

THE ECOLOGICAL SOCIETY
PUNE, INDIA



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Report of Ecological Survey undertaken in Panshet
Catchment and Bhimashankar Wildlife Sanctuary

Under Small Grants Program, Global Forest Watch

Ecological Society, Pune, India

April 10, 2015

Project Team

Project Coordinator: Shailaja Deshpande

Project Assistants: Gunwant Mahajan, Kirti Amritkar

Field Assistants: Pratik Purohit, Trupti Satpute

Experts: Dr. Vinaya Ghate, Revati Gindi, Sanjay Thakur

Guides: Dr. Swati Gole, Ketaki Ghate, Manasi Karandikar, Yogesh Pathak, Dr. Gurudas Nulkar, Ajay Phatak

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1. Executive Summary

Funded by the Small Grants Program of Global Forest Watch, Ecological Society undertook a survey at two specific locations in Northern Western Ghats over the last six months. Titled 'Ecological survey in Panshet Catchment & Bhimashankar wild life sanctuary', this report describes in detail the objectives of the study, methodology used, the findings and a comparative analysis with data from 1986.

Ecological Society (ES) is a 32-year old NGO engaged in research and education in management and conservation of natural resources and ecosystems. Over these years the ES has conducted various surveys to study the ecological status and recommend management guidelines for conservation and restoration. In the course of these surveys, in 1986 the ES completed a detailed survey in the catchment of 'Panshet' dam which is the major source of drinking water to Pune city. This catchment lies in the northern Western Ghats in Maharashtra, a region of high rainfall and endowed with abundant biodiversity. In this survey biodiversity was looked upon as an indicator expressing the local land use pattern. The findings and the land use classification in the report show the effect of economic activities of local communities on the biodiversity. Based on these observations, Ecological Society suggested a framework for ecological restoration of the degraded areas which would consider the need of the local communities. To validate the framework, an experiment was initiated on a land patch owned by department of irrigation, near Panshet dam. This experiment helped validate and improve restoration guidelines for restoration in Northern Western Ghats.

This study under the Small Grants programme was initiated to evaluate the current ecological status of the catchment, record changes in the land use and make recommendations to conserve and restore potential forest patches. The study was undertaken from August 2014 to January 2015.

Some findings of significance are noted below

- The study region supports both **endemic and special biodiversity** but this is **confined to few tiny patches**. During last 30 years, **no special conservation effort** has been taken to protect the landscape. Meager **passive protection by local communities** by way of social fencing prevalent in the sacred groves area has helped. The findings in this study suggest a compelling and urgent need to protect and conserve these remaining patches.
- **Fire** and **grazing** are two major constraints in natural succession which have left the catchment with various degrees of vegetation and canopy layers supporting associated biodiversity.

- One of the **major potential threats is modern 'development'** which is imposed by demands of farm houses and townships by urban consumers. This threat was absent in the survey of 1986.
- **Improved road connectivity in the catchment has changed economic activities, lifestyle and social structures within local communities.** Livelihood practices of the past are being rendered inefficient by access to modern technology. Proliferation of television has brought about aspirations which demand higher incomes. This has triggered large scale sale of fallow lands to urban developers.
- The study clearly shows that due to changing land use, biodiversity has suffered. The report suggests an **urgent need to prepare a landscape level restoration plan.**

With the help of data collected through this survey and the baseline data of 1986, this project proposes a **restoration template** which may be useful for conservation programs in the northern Western Ghats region. Such a template is developed as an aid in planning and implementation of restoration projects.

The Ecological Society wishes to express its gratitude to Global Forest Watch for the generous grant provided for this project. The team hopes that the recommendations made herein will aid serious conservation efforts in the Western Ghats!

2. Introduction - Significance of the survey

Extending from the river Tapi in Gujarat to Kanyakumari in the south, the mountain range which runs parallel to the western coast of the Indian peninsula is referred to as the Western Ghats. These mountains have played a crucial ecological role for the inhabitants on both sides of it. Posing a formidable barrier to the moisture laden clouds from the Arabian Sea, they receive a heavy rainfall. As a result, the Western Ghats are generously endowed with biodiversity. Their resources have paid rich dividends to humans. Moreover, being source regions of some important rivers like the Godavari, Krishna and the Kaveri, their benevolence extends deeper inland too.

Over the years, changing land use has dramatically reduced forest cover and increased soil erosion. Increasing interventions like agriculture, plantations, mining and residential development have been detrimental to the flora and fauna. However, as the geographical features of the Western Ghats are suited for building dams, the bigger challenge is protecting the remaining biodiversity from changes made by the huge dam reservoirs.

This survey was undertaken in the northern Western Ghats which are locally called the Sahyadri Mountains. The study region comprised of the catchment areas of Panshet dam which are the main sources of water to the city of Pune. In the year 1984-85, the Ecological Society had conducted a detailed survey to establish the status of animal and plant life in these critical areas with an objective of evolving a conservation plan. The current study compiled significant data on species, land use, forest cover, protected areas and fallow patches as well as recorded socio-economic connections of the local communities with the biodiversity. The purpose of the socio-economic study was to find patterns of changes in energy, water, and food demand and sources, occupations, migration, land use, and man-nature connections. Some intriguing findings regarding land sales, migrations to cities, and problems for local communities were learned by us as a result of this study.

This present survey, funded by the Small Grants Program of GFW sets out to document the changes within the region over the baseline data of 1984-85. Ecological assessments and socio-economic studies were conducted in the process. The methodology included use of satellite images, rainfall data and ground truthing in 47 sample areas. The study classified the entire region on land use. Teams visited the sample areas to collect data on forest cover, occurrence of species, regeneration and their IUCN status. Physical features too were noted. Sample areas were marked out on digital images. The photo-documentation was then transcribed into templates which can be used by researchers and conservationists working in the Western Ghats. The data was collected over monsoon and winter seasons in 2014 and was compared with the baseline data of 1984-85.

The comparison should help evolve a conservation and restoration plan for the entire region. The conservation plan should aim at improving the livelihoods of local communities and minimizing environmental impacts of changing land use by urban ownership.

3. Defining signatures for ground survey

Considering the physiography and climate of Sahyadri mountains or the Northern Western Ghats, the region should support **Tropical semi evergreen** around the crestline and moist deciduous forests near the Eastern end of its spurs. This should have been the climax state and applicable to the Panshet catchment area too. However, it has **variously degraded and fragmented** due to use by local communities for cultivation or/and due to intrusion from outsiders. Pressures of modern development are evident too.

