

# Vegetation analysis of Oak Forests of Fambong lho Wildlife Sanctuary in Sikkim Himalayas

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**Abstract**—A total of 4683 plants belonging to 62 families, 92 genera were enumerated from the study site. The topmost canopy was formed by *Quercus lineata*, *Lithocarpus pachyphyllus*, *Quercus lamellosa*, *Castanopsis tribuloides* while the second layer was formed by *Symplocos lucida*, *Caruga pinnata*. The highest adult tree species were recorded of *Elaeocarpus sikkimensis* (119 ind/ha) followed by *Daphne sp.* (56 ind/ha) and *Eurya acuminata* (46 ind/ha). The IVI for adult tree were highest of *Elaeocarpus sikkimensis* (19.4) followed by *Eurya acuminata* (17.1) and *Castanopsis hystrix* (13.1). The species diversity ( $H'$ ) was highest for herbs (1.66), trees (1.54) and shrubs (1.19). Raunkiaer's life form assessment showed phanerophytes as the largest life forms (44.85%) followed by Chamaephytes (32.35%) and Geophytes (14.70%) indicating the prevalence of a phanerophytic phytoclimate in Fambong lho wildlife sanctuary (WS). The poor regeneration of oak as compared to *Eurya acuminata* (50.9 ind/ha), *Symplocos lucida* (30.9 ind/ha) indicates a high chances of change in species composition and vegetation structure in the future.

## 1. Introduction

Sikkim is a small state in the north-eastern part of India which is a repository of rich floral and faunal diversity [16]. Diversity is the result of the combination of abiotic limitations, biotic interactions and disturbances [9]. Abiotic factors such as elevation, aspect, soil texture and climate determine the physical environment and therefore heed way for the distribution of the species. The extent of biodiversity is measured typically on species level and species diversity is one of the important indices used to appraise ecosystem at different scales [1]. The diversity can be measured using various indices such as number of species per unit area (species richness), Shannon index. These indicators are used to study communities and understand the homeostatic capacity of the ecosystem to the unprecedented environmental changes [6]. Primary climate, location and condition of sites have influenced and determined biodiversity and life-forms in a particular area in the long term development of the forest ecosystems [14]. "Biological spectrum" was proposed by Raunkiaer which represented life-form distribution and the phytoclimate under which it thrives [11]. Therefore, the actual biodiversity is the result of the adaptation process of the species to its phytoclimatic condition. Oak species in general have been reported to determine the floral and faunal diversity of the forests. It has also been suggested that a shift of structure and component of an Oak forests ecosystem would likely affect the other ecosystem components as well [18]. As Oak woodlands become denser with shade tolerant trees, plant species which are adapted to frequent disturbance and more open conditions may perish resulting in the decline in plant diversity [13]. Among the other deciduous trees oak species in general produces acorns and nuts which is a good source of food for numerous mammals and birds. The oak forests are degrading in Sikkim which has been converted into thickets, shrubs and blank areas [19]. A shift in forest tree composition from oak to other species would have serious implications for many wildlife species [13]. Therefore, to address the issue Fambong lho WS was selected as a representative site and a study was undertaken to document the species composition, vegetation structure and its life forms under present phytoclimatic conditions.

## 2. Materials and Methods

### 2.1 Study site

Fambong lho WS was established in the year 1984 and is located in the eastern part of Sikkim covering an area of about 51.76 sq km and has its continuation with Khangchendzonga National Park in North Sikkim. The word "Fambong lho" means "orchard of *Machilus edulis*" which is abundantly found in Sikkim Himalaya. The sanctuary is rich in biodiversity and is highly undisturbed [10]. Besides, the sanctuary is a repository of wide range of *Lithocarpus*, *Quercus* and *Castanopsis* species as well as several other flowering plants.

