

**Community Structure and Regeneration of Sub-alpine *Abies spectabilis* (D.Don) Mirb.
Forest in Sagarmatha National Park,
Eastern Nepal**



**A Dissertation submitted for the partial fulfillment of the
Requirements for the M.Sc. in Botany**

By

Amrit Bahadur Nagarkoti

Batch : 2063/64

Symbol No. : 1178/265

T.U. Regd. No. : 41064-95

**Central Department of Botany
Tribhuvan University, Kirtipur
Kathmandu, Nepal**

2012



TRIBHUVAN UNIVERSITY
INSTITUTE OF SCIENCE AND TECHNOLOGY
CENTRAL DEPARTMENT OF BOTANY
OFFICE OF THE HEAD OF DEPARTMENT

Kirtipur, Kathmandu

Nepal

RECOMMENDATION

This is to certify that the dissertation work entitled “**Community Structure and Regeneration of Sub- alpine *Abies spectabilis* (D.Don) Mirb. Forest in Sagarmatha National Park, Eastern Nepal**” has been carried out by Mr. Amrit Bahadur Nagarkoti under our supervision. As to our knowledge, this dissertation work has not been previously submitted for any other degree. Hence, we recommend this dissertation work be accepted for the partial fulfillment of Master of Science in Central Department of Botany from Tribhuvan University, Kathmandu, Nepal.

Dr. Anjana Devkota
Lecturer and Supervisor
Central Department of Botany
Tribhuvan University
Kathmandu, Nepal

Dr. Chitra Bahadur Baniya
Lecturer and Co-Supervisor
Central Department of Botany
Tribhuvan University
Kathmandu, Nepal

Date: July 2012



TRIBHUVAN UNIVERSITY
INSTITUTE OF SCIENCE AND TECHNOLOGY
CENTRAL DEPARTMENT OF BOTANY
OFFICE OF THE HEAD OF DEPARTMENT

Kirtipur Kathmandu

Nepal

EXPERT COMMITTEE

The dissertation work submitted by Mr. Amrit Bahadur Nagarkoti entitled **“Community Structure and Regeneration of Sub-alpine *Abies spectabilis* (D.Don) Mirb. Forest in Sagarmatha National Park, Eastern Nepal”** has been accepted as a partial fulfilment of Master of Science in Botany (Ecology).

External Examiner
Dr. Mukesh Kumar Chhetri
Associate Professor
Amrit Science Campus
Kathmandu, Nepal

Internal Examiner
Dr. Ram Kailash Yadav
Associate Professor
Central Department of Botany
Tribhuvan University
Kathmandu, Nepal

Dr. Anjana Devkota
Lecturer and Supervisor
Central Department of Botany
Tribhuvan University
Kathmandu, Nepal

Dr. Chitra Bahadur Baniya
Lecturer and Co-Supervisor
Central Department of Botany
Tribhuvan University
Kathmandu, Nepal

Head of Department
Prof. Dr. Pramod Kumar Jha
Central Department of Botany
Tribhuvan University
Kathmandu, Nepal

Date: December, 2012

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to my respected supervisor Dr. Anjana Devkota who guided me giving suggestion and encouraged for my research work.

I express my sincere to my research co-supervisor Dr. Chitra B. Baniya, Lecturer of Central Department of Botany for his encouragement during analyses. I like to express deep gratitude to Dr. Bharat Babu Shrestha for his insight comments, suggestions and encouragement.

I would like to express my sincere gratitude to Head of Department Professor Dr.Pramod Kumar Jha and Prof. Dr. Krishna Kumar Shrestha, former head of Department for their encouragement and various supports.

I am thankful to Associate Professor Dr. Ram kailash Yadab, Professor Dr. Mohan Siwakoti and Associate Professor Dr. Suresh Kumar Ghimire for me in identification of my plant specimens.

My special thanks goes to Mr. Binoj Kumar Shrestha for his entire support during the field work and all the local people of study area for their kind help and essential support my field work.