The original forest cover and biodiversity remain in but a few pockets of government protected areas throughout Sahyadri or within semi-protected areas like sacred groves. The Bhimashankar wild life sanctuary is a good representation of a protected area and hence was included in the study region. The rest of the landscape in Sahyadri has degraded to **various seral stages** depending on the degree of disturbance **resulting out of socio-economic changes** in the catchment. Ecological Society had conducted a detailed study of Panshet catchment in 1984-85 which supports similar results. The study of 1984-85 reports dominance of vegetation all over the catchment. Extending this further, the current study attempts to evolve a signature based on composition of the vegetation, height and quality. The term quality is used here based on whether the patch comprises *specialist* species as a remnant from earlier forest or *common* species indicating degradation.

A study of publications was undertaken to arrive at a consistent referencing in the report. Various researchers have used standard terms like Evergreen forests, deciduous forests, grasslands etc. to indicate various seral stages within Northern Western Ghats. In this survey, similar terms were employed with some modification as per the site specificity to cover each vegetation class.

Five major vegetation classes are defined to map the vegetation classes and other biodiversity associated with it. –

1. Open grasslands
2. Scrub
3. Dwarf canopy forests
4. Tall canopy forests and
5. Mature forests

Composition of species pertaining to each of these classes is more or less definite with some overlaps. As the survey progressed, a need was felt to add more vegetation classes. Consequently, *Carvia callosa* patches, *Carvia callosa* & dwarf canopy, Dense shrubbery, Sparse vegetation, Sparse vegetation dominated by trees were added to the above five classes.

The objective of this survey was not only to map vegetation classes and biodiversity but also to assess the current changes in the land use. To assist this, following land classes are also mapped in detail.

1. Agriculture
2. Plantations
 - a. Non-native Plantations
 - b. Bamboo Plantation around Settlement
 - c. Horticulture
 - d. Old Non-native Plantations with regenerating natives
3. Road
4. Area Affected By Road
5. Bamboo
6. Modern Development
7. Quarry
8. Shifting Cultivation Patches
9. Settlements

The above land classes were marked on ground with the help of GPS and co-ordinates and then transferred to the satellite image.

During field survey, 47 different patches were surveyed within six months. Associated biodiversity is documented in standard formats. Endemism, IUCN status, and legal status of each species is also mentioned in these formats.

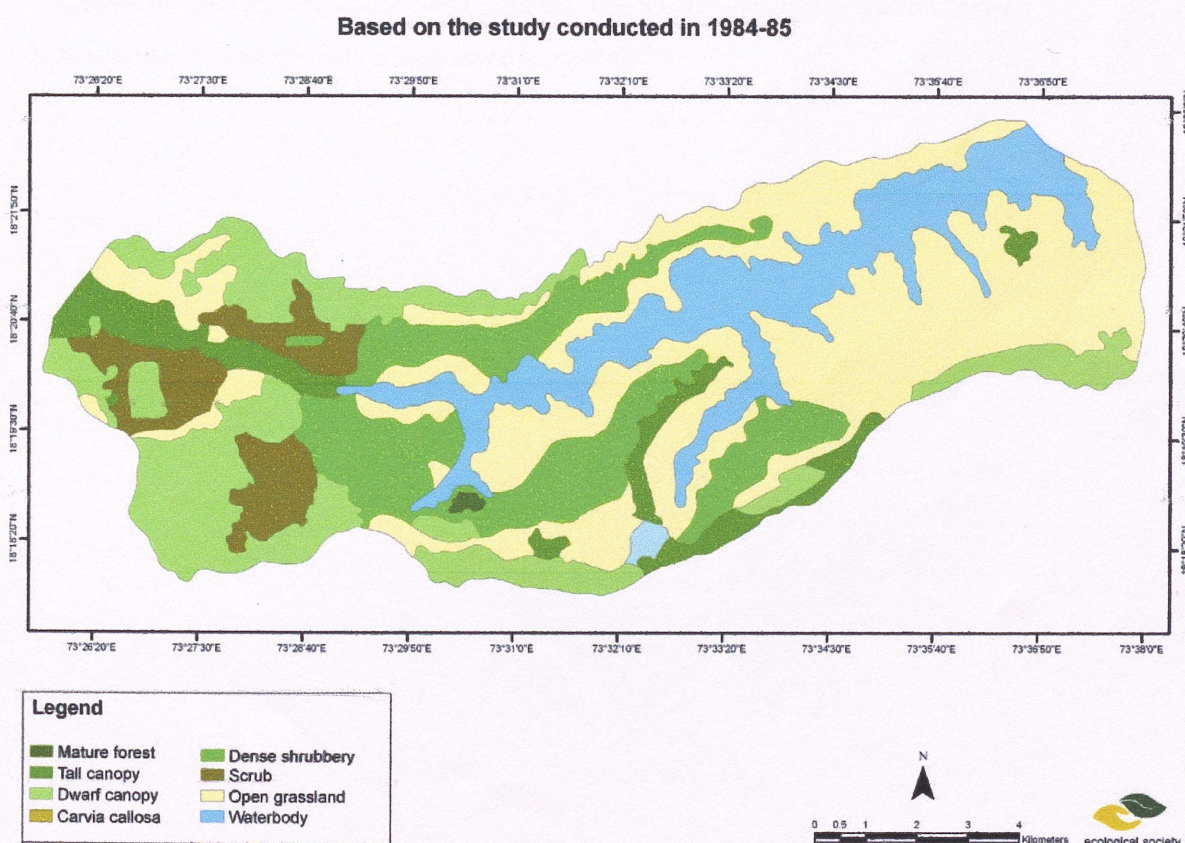
(Reference: Management of Forests in Northern Western Ghats, Ketaki Ghate, Journal of Ecological Society, Volume 26 – 27, 2014)

4. Glimpses of earlier study : 1983 – 1985 (Panshet catchment)

Ecological Society had conducted a detailed survey of Panshet catchment during 1983 to 1985 and the related report was published in 1986.

