2 TYPE 2 – PROBLEM ORIENTED STUDY

The Sanctuary lands include different areas, which have been kept protected and allowed to recover. They range from recently cleared to old growth (but selectively felled) forest. In this study various areas have been grouped together under categories according to the number of years for which they have been undisturbed. The assumptions made are that all the areas have equal access to seeds and methods of dispersal and that the differences in soils, slope and aspect have only marginal effects. All the areas have had different land use histories. The patterns are complex and varied. There are examples in the past of small patches, even of a few square metres within an area, used for a different purpose. As such, effects of previous patterns of land use are extremely difficult to record and analyze, and have not been taken into consideration here, although may be investigated further in future studies. The main focus in this study is the relationship between age of protection and species composition/diversity. A null hypothesis for this study would therefore state – “there is no relationship between species diversity/composition and age of protection”.

2.1 Site Description

Area 1
This area is the youngest, having been under protection for almost six years. The grasses and thorny bushes make it difficult to penetrate. Canopy height is low and one has to crawl rather than walk. Many of the trees are coppiced. Lemon grass and elephant grass are abundant.

Area 2 (7 to 10 years)
This area has been undisturbed for between 7 to 10 years and includes patches that are not contiguous to each other. Though previous patterns of land use have been different they are similar in structures. Many of the trees are coppiced. Within the sampling areas it can be seen that the trees are relatively widely spaced but thorny bushes give a crowded appearance. There is plenty of lemon grass.

Area 3 (10-16years)
The plots in this area have trees that have been allowed to grow undisturbed for 10 to 16 years. There an abundance of lemon grass and elephant grass, which makes the area relatively impenetrable. Many of the trees have been coppiced and therefore their general heights are low. However, there are some individual uncoppiced trees which are around 6-8m. in height.

Area 4 (17-20 years)
This area has been under protection for between 17 and 20 years. The structure of a mature forest, which includes woody vines and creepers, is evident. Grass is absent from the forest floor. The average canopy height is around 10-12m. The area is easily walkable through since there is no dense bushy under-growth.

Area 5 (over 30 years)
This is the old forest area and has never been clear felled. Selective logging was done over 30 years ago. The average canopy height is above 12-15m. There is no dense undergrowth, but there are many woody vines and climbers. The high canopy makes location and identification more difficult. One has to find and follow leaves that belong to particular trees and then identify which genus/species it is.

2.2 Method

I started by dividing the 40 acres into 5 areas with the following age pattern: 0-6 years, 7-10, 11- 16, 17-20 and, 30 years and above. To determine the species composition and diversity, I chose the quadrat sampling method. The size of an individual quadrat is 10m X 10m. Subsequent quadrats of the same size were added increasing the sampling area. Once the plot was established, plot number, species name, and the diameter at breast height of each of the trees (DBH) was recorded. I divided each quadrat into three or four sections in order to map it more accurately. Saplings and trees below 1cm DBH were omitted from the count. The presence of vines and creepers was noted but none of them identified, so in this study they all qualify as one species. In the case of coppiced trees where the complete original trunk could not be measured, the thickest pole is measured. When the species area curve leveled off I stopped adding plots and collecting data since this indicated that the sample was large enough.
For measurement I used the DBH tape, and all the trees have been measured at approximately the same height above the ground. The measurements are rounded off to the nearest 0.1 cm. In the measurement of the plots themselves it was sometimes difficult to maintain 90-degree angles, so this may have caused small differences in plot areas. Another source of error could have been in not accounting for sloping ground. Errors are also possible from the minor sagging or stretching of the tape measure, in densely vegetated areas.

2.2.1. Names of trees

Most of the names that appear in the text are botanical names at the genus level. I do not know or am not sure of the individual species, so species names are mentioned only when I definitely know them. Some of the trees have descriptive names like “Green Fruit” or “Green Berries”, and these have been maintained throughout the study. The unknowns are specific to each area. I have written physical descriptions of each one to be able to identify them better.
Learning to identify trees by their vegetative characteristics needs time and patience. Some times the leaves of a tree just disappear into the canopy or the differences are very subtle. I have tried to be consistent and careful with the unknown species.