## 2.2 Floristic Composition

The Floristic composition was studied by laying 10 × 10 m, 5 × 5 m and 1 × 1m of random quadrats for trees, shrubs and herb species respectively. Vegetation data including density (number of individuals ha<sup>-1</sup>), frequency (occurrence of species), evenness (closeness in distribution of species) were calculated. Shannon diversity index was measured using the formula  $H' = \sum[(n_i/N)\log_e(n_i/N)]$  where  $H'$  is Shannon diversity index,  $n_i$  is number of individuals of species "i" in a community sample, N is the total number of individuals of all species in the community sample [6]. The Generic co-efficient for plant species was calculated according to [4].

$$\text{Generic co-efficient (G)} = \frac{\text{Totalno.ofGenera}}{\text{Totalno.ofspecies}} \times 100$$

Higher generic co-efficient indicates varied habitat and more intergeneric and intrageneric competition in the area. The regeneration status of any tree species was estimated following [17].

## 2.2 Biological Spectrum

Life form of the species enumerated was determined by following Raunkiaer [11] where the species were classified into Phanerophytes, Chamaephytes Hemicryptophytes, Geophytes, Lianas and Epiphytes. The percentage of species classified into each life forms were determined by the following formula:

$$\text{Percentage of Species in Life Form} = \frac{\text{Number of Species in any life form}}{\text{Total number of species of all life form}} \times 100$$

## 3. Results

A total of 4683 plants belonging to 62 families, 92 genera were enumerated from Fambong Iho Wildlife Sanctuary. Among these *Lithocarpus pachyphyllus*, *Quercus lamellosa*, *Castanopsis hystrix*, *Lithocarpus elegans*, *Lithocarpus fenestratus*, *Castanopsis tribuloides*, *Quercus lineata*, *Castanopsis indica*, *Castanopsis lanceifolia* are the oak species that has been recorded so far. The Basal Area of *Quercus lamellosa* is 15.6 m<sup>2</sup>, *Castanopsis lanceifolia* is 4.90 m<sup>2</sup>, *Castanopsis tribuloides* is 0.94 m<sup>2</sup> and *Castanopsis indica* is 1.45 m<sup>2</sup>. Shannon diversity index was measured to be 1.54, 1.19, 1.66 with an evenness of 0.87, 0.84, 0.90 for trees, shrubs and herbs respectively. Among the tree species, Fagaceae comprised the largest family (9 species) followed by Lauraceae (7 species), Magnoliaceae (5 species) and Symplocaceae (4 Species) (Figure 1). The highest regeneration density in its seedling stage was determined to be of *Eurya acuminata* (50.9 ind/ha) followed by *Symplocos lucida* (30 ind/ha) while *Drepanostachyum intermedium* (30.9 ind/ha) showed the highest regeneration status in the sapling stage.

