7) are directly referred to atmosphere moisture (Budowski, 1965 cited in Koop et al, 1995; Oldeman, 1978; Richard, 1984 cited in Koop et al., 1995; Pocs, 1982). They consist of easily recognizable species or family groups that are common and wide spread. In this study, group of orchid and herbaceous bole climber group that stick their leaves to the tree bole. Currently, there were no epiphytic species and herbaceous bole climbers found in the experimental plots. In the past, epiphytic species were abundance in this area, especially in Family Orchidaceae, but they had been wiped out from the forest area for sell and for decorative as ornamental plant (personal communication). Therefore, these indicators could be useful to indicate the recovery of the forest condition as it was before.

Criterion 2.3: To improve and maintain yield and forest products

Indicator 2.2.3: Number of species removed from the forest (for sale/subsistence use)

Harvesting of non-timber forest products (NTFPs) were different from people to people. Most of forest products were mostly used as food and sustenance. The order of the number of species which were commonly used by local people in different categories was show in Table 4.22. There were many vegetation species that could be used as the medicinal plant. However, medicinal plant was normally recognized only by the medicinal plant pharmaceutist. Even though the numbers of species that using as food and selling at the market place were placed as a second rank of utility type but it was the most intensity of NTFPs utilization.

Table 4.22 Number of species removed from the forest

No.	Type of utilities	Number of species
1	Medicinal plants	57
2	Food (included mushroom)	36
3	Fruits	9
4	Ceremony	2
5	Insects	17
6	Amphibians	6
7	Reptiles	5

Indicator 2.2.4: Quantity of certain species harvested from the forest

Mushroom species was the target species of this study because they were the most popular and intensively harvested by local people. Indirect method for quantitative assessing of this indicator was used because it cannot be expected the collecting time of local NTFPs collectors to follow up them for direct assessment. The questionnaires were taken into gathering the data to assess this indicator. From 50 questionnaires, the estimation of quantities of mushroom were slightly different from 7,104 ± 114.62 kg to 7,080 ± 115.62 kg from 2002 to 2003 (Table 4.23). However, the estimation quantities of mushroom from the questionnaires were rough estimation value because most of local people still lack the ability to define the quantity or weight of NTFPs and, moreover, weighting unit that gained from the questionnaires was a roughly estimate unit such as bowls or plastic bags. Thus, the standard unit was later converted from that rough estimation.

Table 4.23 Quantity of harvested mushroom

Group of species	Quantity (kg)	
	2002	2003
Mushroom	7,104 ± 114.62	7,080 ± 115.38

Indicator 2.2.1: Basal area of tree

Basal area of tree dbh $\geq$ 10 cm showed that Diterocarpaceae, Bursearceae, Caesalpinioidae, Mimosoidae, and Conaraceae were ranked in top-five ranks as in IVI ranking, but the priority of was different. Total basal area of trees increase from 11 m^2ha^{-1} in 2002 to 11.67 m^2ha^{-1} in the following year. All tree families of top-five IVI rank showed regularly growth that there was no tree lost and tree keep growing bigger over time. Basal area generally increased with the stand age (Grau et al., 1997; Guariguata et al., 1997) and being a good indicator for tree biomass (Ogawa et al., 1965; Ogino et al., 1967). Compare to the entire families of trees, Dipterocarpaceae showed the greatest increase of basal area while Rhamnaceae had the lowest basal area with a slightly increase in the following year (Table 4.24).