Map showing vegetation classes in 1986

A handmade map was printed in this report which gives approximate idea and an overview of the status of the vegetation classes at that time. (Please see Annexure XII, Part I). The report also provides notes on the rest of the biodiversity and its associations within the catchment area. This map was transferred to a GIS platform to show the following:



Area by land use as of 1986

No	Land class	Area Acres 1986	% 1986
1	Mature forest	1853.705834	8
2	Dwarf canopy	10076.76508	41
3	Scrub	1908.67955	8
4	Open grasslands	10507.1095	43
5	Human use	Not assessed separately	NA

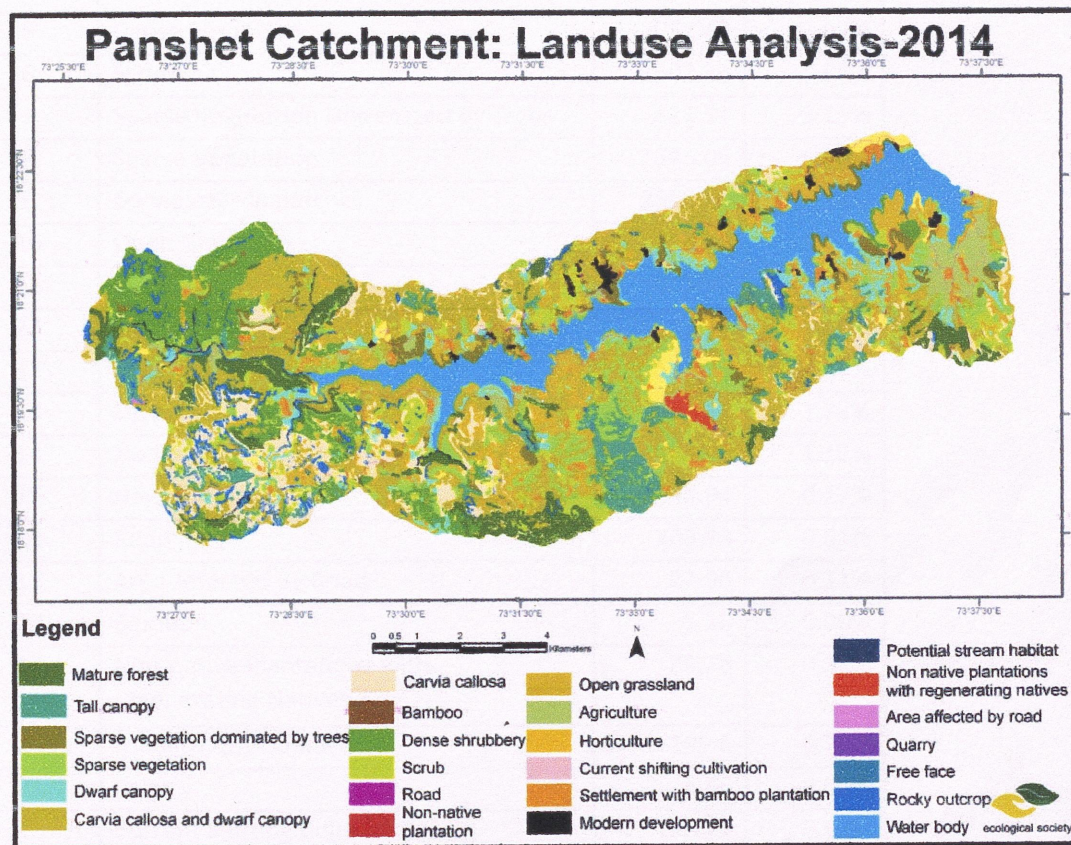
Notes:

1. Area under Tall Canopy was included in Mature Forest.
2. Patches of Karvi (*Carvia callosa*) and Dense shrubbery were included in Dwarf canopy.
3. Area under human use was not assessed separately.

5. Outcome of the survey - 2014 (Panshet catchment)

GIS map for Land use & Vegetation classes for Panshet catchment

The vegetation and land classes discussed in the earlier section were truthed on site and plotted on the digital map of the study region. The figure below is the Land use map for the Panshet catchment.



Area by land use

Field research teams compiled the following area statements for the entire catchment (Table 1).

Table 1: Area Statements of Vegetation Classes

No	Head	Acre	Percent
1	Mature Forest	1542.16	5.99%
2	Tall Canopy	1319.95	5.12%
3	Dwarf Canopy	1026.05	3.98%
4	<i>Carvia callosa</i> and Dwarf Canopy	7034.84	27.31%
5	Dense Shrubbery	2052.47	7.97%
6	Scrub	1502.26	5.83%
7	Sparse Vegetation Dominated By Trees	821.31	3.19%
8	Sparse Vegetation	1545.06	6.00%
9	<i>Carvia callosa</i> patches	2558.51	9.93%
10	Open Grassland	2616.16	10.16%
11	Rocky Outcrop	651.97	2.53%
23	Free Face	25.38	0.10%
12	Agriculture	1571.16	6.10%
13	Settlement with Bamboo Plantation	441.76	1.72%
14	Non-native Plantations	289.7	1.12%
15	Horticulture	44.94	0.17%
16	Road	209.73	0.81%
17	Area Affected By Road	27.98	0.11%
18	Bamboo	1.25	0.00%
19	Non-native Plantations with regenerating Natives	83.28	0.32%
20	Modern Development	195.6	0.76%
21	Quarry	3.56	0.01%
22	Current Shifting Cultivation	158.21	0.61%
24	Potential Stream habitat	34.61	0.13%
		25757.90	100%

Since the above classification was too granular, the 24 areas in Table 1 were clubbed into 5 major land classes as depicted in Table 2. This gives an overview on the current status of catchment.

Table 2: Area Statement of Land Classes

No.	Land class / Vegetation class	Area	%
1	Mature forest	2922.10	11
2	Dwarf canopy	10113.36	40
3	Scrub	6427.13	25
4	Open grasslands	3268.13	12
5	Human use	3027.16	12
		25757.89	100

Conclusion:

1. The study revealed that most of the sensitive species, both floral & fauna are now limited to mature forest only. Immediate action is needed to conserve endemic and special biodiversity.
2. The largest vegetation class is *Carvia callosa* & dwarf canopy (40%). This suggests some change in seral stage, from grassland towards shrubbery i.e. improved canopy vegetation. This shows the regenerative capacity of the hills.
3. There is a need to consider the future threats and develop a conservation strategy for them.
4. Large scale "Landscape Restoration Programs" can be initiated for vegetation or land classes other than mature forests.

6. Comparison with prior data (Panshet Catchment)

Area statement as of 1986

Table comparing the area by land use in reports of 1986 and 2014:

No	Land class	Area Acres 1986	% 1986	Area Acres 2014	% 2014
1	Mature forest	1853.705834	8	2922.1019	11
2	Dwarf canopy	10076.76508	41	10113.363	40
3	Scrub	1908.67955	8	6427.1343	25
4	Open grasslands	10507.1095	43	3268.1327	12
5	Human use		0	3027.1571	12

Comments:

1. The above table shows that dwarf canopy forest has increased marginally since 1986. A probable explanation is that during 1980s large portions of tall canopy forests were felled for coal. As coal usage in the cities decreased, some of those patches are undergoing slow restoration.
2. Scrub land has increased since 1986. The probable reason for this is that grasslands are undergoing restoration and the next level succession is achieved. However, these may not be the same patches and other patches of dwarf canopy may have degraded to scrub land.
3. The dynamics of the mature forests has remained more or less same. Indicator species (flora and birds) pertaining to mature forests or sacred groves, recorded in the 1986 study and today are almost similar. No major change is observed in their composition.
4. Human interventions which were insignificant in 1986 have now increased.
5. Though human interventions overall have increased, one major cause of human intervention from 1983-1985, namely, shifting cultivation, has reduced significantly in 2014. The protection afforded to the forest due to this, is a possible reason for increase in dwarf canopy forest and scrublands.