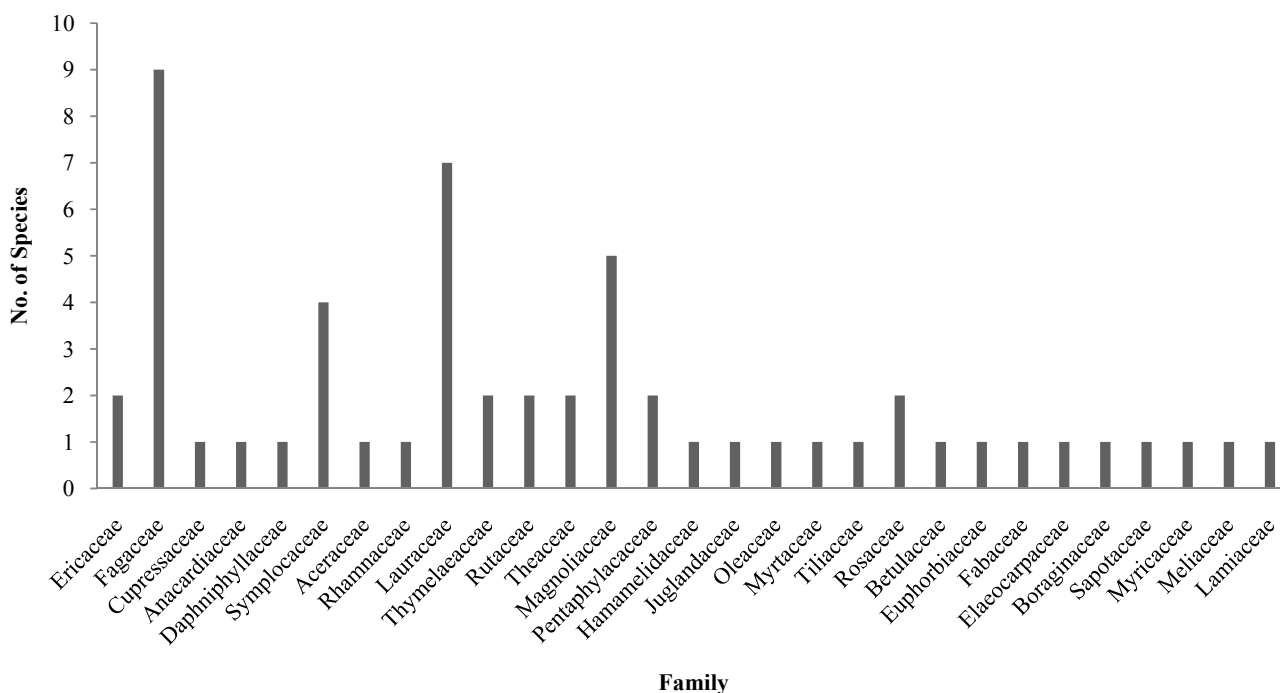


Figure 1: Family-wise species composition

### 3.1 Biological Spectrum

The phanerophytes comprised of the largest life form (44.85%) followed by Chamaephytes (32.35%) and Geophytes (14.70%) indicating the prevalence of a phanerophytic phytoclimate (Figure 2). Raunkiaer's frequency class revealed that 88-92% of trees, shrubs and herbs in the low frequency class with very few individuals in the 21-40% frequency class (Figure 3). Generic coefficient was determined to be 77.31% which indicates that more intergeneric and intrageneric competition exists in the area.