Table 4.24 Basal area of all trees (dbh ≥ 10 cm) families

No.	Family	Basal area (m^2ha^{-1})	
		2002	2003
1	Dipterocarpaceae	3.4654	3.6700
2	Burseraceae	1.9341	2.0119
3	Caesalpinioideae	0.8367	0.8822
4	Mimosoidae	0.7673	0.8525
5	Connaraceae	0.7785	0.8195
6	Bombacaceae	0.7177	0.7622
7	Anacadiaceae	0.5407	0.5665
8	Rubiaceae	0.4480	0.4845
9	Papilionoideae	0.3552	0.3641
10	Bignoniaceae	0.1840	0.1981
11	Tiliaceae	0.1494	0.1675
12	Meliaceae	0.1324	0.1355
13	Flacourtiaceae	0.1273	0.1390
14	Labiatae	0.0920	0.1004
15	Moraceae	0.0904	0.0930
16	Euphorbiaceae	0.0740	0.0794
17	Unknown 1	0.0663	0.0689
18	Lauraceae	0.0411	0.0512
19	Lecythidaceae	0.0379	0.0394
20	Rutaceae	0.0362	0.0371
21	Strychnaceae	0.0283	0.0314
22	Sapindaceae	0.0221	0.0319
23	Ebenaceae	0.0255	0.0274
24	Irvigiaceae	0.0232	0.0239
25	Unknown 3	0.0106	0.0109
26	Lythraceae	0.0095	0.0097
27	Rhamnaceae	0.0081	0.0087
	Total	11.0021	11.6665

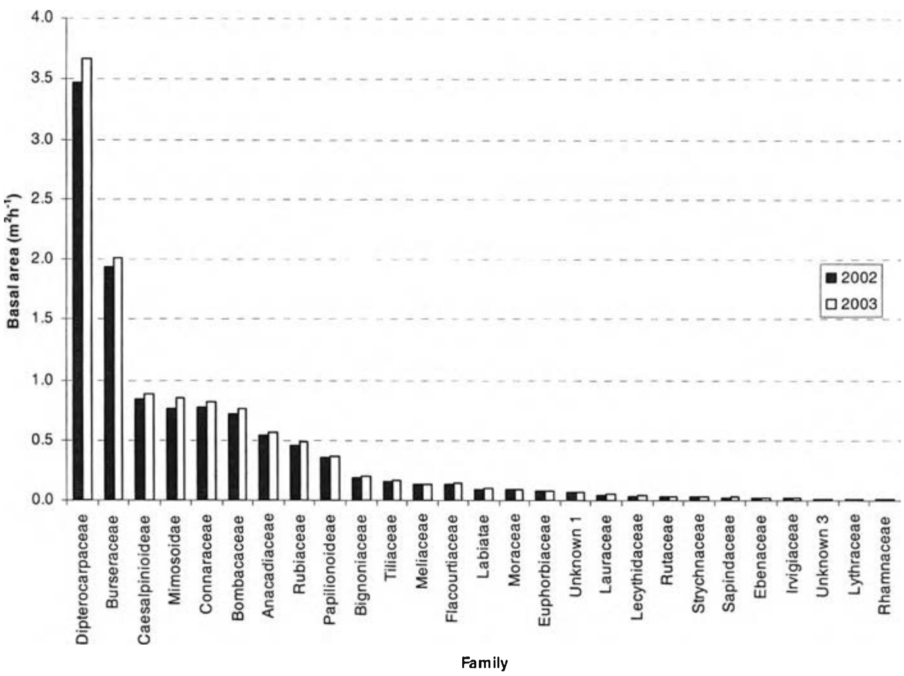

Figure 4.7 Basal area of tree dbh $\geq$ 10 cm

Principle 3: Disturbance sign should be under control

Criterion 3.1: To limit human disturbance

Indicator 3.1.1: Number of stumps and Indicator 3.1.6: Number of digging hole

The sign of stumps were the results of former activities such as selective logging for charcoal making and poling (personal communication). However, currently, cutting trees in the forest area is against the forest organization's rule and will be fined with the highest punishment (Appendix A, Box A1). Thus, there were 3.56 ± 2.38 stumps (dbh $\geq$ 5 cm) found in 2002 but no more stump found in 2003.

There always the common activities that are being a disturbance in NTFPs harvesting season of a year. Some of these activities always leave many holes on the ground level. Most of these activities are: searching for some insects (e.g. May beetle, June beetle); collecting Kra jiaw khaow and/or medicinal plants; and probably activities of villager's pet. The number of digging hole increased from 14.04 ± 5.99 to 21.76 ± 11.38 in 2002 and 2003, respectively (Table 4.25).

