

3: Generating an index of local biodiversity value

ERP project R7112 - Development and promotion of improved methods for identification, assessment and evaluation of biodiversity for tropical mountain environments

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This paper outlines work undertaken by ERP project R7112 in three communities on Mount Cameroon during the period 1999-2001. These are: Bakingili - a low-level multi-ethnic community; Ekona Lelu - the highest community on the mountain, ethnically homogeneous and comprises hunters and farmers; Bova - at low level on the north side of the mountain, ethnically diverse and mostly farmers. The results illustrate points arising out of the background paper 'Participatory assessment, monitoring and evaluation of biodiversity: the art and the science' and is presented as a contribution to Theme 2 - 'Incorporating values' of the ETFRN workshop. The protocols used for the fieldwork are presented in an accompanying document also posted on the ETFRN website (Ambrose-Oji *et al.* 2001) with preliminary results previously published as Lawrence *et al.* (2000).

One of the intentions of the project was to create a single index of local value to set against scientific indices and in particular the "genetic heat index" GHI Hawthorne (1996) which is being used by the Mount Cameroon Project⁶ to evaluate conservation hotspots on Mount Cameroon.

GHI is a single number that seeks to represent a qualitative value for conservation of particular sites. It has the effect of indicating sites which contain rarer species. It is not a measure of diversity *per se*. The basis of GHI, and its sister indices PI (pioneer index) and EI (economic index), is to classify the plant species into groups according to the attribute of interest, be this rarity, ecological profile or economic value. Weights are assigned to each class and a weighted index generated for species occurring at sample sites as outlined in Box 1 for GHI.

When GHI is used to compare sites, the effect is to highlight those which have the greatest representation (as a proportion of species) of rare species - biodiversity hotspots. GHI was developed in species-rich tropical high forest in Ghana and works well when there are more than around 50 species present at a site. The main application of this index is the identification of conservation priority sites.

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Box 1. Calculation of GHI (Hawthorne 1996)

Classification and weights for plant species according to global rarity

Class (stars)	Weight	Extent of area for species
Black	27	Local (country endemics)
Gold	9	Regional (biogeographical zone endemics)
Blue	3	Widespread but locally uncommon
Green	0	Ubiquitous

Count numbers of plants at a site falling into each group.

$$\text{Genetic heat index} = \frac{27 \text{ Black} + 9 \text{ Gold} + 3 \text{ Blue}}{\text{Black} + \text{Gold} + \text{Blue} + \text{Green}}$$

Conceptually a comparable index for community value would be a single number which would represent the value of a site to the community. However, just as the conservation value of a site can be measured according to several attributes such as rarity, diversity or representability, the community value of a site can be measured in many dimensions. Our first idea was to attempt to generate a single index to measure the total local or community value of a site, using GHI as a conceptual starting point. Paper 2 gives discusses the merits of the various ways and scales at which we used to systemise and quantify community values.

Using the species scoring data for the 40+ species as a starting point a conservation trade-off exercise was devised to determine the relative weights of the various criteria and this successfully generated an understanding of how people rate the relative merits of rarity, abundance, beauty and usefulness. Table 1 presents the results obtained from one of the trade-off exercises. In the table, each row represents a different pair of hypothetical plants with the group of participants asked to evaluate the following scenario: 'There are two localities, each containing a plant with the characteristics as given in the table. There is a bulldozer coming into the village to make a new road; it will have to destroy one of these places and you can choose which one. Which place will you save and why?'