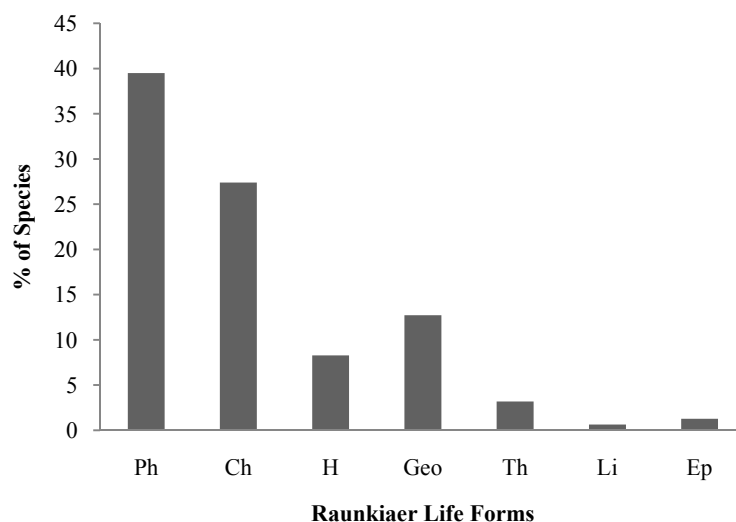


Figure 2: Floristic life-form spectrum of Fambonglho WS

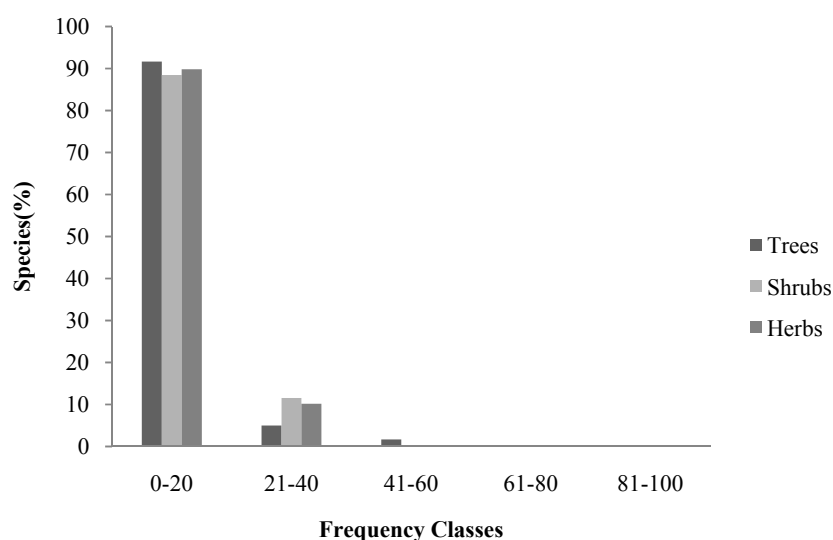


Figure 3: Percentage frequencies of trees, shrubs and herbs in Fambonglho WS

### 3.2 Vegetation Profile

A transect of 30 metre (m) was taken to sketch the vegetation profile in the study site. A total of 11 tree species belonging to 8 families were encountered. Among these the top canopy is mainly constituted by species such as *Quercus lineata*, *Lithocarpus pachyphyllus*, *Quercus lamellosa*, *Castanopsis lanceifolia*, *Myrsine capitellata*, *Machilus edulis* whereas the others such as *Symplocos lucida*, *Caruga pinnata* formed the second layer of canopy (Figure 4). *Eurya acuminata* has the highest density (104 stems ha<sup>-1</sup>), *Daphniphyllum himalayense* (95 stems ha<sup>-1</sup>), *Castanopsis tribuloides* (72 stems ha<sup>-1</sup>) and *Lithocarpus pachyphyllus* (43 stems ha<sup>-1</sup>) (Figure 5, Table 1). *Quercus lineata* and *Caruga pinnata* were the tallest tree with a height of 32m and 30 m respectively in the transect.



**Figure 4: Vegetation profile diagram of Fambonglho WS**

1) *Eurya acuminata*, 2) *Symplocos lucida*, 3) *Morus* spp.4) *Symplocos glomerata*, 5) *Quercus lineata*, 6) *Myrsine capitellata*7) *Castanopsis lanceifolia* 8) *Caruga pinnata*, 9) *Populus ciliata*10) *Arisaema* spp.11) *Viburnum* sp.12) *Quercus lamellosa*, 13) *Acer* sp.14) *Machilus edulis*, 15) *Sinarundinaria maling*

### 3.3 Discussion

The number of species (155) recorded in the present study in an area of 0.46 ha is higher than the species reported by researchers in a temperate forests [15-16]. In a small area the figure obtained can be considered as a relatively fair representation of total floral constituents of Sikkim [15]. Phanerophytes which forms the canopy are the highest life forms comprising of 44.85% of the other life forms. Phanerophytes comprised 44.7% which formed canopy in the Sang-Tinjure of Fambonglho WS (15). This could be attributed to the phanerophytic phytoclimatic condition of the area. Unlike the findings where therophytes were absent [15], it constituted 3.18% of the life form in the study undertaken which could be attributed to the harsh environmental condition in the study site. The diversity index ranged between 1.19 – 1.66 which falls under the range of the values of the diversity index [12]. The density of regenerating individuals of oak was poorer than other species such as *Symplocos lucida* and *Eurya acuminata* which could be a cause of concern. Although oaks have been reported to live upto 700 years [3] the low density of seedlings and sapling would result in the change in the species composition in the future. The growth of oaks has been on the verge of decline due to hydrologic balance and its delayed response to climate [2] or due to pest infestations [5]. Oak species formed the topmost canopy of the forest and even a slightest disturbance would change the microenvironments in the understory [8] with alteration in the ground layer light environment [7]. A sudden shift on the vegetation structure and species composition of Oak forests would directly result in loss of plant species and affect wildlife [18].