Comparison with respect to biodiversity:

Table: Comparison of species count between 1983-85 and 2014

Taxa	Number of species recorded	
	1985	2014
Flora	406	448
Birds	153	134
Mammals	19	8
Reptiles	Not recorded	9

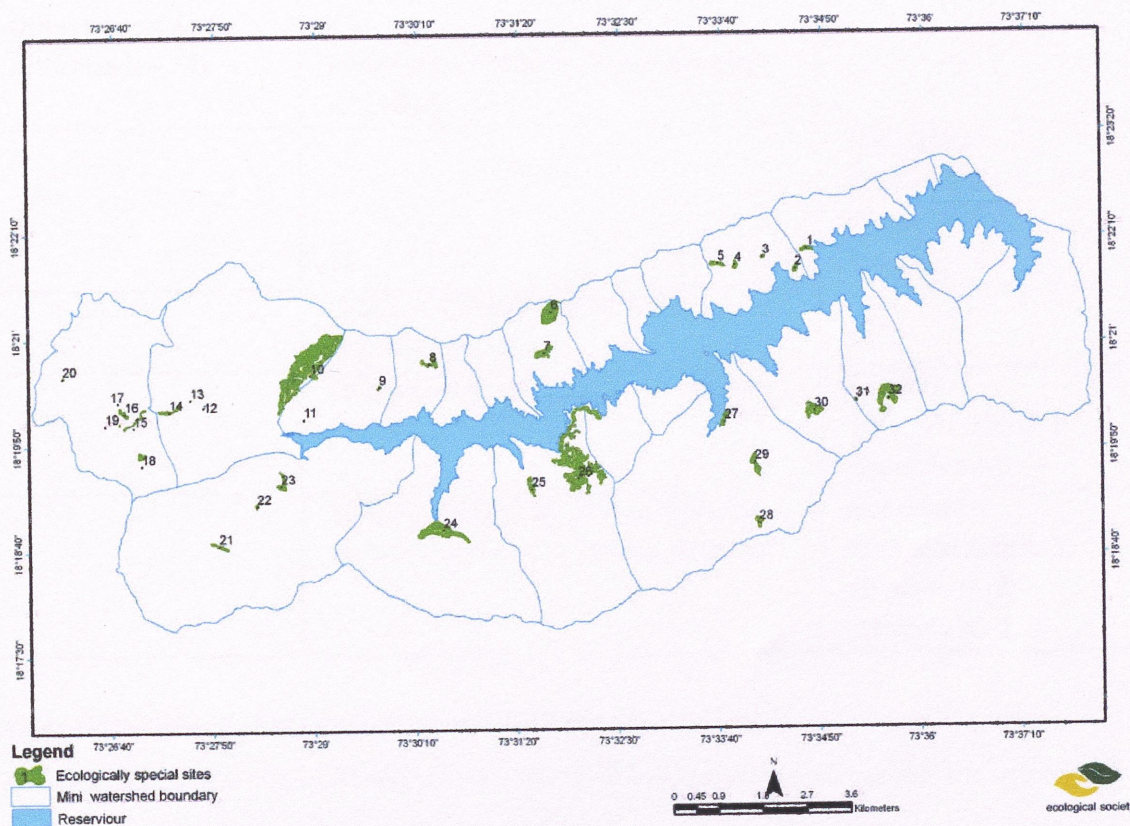
Important findings:

- Other than the apparent changes in the number of flora and fauna species, this data is insufficient to draw further conclusions. The data was collected mainly to assess species as an indicator. Some rare species which were recorded in the earlier survey were not recorded in this survey. The current survey was carried out in a span of 6 months and it is possible that those species might have been absent temporarily, hence no species-specific conclusions are being made.
- Number of bird species recorded in 1985 survey are 153. Number of bird species recorded in 2014 survey are 134. However, 21 bird species observed in 2014 were not recorded in 1985. They are - Indian Cormorant, Grey heron, Little stint, Little grebe, River Tern, Ruddy breasted crane, Laggar Falcon, Nilgiri Woodpigeon, Eurasian collared dove, Grey bellied cuckoo, Common hawk cuckoo, Brown headed barbet, Brown Shrike, Tawny bellied babbler, Plain prinia, Sulphur-bellied Warbler, Greenish warbler, White-rumped Munia, Golden fronted leafbird, Indian Roller, Rufous Treepie.
- The Indian Giant Squirrel is a new sighting as compared to 1985 survey. It was observed in the larger sacred groves in 1960s but not later (Gole, 1985). Bonnet Macaque is also a new sighting compared to 1985.
- New sightings about Reptiles in 2014 - Green Keelback, Common krait, Bombay shieldtail, Phipson's Shieldtail. Both the Shieldtails are endemic to Western Ghats.

7. Supporting data (Panshet catchment)

Map showing forest patches with high endemic biodiversity

Map of 32 forest patches within Panshet catchment showing high endemism and with specialist species.



Short summary of status of the biodiversity within the catchment

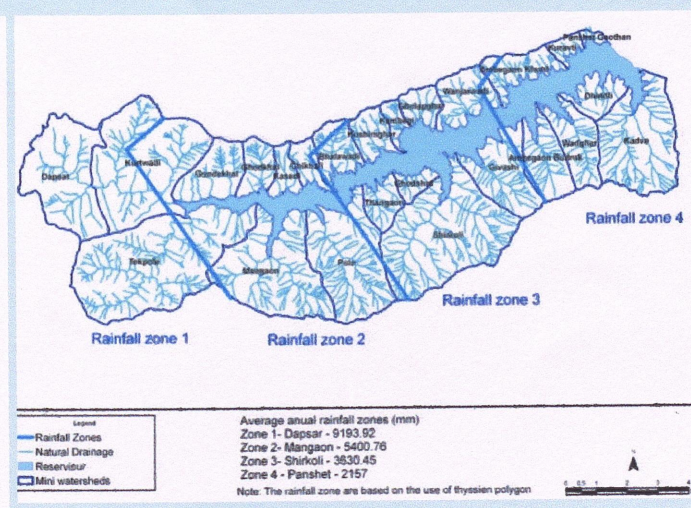
Overall status of the catchment can be summarized as given below :

Number of species recorded	Number of Endemic species	Number of IUCN & WPA Schedule, Specialist / Rare species
FLORA		
425 (Native) + 23 (non-native) = 448	Endemic plants – 74 Endemic to India – 55 Endemic to Western Ghats- 13 Endemic to Northern Western Ghats- 4 Endemic to peninsular India- 2	IUCN – 3 (2 VU, 1 NT) Specialist -32 Rare - 21
FAUNA		