I thank all of my colleagues for their cooperation and special thank goes to my friend Mitra Pathak for his encouragements and suggestions throughout the study period.

Finally, I owe a lot to my family members for their support in my study.

Amrit Bahadur Nagarkoti

ABSTRACT

Community structure and regeneration pattern of Himalayan Fir, *Abies spectabilis* (D. Don) Mirb was studied along the elevation gradient 2750 to 3550 m. asl in mixed *Abies spectabilis* forest located between Guranse danda and Khumjung area of Sagarmatha National Park, Eastern Nepal (Central Himalaya). Vegetation in the study area was sampled through systematic random sampling method. A total of 45 plots of 0.1 ha (33 m x 33 m) were sampled between 2750 m to 3550 m each at 100 m elevation interval. Nine vertical transects were defined within the study area and quadrats were located along each transects. Five sampling plots were laid in each elevation one or the both side of the well-established footpath. The location for the first plot in each elevation was chosen on the side of the path where there was at least one mature *Abies spectabilis* tree was. The distance between two transects were between 30-200m. Other plots in the same elevation were laid at a distance of 30-200 m difference. The distance between the plots was determined on the basis of the accessibility and presence of *Abies spectabilis* trees. If *Abies* trees were not observed along the sampling transect, a sidewise search was conducted on either side of the path at the same elevation. Canopy cover, rock cover, logging, lopping, litter and grazing/trampling damage in each quadrat were determined by visual estimation method. Soil samples were collected from each quadrat from its four corners and their physiochemical characteristics were analyzed. Number of woody plant species, number of individuals of each tree species, diameter at breast height (DBH) of each individual tree, number of seedlings and saplings of tree species were recorded in each quadrat. Various community attributes (e.g. importance percentage, species diversity and beta diversity) and population characteristics (e.g. density- diameter bar diagram) were analyzed. Ordination methods were used to analyze species composition and to relate this to environmental variables. Generalized linear models were used to relate community attributes with environmental variables.

Soil was slightly acidic with soil pH value 5.16. Soil carbon and soil nitrogen were 3.05% and 0.27% respectively. Thirty four species were recorded from the study forest. *Rhododendron arboreum* was the dominant tree species with the highest importance percentage (61.91%) and *Abies spectabilis* was the co-dominant species (22.72%). The value of beta-diversity for tree was 1.26. Simpson's Index (0.44) which was less than Shannon Wiener's Index (1.21). Species diversity of the forest was relatively high. Total tree density

was highest at 3450m and lowest at 3550m. Total tree density found changed with increasing elevation but it decreased from 3550 m towards treeline. Density-diameter curve for all trees measured was nearly reverse J- shaped that indicate a continuous regeneration trend. But the slightly deviation in the curve for *Abies spectabilis* alone from the typical reverse J-shaped, indicate a discontinuous regeneration pattern. The seedling and sapling distribution were not found uniform however 40% of the studied sub-plots were with seedlings while 66.67% without sapling and 40% of plot had no *Abies spectabilis* trees. Seedling mortality was found relatively medium and development of seedlings into saplings was also low. The lower number of sapling might be due to moderate disturbance (grazing and trampling) by livestock or environmental factors. Therefore, regeneration of *Abies spectabilis* was not sustainable.

Keywords: Central Himalayan; Community structure; species richness elevation gradient ; regeneration ; *Abies spectabilis*; multivariate analyses; DCA; beta diversity; Simpson's index; density-diameter curve; correlation coefficient matrix; GLM regression.