Table 1. Results of conservation trade -off exercise in Baking ili

PLANT (1)	PLANT (2)	Plant chosen to save from habitat destruction
Use N = 1 Use quality = 5	Use N = 4 Use quality = 2	Choose (1): because when it cures a disease it does so at once (thus its power for this use is high).
Use N = 1 Beauty = 0	Use N = 0 Beauty = 5	Choose (1): because it has a use.
Distribution= 5 Abundance= 1	Distribution= 2 Abundance= 5	Choose (2): because that species could get finished because many people need it, while plant (1) you could harvest a bit at a time in a certain place and leave more for somewhere else.
Use N = 2 Distribution= 4	Use N = 5 Distribution= 2	No consensus. Some people preferred (1) while other preferred (2), for a number of reasons. In general people seemed to prefer (2) because of the number of uses even though its distribution was limited.
Beauty = 5 Trouble = 1	Beauty = 2 Trouble = 5	There was strong gender disagreement on preference. The four women preferred plant (2) because you have to persist to get something good (no suffer; no gain) while the three men preferred plant (1) because they were not prepared to suffer to obtain it. NB this discussion was really about uses rather than beauty and "trouble" was spininess (or something similar).
Use N = 4 Seasons = 1	Use N = 3 Seasons = 2	Choose (2): because of the continuity of its availability.

PLANT (1)	PLANT (2)	Plant chosen to save from habitat destruction
Use N = 5 Trouble = 5	Use N = 3 Trouble = 1	There was a disagreement: a vote gave 5 people in favour of plant (1) and 3 in favour of plant (2).
Distribution= 1	Distribution= 5	Choose (1): because its only location will be destroyed, eliminating this plant, whereas but plant 2 will survive anyway as it is present in many places.
Distribution= 2 Abundance =1	Distribution= 2 Abundance= 5	Choose (1): because the high numbers of plant (2) mean it should survive even if its location is badly damaged.

This exercise produced surprisingly good results; even arguments over the relative importance of rarity over multiple uses. The results suggest that the highest valued plants would be those that are beautiful, scarce, rare, that can provide a continuous supply of several strongly preferred products and, depending on your gender, are either easy (men) or difficult (women) to collect. The least important plants are those that are common, ubiquitous, ugly, useless and difficult to eradicate. The latter description seems very much like the definition of a weed and local people do tend to view useless plants much as weeds are viewed by fastidious gardeners. Once a plant has a use it is interesting to note that local people would make very much the same evaluation of extinction risk as external conservationists. The only real difference is that conservationists make a virtue out of rarity itself. This does not make sense to the local participants, as they want to know the 'use' a rare plant has. If this can be convincingly explained then they would have little difficulty accepting that scarce and rare plants require protection.

Using the relationships revealed in Table 1 an attempt was made to devise a single index of value for plant species. The information on the relative significance given to the value criteria and scores from the trade-off exercise (from table 1 for example, it is obvious that use=1 is more important than beauty=5 so beauty/5=use) were used to weight the contribution of each criteria to the overall score to give formulae such as:

$$V = (U + (2Q)) + B/5 + (-P -A)$$

if $U > 0$ then multiply V by S
if $U = 0$ then subtract T-1 from V

- V local valuation
- U number of uses
- Q preference for use – quality of plant for its use
- B beauty of plant
- P distribution i.e. number of habitat types in which the plant can be found – 'scarcity'
- A abundance of plant in the habitats in which it is found
- S seasonality
- T troublesomeness

For the Bakingili data this formula calculated for each respondent yields plant scores from -3.0 to +79.6. Within this range few plants are given the same value which means the scores are useful for ranking the plants in order of importance to a particular respondent. The 'community' value for each plant was taken as the sum of individual respondent's scores for that species. This gives a range of values from 16.6 to 532.4, again with few plants being given the same score. The list of species ordered according to this community index was presented to the participants for verification and was emphatically rejected. Neither the ordering nor the scale (whether one plant was twice or three times as valuable as another) were accepted by the participants. It may be possible to improve this acceptance of the outcome by modifying the formula, creating broader classes or treating the combination of individual scores in a different way. However, since it was found that people were happy with the summed scores of individual respondents for each criterion for each plant a different approach was attempted.

Following the reasoning behind the GHI, the species were classified according to their relative value separately for the utility and abundance criteria, which were considered by the local participants to be the most important components of overall value. Given that we only have data for a few species (40-42) only two classes were formed for each attribute. These were represented in a contingency table and the participants were then asked to rank the four resulting combination classes according to their value. All the participants responded with the same rank order (Table 2).