<p>272 {Birds- 134 Butterflies – 70 Amphibians – 9 Reptiles – 9 Mammals – 8 Dragonflies-12 Moths -6 Other insects and Arthropods – 24}</p>	<p>Birds - Endemic birds – 36 Endemic to the Indian Subcontinent -20 Endemic to India & Sri Lanka- 3 Endemic to India- 4 Endemic to peninsular India – 5 Endemic to Western Ghats -1 Endemic to Western Ghats + Tamilnadu – 2 Endemic to Western Ghats + Western satpuda-1</p>	<p>Birds – IUCN - 4 (1 VU+ 2 NT + 1 CR)</p>
		<p>Butterflies – WPA schedule I – 4; schedule II- 1; Schedule IV- 1</p>
	<p>Endemic Amphibians (endemic to Western Ghats) – 2</p>	
	<p>Endemic Reptiles(endemic to Western Ghats) – 2</p>	<p>Reptiles – WPA schedule II- 1 Schedule IV- 5</p>
	<p>Endemic Mammals– 2 (1 endemic to India & 1 endemic to peninsular India)</p>	<p>Mammals – WPA schedule II- 3; schedule III- 2; schedule IV- 1</p>

Comments on the status of biodiversity in the study region:

1. Other than a few mature forest patches where climax communities are seen, the catchment shows an overall degradation in the biodiversity.
2. The distribution of biodiversity within the catchment is correlated to the rainfall. There are four rainfall zones within the catchment and the biodiversity changes from east to west within them.



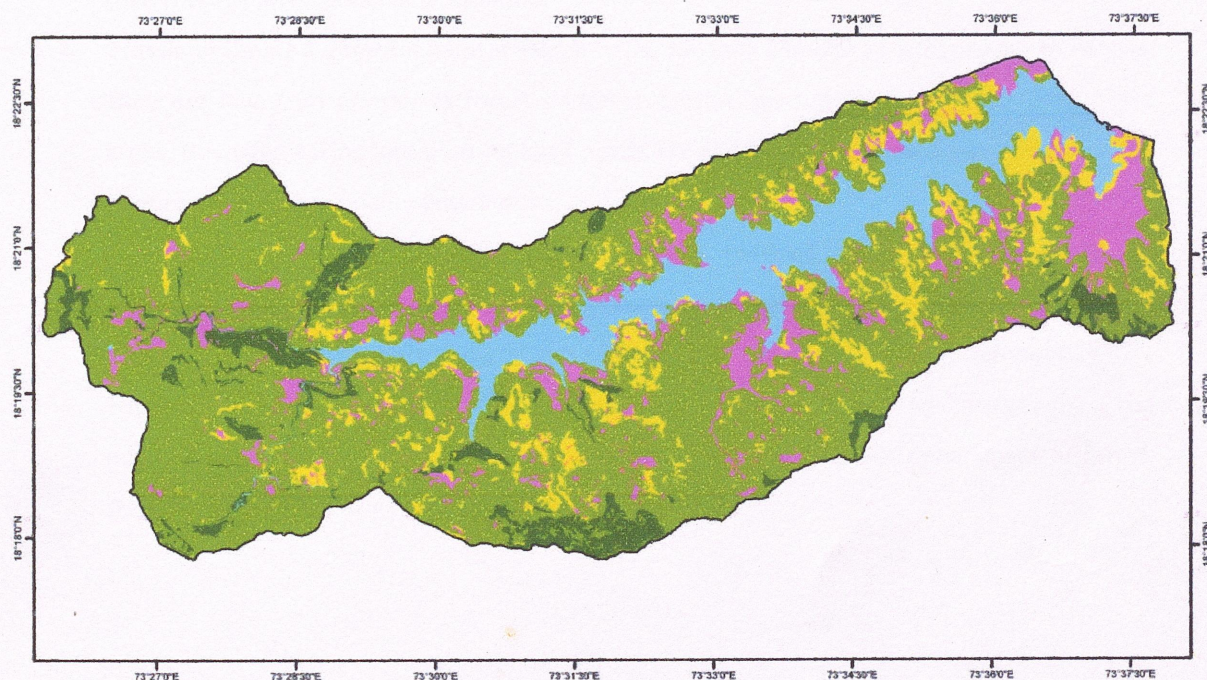
3. Rainfall zone 3 and 4 represents more of **moist deciduous vegetation** with dominance of grasslands and degraded areas. Remnants of original forests are seen only in the form of sacred groves, albeit in a degraded stage.
4. Rainfall zones 1 and 2 represent **tropical semi evergreen vegetation** and are in a better condition compared to rainfall zone 3 and 4. Original tropical semi evergreen forests are seen to be intact in sacred groves, few riparian patches and certain privately protected patches.
5. Rainfall zone 1 seems to be most fragile in term of biodiversity. Patches other than sacred groves and protected areas also show endemic species but in a highly scattered manner. Ecological Society(1986) had suggested making this zone into a sanctuary, it being the source region for the river Ambi. If this strategy is applied to other catchments within Northern Western Ghats it would form a North - South corridor which would not only provide corridor for movement of higher animals but would also conserve source regions of all rivers.

A short summary of the ecological status of each of these patches is given in Annexure IV.

8. Restoration Potential Analysis (Panshet catchment)

The detailed ecological survey of the Panshet catchment enabled us to assess restoration potential of various sections in the catchment based on their current vegetation class and biodiversity.

GIS map of restoration priority classes



Restoration Potential Classes

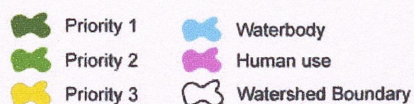


Table: Area statement according to Restoration Priority Class

No	Priority	Vegetation class	Area	%
1	Priority 1	Mature forest	2922.10	11
2	Priority 2	Degraded forests	16540.50	65
3	Priority 3	Open grasslands	3268.13	12
4	Priority 4	Human use	3027.16	12
			25757.88	100

Discussion:

1. The table above classifies areas into priority zones for conservation and restoration.
2. Mature forests with special endemic biodiversity lead the priority list. If their protection and conservation is not immediately undertaken, several species may get locally wiped out from the catchment.
3. There is a great potential in **degraded forests** to be restored back to their original shape, as remnants of earlier forests still exist. Root stock in such areas helps in quicker restoration than totally barren areas or grasslands.
4. Grasslands being a different habitat than forests, will take a longer time to restore to forests. They are lower on priority as forest endemic species have already been lost from these areas. However, taking into account local needs like fodder, some of such grasslands may be restored into higher quality grasslands.
5. Though it appears that land under human use is minimal, future threat needs to be recognized. Urban ownership is evident as farm houses and fenced plots on slopes. This could be a **major future threat** to ecosystem health and biodiversity in the catchment.
6. This restoration potential analysis is only based on 'ecological conditions'. Practically it has more layers to it owing to the ownership status in catchment under department of forest, state department of irrigation & private lands.