2.2.2 Some terms

In the text I have used different terms such as ‘area’, ‘plot’, and ‘quadrat’. Area includes all the pieces of land that come under the same age category. The areas 1-5 range from the youngest to that which has been untouched or kept under protection for the longest period of time. The terms plot and quadrat, in the text refer to the same thing. They are the sample areas of 10m. by 10m. which are taken in each of the areas. Individual plots were added together in the same area to increase the sample size.

2.2.3 Statistical Tests

Once the field data was collected, I applied some standard statistical tests and formulae. These are used to describe and assess community composition.

S = Richness, which is the total number of species in a quadrat

ni = the number of individuals of a particular species i

N = Total number of individuals

bai = basal area of particular species i in cm^2 (same as cross sectional area of the tree trunk at breast height)

BA= Basal area of all species in cm2.

RAi = Relative abundance of species i

> $RAi = (ni / N) \times 100$
> This value shows the percentage of each species present in an area

RDi = Relative dominance of species I

> $RDi = (bai / BA) \times 100$
> This value is calculated using the area measurement and shows the physical representation of each species.

RFi = Relative frequency of species I

> Frequency of plots with species I divided by the summation of frequencies for all species multiplied by 100. This shows the distribution of species across quadrats within an area

To discern a pattern of diversity within the community the species area curve is useful. The graph is constructed by plotting the number of species against area. As the sample area increases new species may be observed or some already observed may be absent. When the area sampled in sufficiently large the number of new species that appear become fewer and eventually the graph levels off.

2.3 Results

2.3.1 Data Tables 1-5

Please see following pages.

2.3.2 Description

The data when looked at together, allows for comparison and brings up several questions. In the beginning the numbers seem confusing and meaningless, but when looked at more closely they show interesting patterns relating to the distribution of species. Here I have chosen a few species to look at their presence through the five areas. Since the Importance value (IV_i), is a sum of the others, and gives a more meaningful measure, I have used these values in the comparison.

Aporosa lindleyana and *Olea dioeca* are two species that are common through all the areas (tables 1-5). In the older areas the trees are of medium size but in the younger areas they are almost always coppiced so their heights are low. *Aporosa lindleyana*, family *Euphorbiaceae* , is a small or medium tree and *Olea doieca* grows into a moderate to large tree. They both flower around January to march. Though the two species occur in all the areas, their importance values vary. The values of *Aporosa lindleyana* fall steadily. When encountered in the mature forest trees of both the species are well-grown and almost full size. They both seem to be relatively important in the younger as well as the old forest areas. See figure 1.