CONTENTS

1.	INTRODUCTION	1-5
1.1	Background	1
1.2	Biology of <i>Abies spectabilis</i> [D.Don.] Mirb	3
1.3	Justification	4
1.4	Hypothesis	5
1.5	Objectives	5
2.	LITERATURE REVIEW	6-8
2.1	Community Structure	6
2.2	Regeneration	6
3.	MATERIALS AND METHODS	9-18
3.1	Study Area	9
3.2	Phytogeography	12
3.3	Cultural landscape	12
3.4	Site characteristics	13
3.5	Research design and data collection	13
3.6	Laboratory Analysis of soil	14
3.7	Numerical Analysis	16
4.	RESULTS	19-30
4.1	Environmental Conditions	19
4.2	Community Structure	22
4.2.1	Species Composition	22
4.2.2	Species Richness and Diversity	25
4.3	Community attributes vs. Environmental variables	26
4.4	Regeneration and size class distribution	28
4.5	Population density and land use Environmental correlation	28
5.	DISCUSSION	31-35
5.1	Soil	31

5.2	Community Structure	31
5.3	Regeneration	34
6.	CONCLUSION AND RECOMMENDATION	36
6.1	Conclusion	36
6.2	Recommendation	36
	REFERENCES	37-44

Appendix I: Population of *Abies spectabilis* along the environmental variables

Appendix II: Frequency of shrubs along the elevation gradient

Appendix III: Density and Basal area along the elevation gradient

LIST OF TABLES

Table1.	Environmental variables of the mixed <i>Abies spectabilis</i> forest in the study area	19
Table 2 .	Community attributes of the mixed <i>Abies spectabilis</i> forest in the study area.	19
Table 3.	DCA summary from dataset	21
Table 4:	Frequency (F), Relative Frequency (RF), Density (D), Relative Density (RD), Basal Cover (BC), Relative Basal cover (RBC) and Importance Percentage (IP) of tree species in mixed <i>Abies spectabilis</i> forest of the study area.	23
Table 5:	Plant species forming shrub/sapling layer in mixed <i>Abies spectabilis</i> forest.	24
Table 6.	Number of seedlings and sapling per individual tree of the tree species in the study forest.	25
Table 7:	Summary of environmental correlation matrix among the explanatory variables ($n > 100$, $P = 0.05$, $r = 0.195 $)	30

LIST OF FIGURES

Figure 1:	Average monthly temperature (°C) and rainfall (mm) recorded at Khumbu weather station	10
Figure 2:	Map of the study area showing plot locations	11
Figure 3:	Density of all species along with elevation	20
Figure 4:	Ordination diagram obtained by Detrended correspondence analyses (DCA).The diagram represents Species composition along with significant environmental parameters of study area	21
Figure 5:	Diversity-dominance curve for the tree species of the mixed <i>Abies spectabilis</i> forest.	24
Figure 6:	Total Sapling density along with Elevation	26
Figure 7:	Species richness along with Elevation	26
Figure 8:	Seedling density of <i>Abies</i> along with elevation	26
Figure 9:	Total tree density along with elevation	26
Figure 10:	Species richness along with Total sapling density	27
Figure 11:	Total Tree density along with Litter content	27
Figure 12:	Population of <i>Abies</i> Tree along with Canopy	27
Figure 13:	Total Basal area along with Canopy	27
Figure 14:	Total Tree density along with RRI	27
Figure 15:	Seedling density of <i>Abies</i> along with canopy	27
Figure 16:	Density-diameter curve for <i>Abies spectabilis</i> alone as well as all tree species of the forest	28

ABBREVIATIONS AND ACRONYMS

AsaD	Abies sapling density
AseD	Abies seedling density
ased	Abies seedling density
asap	Abies sapling density
a.s.l.	Above Sea Level
BC	Basal Cover
<i>CANOCO</i>	Multivariate software
Cano	Canopy
°C	Degree Centigrate
Cum	Cumulative
DBH	Diameter at breast height
DCA	Detrended Correspondence Analysis
DHM	Department of Hydrology and Meteorology
Ele	Elevation
F	Frequency
Gra	Grazing
GLM	Generalized Linear Model
IP	Important Percentage
Lit	Litter
Log	Logging
Lop	Lopping
OC	Organic carbon
RBC	Relative Basal Cover
RF	Relative Frequency
RD	Relative Density
RRI	Relative reflective index
SNP	Sagarmatha National Park
Spp	Species richness
ttD	Total tree density
ttBA	Total tree basal area
tseD	Total seedling density
tsaD	Total sapling density