9. Report on socioeconomic study(Panshet catchment)

In order to connect changes in vegetation and bio-diversity with human actions, socio-economic data was collected from villages in the Panshet catchment. The objective was to assess:

1. Energy demand and its sources, food, forest resources, water demand and sources, land use, agricultural inputs, soil quality in the village.
2. Occupations and livelihood in the villages
3. Migration of locals to the city
4. To understand the local economy and its integration with urban economy
5. Health, happiness, and well-being
6. To understand local problems and key demands of local populations

Adipstick study was undertaken with a semi-structured questionnaire. Eight families across six villages were interviewed in the catchment area in each of the four rainfall zones defined in (Gole, 1985) and (Brahme, 1986). A questionnaire template was filled in based on the interview notes.

Key Socioeconomic Findings

Population & Households: Relative to 1986, the population and households of individual villages has mostly declined or lagged the state/national population growth rate. This is more pronounced in smaller villages than larger villages like Panshet Colony or Kadve.

Table: Population by village

Zone	Village	1981 census		2014 interviews	
		Population	Households	Population	Households
I	Panshet <i>gaothan</i>	71	9	40-50	8-10
	Ambegaon Khurd	339	65	90	10-12
	Kadve	741	134	1300	170
II	Kambegi	95	21	50-60	10-12
III	Gondekhal	128	39	50-60	12
IV	Dapsare	187	44	180-200	28

The primary reason is migration to the cities (or in some cases, to Panshet Colony). While Kadve's population has actually increased, it should be noted that, being situated in a side valley, Kadve was

not displaced when the Panshet dam was built, unlike the other 23 villages in Panshet catchment area.

Occupations: In 1985, "rice was no longer cultivated in the catchment except for some families in segment III and by some who have parts of their holdings near stream" (Gole, 1985). At that time, a three-year shifting cultivation pattern of Nachani-Varai-Karale-Teel (*Eleusine coracana*, *Panicum miliaceum*, *Guizotia abyssinica*) was dominant. This pattern is still followed at very few places.

Today rain-fed agriculture continues to be the main occupation of those who stay in the villages. In cases where little to no land is farmed, cattle-rearing for milk is a key occupation.

Income from agriculture has continued to stay at sustenance levels or below it. Most farmers take crops of Rice and *Nachani*, for household consumption and not for sale. This was recorded in 1985 too. *Varai*, and *Teelare* also being grown but declining. No cash crops are present.

There seems to be variation in the rice yield across farmers. Farmers mentioned yields of between 100 kg/acre to 500 kg/acre. Some variation could be attributed to (1) Destruction of crops by wild boar (2). Extensive use of chemical fertilizers by some farmers and (3). Productive agriculture by some farmers due to relatively higher availability of labour.

These are anecdotal findings and definitive view on yields will need a detailed survey.

Other occupations or supplementary income sources include rearing cattle to sell milk, cultivating and selling Bamboo or household items from Bamboo, rearing goat and sheep for self and for others, working with the *Gram Panchayat* (Village Council), etc. Other than the larger villages like Kadve or Panshet Colony, there are no signs of specialist services like barbers, carpenters, etc.

The purchase rate for milk now stands at Rs. 30-32/litre, relative to Rs. 2.5-3 in 1985. An average annual rise of 9%, this is just slightly above India's inflation rate of approximately 7% during this period. Milk production occupation is not profitable due to the increasing scarcity of fodder and rising prices of cattle.

Compared to 1985, some natural resource-centric occupations have closed down. Coal making from forest wood has reduced as has harvesting of *Hirida* (*Terminalia chebula*) tree produce. In 1985, 15% of the annual household income was estimated to come from mango and minor forest

produce. In this study, sale of mango was not found to be significant. It is undertaken mainly by those who have access to the produce. Similarly little evidence was recorded of sale of Jamun and other minor forest produce. Relative to 1985, it seems to be declining even as a temporary occupation.

One new occupation has emerged- services of household help / laborers / watchman / cook and similar services being provided by individuals to occupants of urban owner bungalows. These jobs pay about Rs.100/day and in some small villages nearly 10% of the population is engaged in them.

The milk-vending *dhangar* (pastoralist) households have also declined, mostly to single digits in any given village (in some cases, only 1-2 in a village). They continue to reside in the mountain slopes near the villages.

Some other new occupations recorded are in the land business, serving urban buyers for fulfilling their land based demands. These include real estate agents, building contractors, craftsmen, consultants, architects, and others. Most of this, however, is visiting population.

Land Use: Shifting cultivation continues to be the dominant method for agriculture and continues to affect land use. Relative to 1985, the following changes are observed:

1. In the absence of land share arrangements, farmers have left part of their land permanently fallow
2. The fallow period in shifting cultivation is declining as farmers are trying to maximize output and are ready to use chemical fertilizers extensively. (Gole, 1985) mentions that in Sector I, fallow period was already shortening even in the mid-80s. This process seems to have continued further and become more widespread.
3. Overall land under active agriculture has declined. As per (Brahme, 1986), 1044 hectares was the cultivated land area in 1986. According to the 2014 study, 1571 acres is under paddy cultivation while 158 acre is under shifting cultivation of *nachani*, *varai*, or *teel*. This is a total of 1729 acres or 691 hectares.

Some of the land has also been claimed in land deals by urbanites – mostly for non-agricultural use. The land ownership transfers started in 1970s/80s, caught momentum in the mid-1990s and continues today. It is likely that some of these land parcels have changed hands multiple times among urban land investors with surplus wealth. Even as the landscape appears rural, it is partially composed of urban ownership.

Caste Mix: *Kunabi*, *Maratha* and *Bouddha* continue to be the main castes in most villages. Caste tolerance has increased somewhat relative to the prior decades, perhaps due to urban integration of most families.

Land Holding: Small farmers hold 4-5 acres of farmland while a relatively large land holding would comprise of 10-15 acre. There are some families holding as small as 1-2 acres, primarily due to the successive distribution of holdings across generations.

Cattle: In 1985, while qualitative depletion of habitat was noted, a large number of families had cattle (Gole, 1985). By 2014, several farmer households have sold off cattle due to lack of fodder, lack of use, or increasing costs. In some villages less than 20% households own cattle (1-6 each). In 1985, Dapsare had a population of 187 across 44 households. It had 98 cows, 67 bulls, and 53 buffalo (total 218 cattle) or an average of 4.95 cattle per household assuming each household had cattle. In 2014, only 20% households had cattle and only 2-4 each. In Ambegaon Khurd, the cattle count has reduced from 310 (excluding goats) in 1985, to 40-50 in 2014.

