CHAPTER V

CONCLUSIONS AND RECOMENDATIONS

The goals of this study were to develop the criteria and indicators for assessing ecological integrity and test them in community forest. Ecological integrity concept plays a significant role to in achieving the goal of the sustainable forest management. Forest ecosystem structure and composition, function and disturbance were considered as the main components of forest ecosystem integrity. Moreover, several of the standard generic templates were also taken in consideration to generate the initial set of C&I. In this study, the process to select C&I was divided into 2 phases (Phase I and Phase II).

In Phase I, the first initial set of criteria and indicators (3 principles, 8 criteria, and 40 indicators) were generated. Top-down and bottom-up approaches were used to selecting and testing C&I. At the end of Phase I, the revised initial set of criteria and indicators consisted of 3 principles, 7 criteria, and 41 indicators. During Phase II, the Multi-Criteria Analysis (MCA) was adopted in general and fine filter step of C&I. Scoring and ranking method were used in general filter step. MCA act as a decision tool for addressing many issues relating to C&I assessment which specific to the forest management unit case study (Mendoza and Prabhu, 2000a). At this step, sixteen indicators were omitted from the revision list according to their redundancy meaning and impracticality at this scale of management level and/or irrelevant to management goals (Table 5.1).

Table 5.1 Rejected indicators after Phase I: General filter

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
Indicator 1.2.3: Frequency distribution of leaf size and shape
Indicator 1.3.2: Abundance of key stone species
Indicator 2.1.3: Decomposition rate determines from leaf bag
Indicator 2.1.6: Abundance of epiphytic mosses
Indicator 2.1.10: Soil nutrient contents
Indicator 2.2.2: Above ground biomass of tree
Indicator 3.1.3: Frequency occurrence of fire
Indicator 3.1.5: Number and distance of walkways/trails in forest area

As a result, scoring and ordinal ranking are excellent techniques to general or coarse filter a long list of C&I. Thus, there were 3 principles, 6 criteria, and 25 indicators remaining for further analysis in the next step (fine filter). Analytic Hierarchical Process (pairwise comparisons) was used in this step. Indicators were taken into one on one judgement under the numeric nine-point scale. Pairwise comparisons provided the priority rank of relative weight (important priority) of each indicator under its own criterion and also assessed the consistence of participant's judgement (C.I.). The results showed that most of C.I. fell in the acceptance level (<10%). The exception was for Criterion 2.1 of Principle 2. This is because the inconsistency generally increases as the number of compared indicators (Mendoza and Prabhu, 2000b). However, to eliminate the inconsistency was beyond the scope of this study. In conducting MCA, the participants were most comfortable with scoring and ranking while least comfortable with the pairwise comparisons. This mainly because there were many indicators in one-on-one judgements that participants have to compare.

The study showed that the MCA offers several desirable characteristics that are suitable for a decision-making tool. It enhances the participatory approach (bottom-up approach) where the local organization is involved as decision-maker. It also accommodates different C&I with a high transparency for all participants. However, to concrete the MCA techniques, workshop should be occasionally established for local organization to strengthen the abilities and to clarify the special techniques which are relevant to ecological practices and concept. Moreover, translation of theoretical concepts to local language should be correctly done to achieve the goal.

The annual assessment results of C&I in experimental plots showed that most of the indicators could be measured (direct/indirect) with common practical method. However, alternative additional method should be developed to concrete some indicators gathered from indirect method such as Indicator 2.2.4: Quantity of certain species harvested from the forest that presented the rough estimating value. According to the concept, measurement value of each indicator altogether could represent the cultural forest ecosystem integrity under management practices. Monitoring the change of C&I will present the dynamic of forest, both structure and function, caused by natural changes and/or human disturbances. Human disturbances (harvesting activities) could be considered as a small-scale (light) disturbance because it showed no negative effect to overall integrity but the specific mechanism needs a further study. Beyond the better trend of indicators relevant to forest structure and function, the study of nutrient contents of forest soil showed a better trend of important contents in soil over time.

Finally, C&I were justified under ecological rationale before propose to be a final set. Under Criterion 1.3 (To improve and maintain richness/diversity), Indicator 1.3.3: Abundance of nest of social bee, Indicator 1.3.5: Abundance of butterfly species, and Indicator 1.3.4: Abundance of bird species were considered to be redundancy meaning. Thus, Indicator 1.3.5: Abundance of butterfly species was recommended to be cut off. Under Criterion 2.1: To conserve soil and water, Indicator 2.1.3: Decomposition rate determines from leaf bag was recommended to be added back to the final list.

In some situation, indicators could be substituted with the secondary indicators that represent the similar objective or meaning when it is not available or cannot be measured at that time. Hartanto et al., 2003 suggested that indicators such as canopy cover, sapling density, and amount of woody debris could indirectly refer to the magnitude of soil loss. Long-term monitoring those set of C&I will represent the

dynamic of forest caused by natural changes and/or human disturbance. However, the categories or composition of C&I might be changed in according with the management goals.

The results gained from this case study were practical, theoretical sound, and conceptually defensible. The approaches themselves are appealing because they included the stakeholder participatory principles that are now widely accepted in managing of forest resources (Prabhu et al., 1996; Mendoza et al., 1999; Ladelma, Salmeden, and Hokkanen, 2000; Mendoza and Prabhu, 2000a, b).