**Table 1: Structural data on some major trees of Fambonglho Wildlife Sanctuary, East Sikkim**

| Scientific name   | Family           | Density (plant/ha) | Abundance | Relative density | Relative frequency |
|---|------------------|--------------------|-----------|------------------|--------------------|
| <i>Lyonia ovalifolia</i> (Wall.) Drude                  | Ericaceae        | 11.82              | 49.08     | 2.04             | 2.07               |
| <i>Castanopsis hystrix</i> Hook. F. & Thomson ex A. DC. | Fagaceae         | 30.00              | 19.33     | 5.17             | 7.89               |
| <i>Cryptomeria japonica</i> (Thunb. Ex L.f.) D. Don     | Cupressaceae     | 9.09               | 63.80     | 1.57             | 2.49               |
| <i>Quercus lamellosa</i> Sm.                            | Fagaceae         | 20.00              | 29.00     | 3.45             | 4.15               |
| <i>Lithocarpus elegans</i> (Blume) Hatus. Ex Soepadmo   | Fagaceae         | 4.56               | 127.60    | 0.78             | 1.24               |
| <i>Rhus insignis</i> Hook. f.                           | Anacardiaceae    | 7.27               | 79.75     | 1.25             | 1.66               |
| <i>Daphniphyllum himalayense</i> (Benth.) Müll. Arg.    | Daphniphyllaceae | 38.18              | 15.19     | 6.58             | 5.81               |
| <i>Lithocarpus pachyphyllus</i> (Kurz) Rehder           | Fagaceae         | 17.27              | 33.58     | 2.98             | 3.73               |
| <i>Rhododendron griffithianum</i> Wight                 | Ericaceae        | 13.64              | 42.53     | 2.35             | 2.90               |
| <i>Acer campbellii</i> Hook. f. & Thomson ex Hiern      | Aceraceae        | 6.36               | 91.14     | 1.09             | 1.66               |
| <i>Berchemia floribunda</i> (Wall.) Brogn.              | Rhamnaceae       | 1.82               | 319.00    | 0.31             | 0.83               |
| <i>Beilschmiedia sikkimensis</i> King ex Hook.f.        | Lauraceae        | 3.64               | 159.50    | 0.63             | 1.24               |
| <i>Daphne cannabina</i> Lour.                           | Thymelaeaceae    | 9.09               | 63.80     | 1.57             | 2.07               |
| <i>Michelia</i> sp.                                     | Magnoliaceae     | 3.64               | 159.5     | 0.63             | 0.83               |
| <i>Eurya acuminata</i> DC.                              | Pentaphylaceae   | 41.82              | 13.87     | 7.21             | 0.95               |

|  |                |       |        |      |      |
|--|----------------|-------|--------|------|------|
| <i>Symplocos lucida</i> (Thunb.) Siebold & Zucc.       | Symplocaceae   | 11.82 | 49.077 | 2.04 | 1.66 |
| <i>Michelia cathartii</i> Hook. f. & Thomson           | Magnoliaceae   | 10.00 | 58.00  | 1.72 | 3.32 |
| <i>Castanopsis tribuloides</i> (Sm.) A. DC.            | Fagaceae       | 9.09  | 63.80  | 1.57 | 1.66 |
| <i>Michelia lanuginosa</i> Wall.                       | Magnoliaceae   | 4.54  | 127.60 | 0.78 | 1.24 |
| <i>Machilus odoratissima</i> Nees                      | Magnoliaceae   | 1.82  | 319.00 | 0.31 | 0.41 |
| <i>Betula utilis</i> D. Don                            | Betulaceae     | 0.91  | 638.00 | 0.16 | 0.41 |
| <i>Machilus edulis</i> King ex Hook. f.                | Lauraceae      | 2.73  | 212.67 | 0.47 | 0.83 |
| <i>Lithocarpus fenestratus</i> (Roxb.) Rehder          | Fagaceae       | 0.91  | 638.00 | 0.16 | 0.41 |
| <i>Fraxinus floribunda</i> Wall.                       | Oleaceae       | 0.91  | 638.00 | 0.16 | 0.41 |
| <i>Exbucklandia populnea</i> (R.Br. ex Griff.) R.W.Br. | Hamamelidaceae | 2.72  | 212.67 | 0.47 | 0.83 |