Table 2. Ranking of species value according to alternative combinations of use and abundance

		Abundance ¹	
		Low	High
Utility ²	Low	4	3
	High	2	1

¹ Numbers of plants multiplied by the number of habitats in which it is found (see paper 2)

² Number of uses for a plant multiplied by its quality for those uses

Table 2 suggests that utility is the most important component of value with more abundant plants being more valuable than rarer ones. This is at odds with the findings of the trade-off analysis reported in Table 1, which suggests that rarer plants are valued more highly than common ones. It is possible that *both* observations are true with the difference reflecting the different circumstances and questions being posed. In general, one would value highly something that is useful, plentiful and easy to find. However, as Table 1 shows, when given the choice between saving something or losing it that they would prefer to save it. Whether this should be interpreted as an expression of *value* is an open question, which we did not have time to pursue with the communities.

We did not have the opportunity to pursue the lead given in Table 2 through the whole process of weighting the classes and testing a CVI index for particular sites but it would appear to be useful avenue for further research. However, our experience suggests that the derivation of a single index to represent community value may be futile. The participants were generally happy with the use of their combined scores as a means of ordering and scaling species in terms of their local value for individual criterion. A better way of facilitating discussion about management alternatives might be to map criteria separately and to make the trade-offs between them explicit.

Comparing values across scales

Value judgements are made at many levels and it is necessary to have some means of understanding the linkages between them. For example, we can derive habitat values as counts of the number of attributes mentioned for each and also as the sum of the values of the species present. Our work included the quantification of values at the landscape, habitat and species levels and we wished to contrast these with the scientific equivalents. However, this is not possible at present, as there appear to be few *quantified* rather than *categorised* scientific values that are used at either the species or landscape scales (Table 3) or have been applied to the Mount Cameroon area. GHI and other similar indices work at the habitat level but represent habitat value as the sum of its species and not as a whole. Apart from GHI, at the habitat scale only species richness is mentioned in Table 3, but there are other biodiversity measures that can be applied such as indicators of species relative abundance, e.g. evenness. The Abundance species scores provide a measure of perceived relative abundance but there is no comparable scientifically based data for Mount Cameroon with which to compare these data. Evenness could be calculated from the existing RBS or forest inventory plot data but this has not yet been attempted.

Table 3. Comparison of local and scientific value measures

Scale	Local community (as collected by ERP project)	Scientific (as collected by MCP project)
Landscape	Ranks of photographs	None

Habitat (site)	Ranks of habitat photos Counts of numbers of habitat attributes mentioned Counts of folk taxa	GHI Species richness
Species	Scores against a range of criteria	Star ratings

Table 4 (at the end of the document) gives the values for a range of measures derived from ERP project data for 17 sites (distributed amongst the land of the three studied communities). This is provided as an example of the kind of comparisons than can be made. There appear to be some interesting patterns in these data but we cannot yet give a full interpretation of them. However, there seem to be differences amongst the three communities, e.g. the number of attributes named in Bova, across all the habitats there, seems low compared to the other two communities and a higher proportion were negative attributes. Habitat rarity also seems to have been poorly captured, e.g. the amda (coastal swamp) habitat at Bakingili was scored low for rarity (presumably because it is large and close to the village), despite being one of only two patches on the coast along the whole western side of Mount Cameroon.

On balance it would seem that the local measures/scores of biodiversity have provided more useful quantitative information than the scientific side of the ERP project. This might suggest that there would be merit in using some of participatory techniques to enhance the holistic evaluation of habitats and landscapes in general biodiversity assessment activities.

Valuing processes

Interestingly the participants mentioned processes as being linked to diversity and an integral part of forest habitats in particular. This is apparent in comments such as 'the forest has many plants because there are many animals there to spread seed', 'that squirrel is important because it is a planter' and 'the animals hide in the forest and come out at night to feed in our chop farms which is why many different kinds of animals can be found on the farms'.