Table 4.25 Number of digging hole and number of stumps

No.	Indicators	Mean ± SD	
		2002	2003
1	Number of digging hole :number per 200 m^2	14.04 ± 5.99	21.76 ± 11.38
2	Number of stumps :number per 200 m^2	3.56 ± 2.38	3.56 ± 2.38

Indicator 3.1.2: Frequency occurrence of charcoals/burned logs and Indicator 3.1.4: Frequency occurrence of garbage/wastes

In the past, wildfire often occurred after harvesting season from adjacent rice field burning. However, there was no wildfire occurred since 1995 (Personal communication). During 2002 and 2003, there were no evident of charred residues in the experimental plots but there were the signs of charred residues and burn marks on tree trunk present in the area border to local land properties. The occurrence of charred residues in the forest area was from cooking activities of local people and the visitors.

There was also no deposition of garbage found in plots area. However, forest area is often used as the recreation both formal and informal activities by nearby government unit (e.g. school, authorities of local administration, etc.), the high probabilities to be deposited by human wastes. These indicators can be used as the early warning of the wildfire and pollution that become more severe problems in near future.

From the annual assessment of indicators, overall results showed that C&I could be used as an effective tool for assessing ecological integrity. Most of indicators under Principle 1 (Structure and composition of forest ecosystem are maintained); Principle 2 (Forest ecosystem function is maintained); and Principle 3 (Disturbance sign should be under control) could be directly or indirectly measured to represent their inherent values which altogether represent the overall integrity of the forest under management practices. Comparison between baseline data of 2002 and data of 2003 showed that forest ecosystem integrity could be assessed was showed in Table 4.25.

Table 4.26 Annual assessment results of indicators

Principle 1: Structure and composition of forest ecosystem are maintained	**Indicators value 2002-2003**
Criterion 1.2: To improve and maintain habitat heterogeneity	
Indicator 1.2.1: Distribution in vertical stratification	+
Indicator 1.2.2: Percentage of canopy cover	+
Indicator 1.2.4: Percentage of similarity of vegetation community	**85%**
Criterion 1.3: To improve and maintain richness/diversity	
Indicator 1.3.1: Species richness of vegetation	≈
Indicator 1.3.3: Abundance of nest of social bee	N/A
Indicator 1.3.5: Abundance of butterfly species	≈
Indicator 1.3.4: Abundance of bird species	≈
Criterion 1.4:To monitor population sizes and demographic structures of selected group	
Indicator 1.4.3: Percentage of sapling and seedling	+, -
Indicator 1.4.2: Height class distribution of sapling	+
Indicator 1.4.1: Density and size class distribution of tree	+
Principle 2: Forest ecosystem function is maintained	
Criterion 2.1: To conserve soil and water	
Indicator 2.1.11: Frequency occurrence of soil erosion	N/A
Indicator 2.1.9: Percentage of ground cover	+
Indicator 2.1.8: Abundance of amphibian species	
Indicator 2.1.1: Frequency occurrence of detritivorous soil fauna of selected group	+
Indicator 2.1.4: Quantity of leaf litters and small woody debris (under 10-cm diameter)	-
Indicator 2.1.2: Soil pH and conductivity	+, -
Indicator 2.1.5: Abundance of epiphytic species	N/A
Indicator 2.1.7: Abundance of herbaceous bole climbers	N/A
Criterion 2.2: To improve and maintain yield and forest products	
Indicator 2.2.3: Number of species removed from the forest (for sale/subsistence use)	≈
Indicator 2.2.4: Quantity of certain species harvested from the forest	≈
Indicator 2.2.1: Basal area of tree	+
Principle 3: Disturbance sign should be under control	
Criterion 3.1: To limit human disturbances	
Indicator 3.1.1: Number of stumps	≈
Indicator 3.1.6: Number of digging hole	+
Indicator 3.1.2: Frequency occurrence of charcoals/burned logs	N/A
Indicator 3.1.4: Frequency occurrence of garbage/wastes	N/A