### 3.4 Conclusion

Vegetation analysis has depicted prevalence of high diversity in temperate forests with a considerably high generic coefficient. However, the state of regeneration of oak was poor with respect to its associative species which thrived well in the present phytoclimatic condition. However the lack of regeneration of oak is a cause of concern which if not dealt with will cause a massive impact on the species composition and wildlife respectively.

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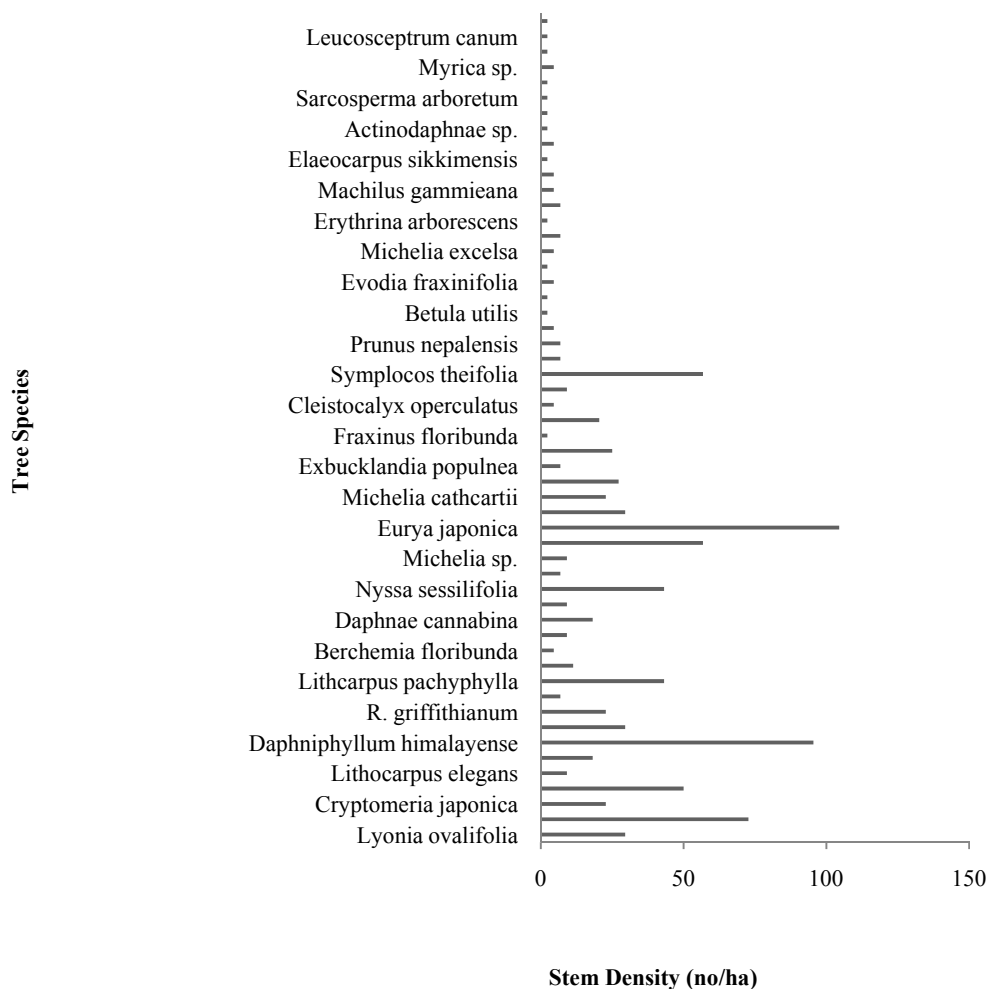


Figure 5: Percentage frequencies of trees, shrubs and herbs in Fambong lho WS

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