Those in the milkbusiness own relatively more cattle. Majority of the cattle are native species. Farther in the catchment, transport imposes increased costs in selling of milk.

Cattle feed on forest land and agricultural residue. Grazing commons (*gaayraan*) which existed in some villages earlier are now ignored or barren. As such, even though overall cattle numbers have declined relative to 1985, cattle grazing continues to be a cause of the degradation of the forest ecosystem.

Quality of soil (agricultural land) is declining, particularly in Zones I-III, as per the survey respondents. There is a relatively higher use of urea mix than before, while organic manure also continues to be used. Farmers are realizing that though yields have improved in short run due to use of chemical fertilizers, the crops have also become more prone to diseases and quality of soil will decline over the long term.

Vegetation around villages is on a general decline too, over the last 20+ years. e.g. The *Hirda* trees, once common in this area, are now almost completely exploited.

Forest food and resources: The villagers' food habits have increasingly grown to be similar to urban tastes. Consumption of wheat has increased. Apart from some forest vegetables during the monsoon season or the seasonal mangoes and jackfruit, no other forest food is consumed. They are heavily dependent on the forest for fuel wood – *Karavanda*, *Kaarvi*, *Ain*, and *Bor* being the plants of choice. A few of them make items of household use from bamboo as a side occupation. Awareness of medicinal plants is on the decline, except for places like Dapsare which are closer to Sacred Groves.

Villagers admitted to cutting fuel wood from all over the catchment except sacred groves. As urban land owners fence off their properties, access to fuel wood has decreased.

Sacred Groves: In Gondekhal, a small sacred grove (*devrai*) is adjacent to the village. It has 4 deities: Mari Aai, Lakshmi Aai, Somjatee, Varadani. Cattle-grazing is allowed in this sacred grove. Dapsare has a sacred grove adjacent to village. Some of its plants include *Entada rheedii* - Garambi, *Persea macrantha* - Gulum, *Dimocarpus longan* - Yeru, *Adhatoda vasica* - Adulsa, , *Memecylon umbellatum* - Anjan, *Mallotus philipens* - Shendari, *Solanum indicum* - Raanvangi, *Zanthoxylum rhetsa* - Khokla. The sacred grove is respected and cattle-grazing/cutting does not seem to be too common in it.

Schools: Some of the villages have nursery schools (*Aanganwadis*) and schools till 8th grade, while some with lower population (e.g. less than 15 households) do not have any schools. Children from these villages have the option of walking to schools in nearby villages, which may be some distance away. The schools have teachers on government roll. Due to the decline in population, the number of students enrolled is small. Absenteeism within teachers is also an issue. Beyond 8th grade, the only option is to study at schools at Panshet township. Many students commute daily, which is tiresome and time-consuming, because there is only one bus from these villages to Panshet town. Some others live in hostels in the town, but they are expensive. Due to urban integration, many of the young families have anyway migrated to Pune, Mumbai, and other cities, and their children are studying in city schools.

Other Amenities: There are no Primary Health Centers or Ration Shops in these villages, though they are a necessity of the villagers. Particularly in case of health emergencies, the patients either have to be taken to places like Panshet or Khanapur and some patients even die due to the lack of transport.

NGO presence: Other than occasional associations with NGOs (e.g. Ecological Society's field station providing grass to Panshet *gaathan* villagers, or the Rotary Club making a donation/ providing a facility), there is no presence of NGOs in this area.

Some Local Problems & Pain Points

1. Destruction of crops by animals like wild boar, monkeys, and barking deer.
2. Declining agricultural yields and degrading soil quality
3. Poor public transport to connectivity to Panshet and Pune. There is only one bus per day to go to Panshet.
4. Schools are not well managed. Students may walk long distances wasting time.
5. Most children residing here can get education only till 8th/9th (that too in Panshet) and later have to work in menial jobs like labourers, drivers or unskilled computer work.
6. Farmers do not grow enough food to meet their sustenance needs. They have to buy food from the market or are dependent on income sent by urban family members.
7. Transport costs have increased rapidly. Producing and selling to the city is increasingly expensive.
8. Local governance bodies (*gram-panchayats*) are dominated by some families and may not hold regular meetings or do not pass information about government schemes to villagers.
9. Local communities in this region are seen to have a hand to mouth existence. There are daily struggles for food, fodder, and health services. They do not have major aspirations for local growth as their basic needs are not being met. Sometimes, they have misplaced aspirations. E.g. in Dapsare, villagers are unhappy because a nearby road connecting to Konkan cannot be built due to forest land reservations. They are also unhappy because the Western Ghats Panel declared the area an eco-sensitive zone and new construction activity is restricted. They feel this constrains 'development' of their area. They have no idea of what alternative growth models could be used.

Analysis and Discussion

- (Gole, 1985) wrote, "*the average family residing in the Panshet catchment today barely earns enough to sustain itself. The agriculture they practice is primitive, less productive, and generally harmful to the environment. The cattle they keep also produce less, do not get enough nutrition, and are a drain on the time and energy of the family*". The present dipstick survey shows that **these trends have either remained the same or worsened**. Farmers are relying on chemical fertilizers to produce more. Soil quality has declined. The number of cattle have declined significantly. Despite all the investments and extensive agricultural research and outreach by the government, the farmer of the Panshet catchment seems to be more or less at the same place socio-economically.
- (Gole, 1985) also noted "*With the disappearance of the forest, their sources of income are also fast declining*". **This process has worsened**. Not only income, but even knowledge of

the forest and its produce has shown a decline from 1985 to 2014. The forest department has taken efforts to protect the forests, but a symbiotic relationship between the forest and people or preservation of any kind of significant ecological niche could not be seen. Barring a few examples, even the sacred groves have suffered from degradation, as noted elsewhere. There is little interest among villagers to conserve local nature other than the sacred groves.