However, results from annual assessment revealed that C&I (the revision set) were not completely presented forest ecosystem integrity. C&I need to be justified under ecological rationale and justified as the following:

Principle 1: Structure and composition of forest ecosystem are maintained

1. *Improve and maintain habitat heterogeneity.* Habitat structure refers to 2 components of vegetation structure: vegetation structure which describes the diversity of habitat within a forest, and architectural or physiognomic complexity which refers to the structural (and/or functional) heterogeneity of forest plant (Stork et al., 1997). Vegetation structure can indicate ecological change regarding disturbance regime that may occur over a few year to decade (Dale and Beyeler, 2001; Dale et al, 2002). It is generally known that disturbances influence the out come of succession and biodiversity in many communities (White, 1979; Huston, 1994; Robert and Gilliam, 1995). All indicators under this criterion reflect forest stand structural diversity, stand characteristics that measure as variation along vertical distribution, canopy cover and similarity of vegetation species. The assessment results showed higher ratio in each height class, greater of canopy cover, and high similarity of species composition over time. However, in the smallest height class, some seedlings (h <1.3 m) could not grow up to the higher height class. This found to be only the negative trend of this criterion.

2. *Improve and maintain richness/diversity.* Ecologist recognized that disturbances influence not only to individual organism but also to species abundance (White, 1979; Huston, 1994). Human activities such as harvesting forest products also considered as the disturbance that will effect to several level of ecosystem organization such as individual organism, species abundance, and habitat diversity (Stork, et al., 1997). It is no suspect and straightforward that index of species richness would be total number of species in a community. Number of species found depends on the sample size. It is limited as a comparative index. In this case, a richness index named Magalef index, which is based on the relationship between number of species and the total number of individuals, was proposed regarding it can avoids the problem of sample size to be compared (Ludwig and Reynold, 1988). Therefore, this study prefers an equal sample size to compare. As a results, there was slightly decrease of richness index of vegetation species because a plenty of number of Graminae and Zingiberaceae increase in the following year. Variation in species composition and

number of species of each Family mostly happened in sapling and seedling stratum. However, total numbers of species found in both years did not different.

Bird, bee, and butterfly were considered as a guild of pollinator that involve in trophic dynamic processes, which is the ways that species from different trophic level interact, of forest ecosystem (e.g. pollinator, predation). In addition, there was no different in abundance of butterfly species and bird species during a year. Moreover, population of bee (*Apis florea*) could be observed, but no nest found in plots area. However, from ecological point of view, these indicators, which were selected by local team, were considered redundancy. In this case, from practical of indicators point, assessing abundance of butterfly species showed the most impractical to local people compare to bee and bird species. These because of there are morphological diversity in butterfly species especially in Family Papilionidae, Nymphalidae, and Lycaenidae, respectively (Ehrlich and Raven, 1964). Local team felt unfamiliar and had no knowledge to identify butterfly species. In addition, from trophic level point of view, butterfly was considered as a lower trophic level in food web compare to bee and bird species. In addition, Honey from bee, *Apis florea*, has economic value and medicinal value for local people. The recruitment of bees in forest area could be flavored for forest ecosystem itself and for local people. Thus, I1.3.5 abundance of butterfly species does not important, in term of ecological meaning and socioeconomic aspect, to use at this time. However, for a long-term adaptive management, this indicator might be suggested suitable reused when local team is academic trained and supported.