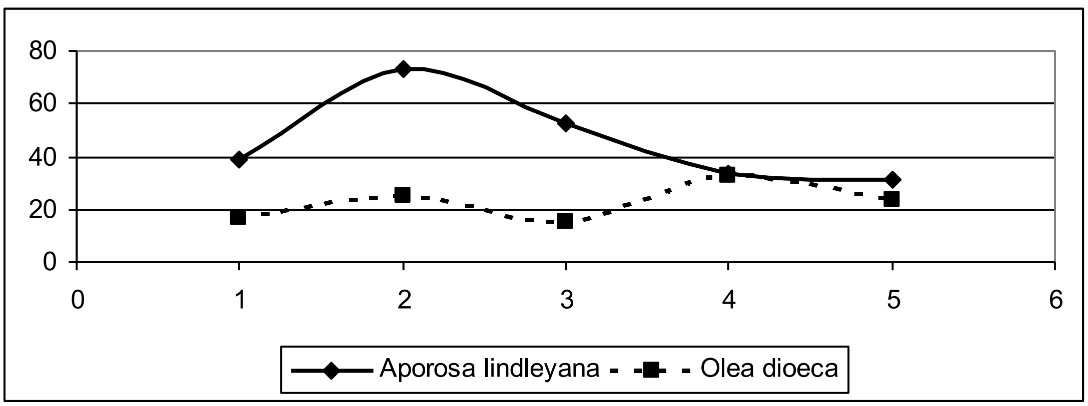

Figure 1

Clerodendron sp., Green Fruit and *Wendlandia* are three trees that are common in the first three areas, suggesting that they may be pioneer species. *Clerodendron*, family *Verbenaceae*, is known to be abundant in wastelands and is difficult to remove once established. The trees are usually small and shrub-like. Green Fruit is a very small, almost bush-like tree with thorns. It also seems very common in cleared areas. *Wendlandia*, family *Rubiaceae*, is also a small tree. It is abundant on land that has been cleared for cultivation, and also in open forests. The occurrence of all three species is only in the three younger plots. From the fourth area they are completely absent. Maybe their size becomes a disadvantage as the forest becomes more mature causing them to get shaded out. This pattern is clearly visible in the graph showing the importance values, especially in the case of *Clerodendron* and Green Fruit. See figure 2.

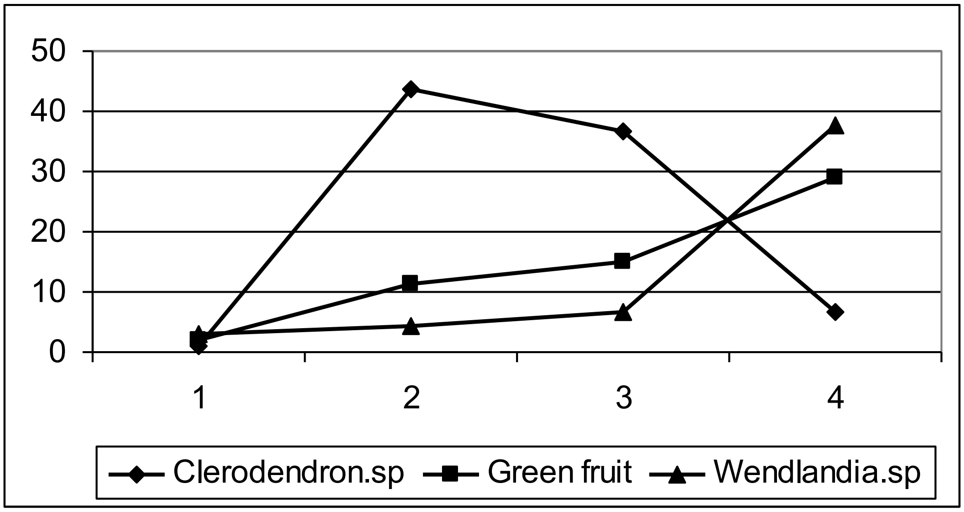

Figure 2

Symplocus and wild mango are two species that occur only in the two oldest areas, that is the areas that have been under protection for more than 17 years. *Symplocus* is a medium sized tree. Two species are seen in the Sanctuary, but 18 are found in the Western Ghats. The wild mango tree is known to be a tree common to the forests of the region. The trees can be very large. See figure 3.

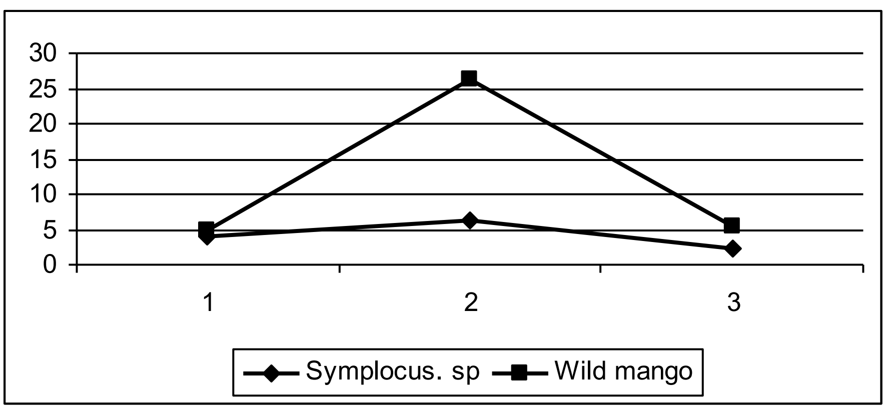

Figure 3

The presence of woody vines and lianas is also increases as the age of protection of the area increases. These growth forms, with their amazing size and abundance are one of the striking features of the Tropical Rain Forest. They are abundant in tropical regions where the trees are able to support them and they are ecologically important. An estimated 90% of all species of climbers or lianas occur in tropical rain forests. See figure 4.