In local community biodiversity assessment it is obviously difficult to quantify processes or indeed to deconstruct a habitat into its component processes for valuation, as is done for indices such as GHI. Local people's perception of the value of the forest as whole includes processes and is perhaps a more realistic way of achieving a whole ecosystem assessment, then any readily available scientific alternatives. Interestingly, in Ghana the Forestry Department developed a subjective condition scoring system for forest integrity which has been widely incorporated into forest management planning there. Experience with species scoring suggests that local people, and very probably also the local forestry staff in the Mount Cameroon area, would be able to develop a scoring system which incorporates ecosystem functions and could be used to guide management planning as in Ghana. Our work indicates a general acceptance within communities that it is those who are most familiar with particular habitats who should be responsible for determining their scores, and this should increase their reliability; in most of the forest and high altitude habitats on Mount Cameroon this would need to be the professional hunters.

Mapping values

Our study focussed on the quantification of values for sample sites to test the methods under development. However, management and monitoring require that the spatial location and extent of biodiversity value is known which is best served by the production of maps. Using an extension of the field walk technique it should be possible to prepare maps showing the variation in habitat values across the landscape. However, experience suggests that it would be best to prepare individual maps for each attribute of interest rather than attempting to combine values on a single map. Since uses are perhaps that biggest determinant of value, maps showing the value of the forest for the main uses would be of particular interest.

References

- Ambrose-Oji, B., Lawrence, A., Lysinge, R. and Wong, J. (2001) Obtaining local values for biodiversity: Protocols used by the ERP Mount Cameroon Project. Posted on ETFRN website.
- Hawthorne W.D. (1996) Holes and the sums of parts in Ghanaian forest: regeneration, scale and sustainable use. *Proceedings of the Royal Society of Edinburgh*, 104B: 75-176.
- Lawrence, A., Ambrose-Oji, B., Lysinge, R. and Tako C. (2000) Exploring local values for forest biodiversity on Mount Cameroon. *Mountain Research and Development* 20(2): 112-115.

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Table 4. Values for specific sites on Mount Cameroon

Village	Site	Botanical species richness	GHI ¹	Black & gold stars	Local free list species richness	Numbers of attributes mentioned ²			
						Positive	Negative	Diversity ³	Rarity ⁴
Bakingili	Secondary forest (volcanic 'black' soil, former oil palm plantation)	104	227	11	52	120	14	2	
	Secondary forest on 'red ground' (soil derived from a volcanic vent, former oil palm plantation)	121	91	8	55	126	22	7	3
	'Thick' forest (older secondary forest on black soil)	149	151	13	53	114	26	7	1
	Tondo bush (land dominated by herbaceous species of <i>Afromomum</i>)	23	13		40	106	17	1	
	Chop farm (land under cultivation for food crops)	38	0		40	89	9	2	
	Lamda (coastal swamp - mix of trees and herbaceous vegetation)	13	23		39	102	17	1	1
Ekona Lelu	Chop farm (land under cultivation for food crops but with extensive weed cover)	48	25		67	101	6		
	Young secondary forest – fallow land more than 10 years since cultivation	62	29		60	118	13	2	
	Thick forest (reputedly not previously farmed or logged)	42	121	1	50	115	6	4	1
	Savannah (on a 100 year old lava flow)	9	133	1	20	86	12	2	2
	Elephant bush (fallow land dominated by tall grasses)	22	68	1	35	95	12		7
Bova	Lowland savannah (<i>Borassus</i> palm cover over crops but formerly grassland)	83	43	1	87	66	12	5	3
	Thick forest (reputedly not previously farmed or logged)	49	24		76	63	21	1	2
	Secondary forest (old fallow)	56	26	1	53	73	20	1	
	Chop farm (land under cultivation for food crops)				73	55	18	1	
	Teak plantation				13	33	18		
	Cocoa farm				39	48	16		1

1 Note that this index does not perform well with less than 50 species.

2 The number of times a group of attributes of the habitat was mentioned in response to the question 'what do you like/dislike about this place?'

3 Diversity is the number of times a respondent mentioned that there were many plants/animals present, or different things that they could do at the site

4 Rarity relates to the site, i.e. the rarity of the habitat not of the species.