3. *Population size and demographic structure of selected group.* Five dominant families of IVI (Dipterocarpacea, Burseraceae, Mimosoidae, Conanraceae, and Caesalpinoidae), were analyzed. All vegetation stratums *i.e.* tree, sapling, and seedling were considered. The results showed that number of sapling increase while number of seedling decrease over time. This means that there was a recruitment problem of seedling of dominant families. This might be because of recruitment of seedling of dipterocarp tree were coppice form stumps and from root suckers (Washrinrat, 2000). However, for all families, number of seedling stratum increase over time especially Graminae and Zingiberaceae. Distribution in each height class of all 4 classes of sapling showed a positive development. The exception was for the lowest class that there were no seedlings recruited into the higher class. Therefore, the smallest height class decreases in following year. Density of five dominant tree

families showed upward trend in all families except in Burseraceae and Caesalpinioidae that showed no different in number. However, size class distribution of five dominant groups showed balance maintenance (L shape curve) that trees are being continually recruited from high number of small dbh size trees. These changes could be the results of forest dynamic and/or human disturbances that need a further research. However, monitoring this criterion will be showed a changing trend of population of group of interest (Hitimana, Kiyiapi, and Njuge, 2004; Onaindia et al., 2004).

Principle 2: Forest ecosystem function is maintained

1. *Conserve soil and water.* Indicators that reflect air moisture *i.e.* abundance of epiphytic species, and abundance of herbaceous bole climber and reflect ground level humidity *i.e.* percentage of ground cover, and abundance of amphibian species were selected for representing water conservation. Nong Meg-Nong Hee forests are secondary dry dipterocarp forest that is categorized as xeric forest and, moreover, trees are sparsely distributed and canopies are quite opened, thus air moisture indicators were scarcely presented. Percentage of ground cover increased corresponding with higher annual rainfall might be increased soil moisture and might be reduced soil electric conductivity and soil acidity (Popan, 2000; Wang, 2004).

In accord with soil conservation, soil properties or processes can be used as indicators of the impacts of management practices and, if monitored, can indicate trend in property change relevant affect to production (Cornfort, 1999). Indicators that relevant to soil conservation were selected *i.e.* soil erosion, soil pH and soil conductivity, occurrence of detritivorous soil fauna, and quantity of litters. As a result, all indicators indicated a positive trend of soil conservation.

However, remarked that soil conservation that maintained forest ecosystem function were considered missing the indicator of soil processes which reflect the normality of function of forest soil. There is the recycling process that is the most important in sustaining the system in term of recycling the matter back into the system (e.g., weathering, decomposing) (Gajaseni, 1997). Soil properties or processes can be used as indicators of the impacts of management practices and, if monitor, can indicate trend in property change relevant affect to production (Cornfort, 1999). Increasing rates of litter decomposition accelerate nutrient cycling and indicate better soil quality that could ultimately lead to the increase of forest productivity (Knoepp et al., 2000).

Many study revealed that dry dipterocarp forests were strongly influenced by environment factors, for example, seasonal rhythm, topography, soil types and properties, etc. (Bunyavejchewin, 1983; Bunyavejchewin, 1985; Sahunaru, Dhanmanonda, and Khemnark, 1994; Gomontean, 1996). Therefore, investigation of soil is also necessary for management databases. Soil nutrients contents were analyzed. The mean values of important nutrients and some chemical properties showed the better status overtime (Table 4.27).

Table 4.27 Nutrient contents in soil

Nutrients	Mean ± SD	
	2002	2003
Organic matter 0-30 cm: (g kg^{-1})	5.19 ± 0.883	6.51 ± 1.035
Nitrogen 0-30 cm: (g kg^{-1})	0.41 ± 0.083	0.51 ± 0.088
Phosphorus 0-30 cm: (mg kg^{-1})	4.91 ± 3.323	7.79 ± 3.113
Calcium 0-30 cm: (cmol(+)kg^{-1})	4.25 ± 0.440	4.31 ± 0.420
Magnesium 0-30 cm (cmol(+)kg^{-1})	1.62 ± 0.167	1.64 ± 0.160
Potassium 0-30 cm: (mg kg^{-1})	40.23 ± 4.169	40.78 ± 3.968
Cation Exchange Capacity 0-30 cm: (cmol(+)kg^{-1})	9.49 ± 0.899	9.76 ± 0.897

Although soil nutrient contents are useful to indicate soil quality, but to assess this indicator need specific knowledge and expensive equipments. Therefore, an alternative indicator such as decomposition rates that also relevant to forest soil processes is considered. Decomposition rates can provide an accurate prediction of soil and site quality or productivity (Johansson, 1994). In this study, I2.1.3: Decomposition rate determines from leaf bag recommended restoring into the final list of C&I.