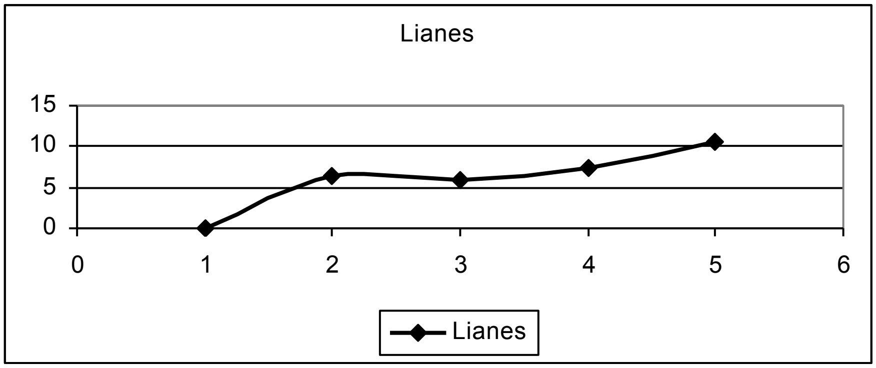

Figure 4

In each of the Areas, species diversity increases with an increasing sample size. The graphs on the following page show the rates of increase in the number of species in Areas 1-5.When the graph stabilizes is an indication that the sample size is large enough, since there are no new species that appear.
See Facing Page Graphs 1-5

2.4 Discussion

The study has brought out many interesting results and patterns. The null hypothesis states that there is no relationship between species diversity/composition and the age of protection. In doing the study I had always expected there to be a positive relationship between the age of protection and the species diversity, and had assumed that the diversity would continue to rise, making the oldest area the most diverse. However, I found that though diversity increases, it is upto a point. See figure 5. The graph peaks at around 17 years of protection and then the diversity begins to fall. This was surprising and brought up many questions. One explanation for this pattern could be the shade factor. As the forest matures each individual tree requires a larger area. This would be in terms of basal area and the canopy cover. The result of this would be increased shade for the younger trees and saplings and this would eventually lead to a decrease in diversity. Or it may simply be that as the trees mature and grow they need more space and therefore individual plots contain fewer trees and species. In the old growth forest the number of tree species are less and also the species composition is different. In the younger areas pioneer trees seem to dominate, the number of species increasing with age of protection. The composition also varies with new species coming in. In the old growth forest, however some of the early pioneer species are almost completely absent, having been replaced by mature forest tree species. In the process of regeneration the land is colonized by different sets of species depending on the number of years for which it has been left untouched. Eventually in a mature forest, species typical of that forest type will become established, and the pioneer species are not common since they lose their initial advantage. It would be very interesting to do a more detailed study, focusing on species typical of the old mature forest, to see at what stage they appear and become established. This could then be an indicator to estimate at what stage an area of regenerating forest may be. Determining a more precise correlation with age and species may help to assess an area and also predict the rate of regeneration. The distance from an undisturbed and established old growth forest may also influence the process. A possible next step to this project could be to study and determine the species diversity and composition of a similar sample in the State Forest Reserve, which is in a relatively good condition. It would be interesting and of great value to compare the oldest area in the Sanctuary with an area in the Reserve Forest, in terms of species richness and composition. In addition a similar study as this repeated a few years later would show and establish the pattern more clearly. Can we assume for example, that the area which is the youngest now, will in seven years have the species composition and diversity of area 2? It has been a great advantage at the sanctuary to have areas of land that are at different stages of regeneration. It allowed for comparison between them. However, the understanding of the trajectory of forest recovery would be more complete if similar studies were repeated in the future.

Bibliography

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