2. *Improve and maintain yield and forest products.* All indicators under this criterion aim at the products of dry dipterocarp forest that involve in productivity of forest itself and products utilities by local people to monitor changing in yield and products that commonly provided by this forest type. The results showed no different in species utilization of local people and quantities of mushroom collected from forest area. Moreover, there was no logging operation in cultural forest, thus there was increasing of tree basal area overtime.

Principle 3: Disturbance sign should be under control

Limit human disturbances. Harvesting activities of non-timber forest products were considered as disturbance. These indicators groups reflect harvesting activities of local villager. Annual assessment showed that only digging hole increase in the later year. Corresponding with decrease in percentage of seedling in I1.4.3, this evident should be taken into the awareness of this harvesting pattern. For this study, there was no intensity disturbances that were affected to other forest components found in this area. However, the occurrence of disturbance type (harvesting activites) in cultural forest were considered to be small-scale disturbance that, in this forest, could not leading the severe negative effect to forest ecosystem integrity as showed in the overall result of indicators measurement. The further studies need to be conducted to point out specific impacts of disturbance to forest integrity. Kennard et al., 2002 found that the small-scale disturbance could be an intermediated disturbance that brought benefits to forest ecosystem.

Regarding with ecological rationale, the C&I that recommend being a final set for assessing forest ecosystem integrity in cultural forest were rearrange as showed in Table 4.28.

Table 4.28 The final set for assessing forest ecosystem integrity in cultural forest

Principle 1: Structure and composition of forest ecosystem are maintained
Criterion 1.1: To improve and maintain habitat heterogeneity
Indicator 1.1.1: Distribution in vertical stratification
Indicator 1.1.2: Percentage of canopy cover
Indicator 1.1.3: Percentage of similarity of vegetation community
Criterion 1.2: To improve and maintain richness/diversity
Indicator 1.2.1: Species richness of vegetation
Indicator 1.2.2: Abundance of nest of social bee
Indicator 1.2.3: Abundance of bird species
Criterion 1.3:To monitor population sizes and demographic structures of selected group
Indicator 1.3.1: Percentage of sapling and seedling
Indicator 1.3.2: Height class distribution of sapling
Indicator 1.3.3: Density and size class distribution of tree

Principle 2: Forest ecosystem function is maintained
Criterion 2.1: To conserve soil and water
Indicator 2.1.1: Frequency occurrence of soil erosion
Indicator 2.1.2: Percentage of ground cover
Indicator 2.1.3: Abundance of amphibian species
Indicator 2.1.4: Frequency occurrence of detritivorous soil fauna of selected group
Indicator 2.1.5: Quantity of leaf litters and small woody debris (under 10-cm diameter)
Indicator 2.1.6: Soil pH and conductivity
Indicator 2.1.7: Abundance of epiphytic species
Indicator 2.1.8: Abundance of herbaceous bole climbers
Indicator 2.1.9: Decomposition rate determine from leaf bag
Criterion 2.2: To improve and maintain yield and forest products
Indicator 2.2.1: Number of species removed from the forest (for sale/subsistence use)
Indicator 2.2.2: Quantity of certain species harvested from the forest
Indicator 2.2.3: Basal area of tree

Principle 3: Disturbance sign should be under control
Criterion 3.1: To limit human disturbances
Indicator 3.1.1: Number of stumps
Indicator 3.1.2: Number of digging hole
Indicator 3.1.3: Frequency occurrence of charcoals/burned logs
Indicator 3.1.4: Frequency occurrence of garbage/wastes