- (Gole, 1985) noted, "*The people...have to fall back on selling off remaining trees to charcoal merchants and to rely heavily on government subsidies*". **The degradation of the forest has continued.** Charcoal was a temporary cash cow back then. Today, real estate is the cash cow. A farmer cannot justify continued productive use of land for agriculture when urban demand offers several times their annual incomes for the same piece of land particularly in face of all the hardships in agriculture in the Western Ghats. Those who do not have access to such wealth creation tools are increasingly dependent on their city-based relatives who migrated from here.
- There is a depressed or negative feeling among most of the villagers who have been residing here, particularly in Zone I-III. Decades of lack of facilities and poor **governance have created this depression** (e.g. healthcare, education, transport). Their next generations have little by way of development options and may need to migrate to cities.
- For new occupations and ideas, lack of manpower may prove to be an impediment as younger people have migrated out.
- Discussion: Land sales to urbanites are and will continue to be the main tool for wealth creation in this area. Setting up ecological restoration programs involving the locals to conserve nature may face hurdles, **unless** linked to monetary rewards or short-term benefits. Urban owners in these land markets will be key influencers of this landscape as well as its conservation. Urban ownership is more likely to attract real estate development and tourism putting more demand on roads and creating townships, farmhouse/bungalow schemes, and industrial parks. This may increase destruction than make way for conservation. **A landscape-based ecosystems management approach practiced over the region, significant government support in conservation, a good governance approach and a stop to further roads and real estate development will save this landscape.** If conservation and restoration programs are designed to reward the local populations meaningfully and also create better soft infrastructure for the community, these could prove to be saviors of the region.

References for socio-economic study:

- *An enquiry into the status of animal and plant life in the critical areas of Western Ghats in order to evolve a plan to conserve their biological diversity, Vol. 1*, Gole, Prakash and Telali, P., Ecological Society, 1985
- *Economic and ecological impact of Panshet reservoir: A study in problems and ecodevelopment alternative*, Brahme, Sulabha and Tetali, P., Gokhale Institute of Politics and Economics, 1986

10. Templates for Restoration for Northern Western Ghats

Our 1985 survey showed a depressed resource situation in the Panshet catchment. The villagers had little access to water, little fertile land, and faced several livelihood issues. Their lifestyle was dependent on natural resources, but because of the forest's degradation, grass and forest produce availability was not abundant.

As a solution both to the ecological and socio-economic problems, the Ecological Society (ES) suggested nature restoration. The high rainfall in this region is a true 'nature's subsidy'. We felt that with a little extra effort of restoration, resource availability may increase significantly.

In 1986, ES leased a patch of a hill slope in the forest land from the Department of Irrigation, State of Maharashtra. A 3-year passive restoration exercise was initiated at this site. The detailed chronology and results of this restoration experience is summarized in Annexure VI. As a result of this project, ES developed initial templates and methodologies for forest restoration in the Northern Western Ghats. Similarly, the project guides (Oikos Eco-Services) brought experience from commercial work in restoration in others sites of Northern Western Ghats.

In the current project, we enhanced these templates to take into account the starting point (current vegetation class of a landmass), the end point (the desired end state ecosystem) and the set of restoration techniques which will take us from the starting point to the end point.

Below we provide

- A *high-level* template for a pure conservation approach which may or may not have community livelihood-related objectives
- A *high-level* template for a community-centric approach with clear livelihood support objectives
- A *detailed* template which can be implemented with expert involvement

A. Conservation approach

No.	Restoration technique*	Broad Scheme of the technique
1	Protection	Total protection from cutting of vegetation, cattle and fire is the necessary first step. Use of dry fencing and live hedges.
2	Soil & moisture conservation	Erosion prone areas or slopes to be worked on with the help of local materials like stones and boulders

		arrest soil and reduce water velocity.
3	Vegetation management	Protection to existing flora. Stage wise plantation of natives: initially hardy plants and then desired plants. Removal of non-natives.
4	Habitat creation	Creation of rock piles, log piles, wetlands. Plantation of larval host plants, shrub clusters.
5	Plantation (Native plants)	Native plants to be selected as per the current status of the soil and land.
6	Seed dispersal (Native plants)	An economical way of introducing native plants and test the regenerating capacity of the soil.

* Please refer to Annexure II for photographic explanation of the above restoration techniques.

Application of above techniques over the restoration road map is suggested as below:

Current status of land							End point
	Grasslands	Scrub	Shrubbery	Dwarf canopy	Tall canopy	Mature forest	
Restoration technique No. (from above table)	1, 2, 3, 4, 5, 6	1, 2, 3, 4, 5, 6	1, 3, 5, 6	1, 5, 6	1, 5, 6	1, 5, 6	Semi-evergreen Forest
Approximate time frame (years)	15 - 20	10 - 12	10 - 15	10 - 15	10 - 15	15 - 20	

The time frame is based on observations of local people & the restoration experiment carried out by Ecological Society in the Panshet catchment and our experience on other such projects.

B. Community approach

No.	Restoration technique	Starting point		
		Grasslands	Scrub	Dwarf Canopy
1	Protection	✓ (Objective: Management for fodder)	✓	✓ (Objective: Management for fuel wood)
2	Soil & moisture conservation	✓	✓	
3	Vegetation management	✓	✓	
4	Habitat creation	✓	✓	✓
5	Plantation			✓
		End point : Sustainable livelihood support		

This approach does not include tall or mature canopy patches as they have to be protected and conserved as is.

C. Detailed template for restoration useful in implementation

Measuring the key indicators below will help track the path of the restoration effort. Often the direction of restoration may be subject to nature's vagaries, local climatic effects, and impacts of human interference. Tracking these indicators will help judge the kind of interventions needed to keep restoration on the desired path.

	Indicator	Details	Year wise data		
			Year 1	Year 2	Year 3
A	Biomass				
	Increase in biomass	Dry and wet biomass of grasses, Leaf litter			
B	Overall biodiversity				
	Increase in habitat diversity	Grassy areas : Shrub Clusters : Tree clusters : Instream habitats* : Wetlands			
	Index of diversity (Pre-monsoon) - May	Number of species to be recorded from each habitat			
	Index of diversity (During monsoon) - August	Number of species to be recorded from each habitat			
	Index of diversity (Post-monsoon)- October	Number of species to be recorded from each habitat			
	Improvement in biodiversity	Ratio of Species indicating degradation to Species indicating improvement			
C	Soil and moisture conservation				
	Soil quantity arrested				
	Soil pH				
	Soil temperatures				
	Soil carbon				
	Water recharge capacity				
	Conductivity				
	Moisture monitoring	Thrice a year			
D	Vegetation				
	Change in % of cover types	Ratio of No-vegetation : grass : shrub : tree			
	Revival of shrubs	Av. height and width of monitored clumps			
	Natural regeneration	Number & species of regenerated saplings within quadrates			
	Increase in herbaceous	Species Status : Common, Few,			

	flora	Rare			
	Change in Grass community	Composition of grasses, % area for each species			
	Overall plant list				
	Survival of saplings during dry season and their ht.	Lists along with numbers			
E	Habitat Improvement				
	Safe site development	Safe sites for special plant, Nesting of birds, Webs of spiders, insect diversity and population etc. : Lists of species and numbers within quadrates			
	Improvement in microclimate	Ambient Temp and humidity readings : Open areas and Shady areas			
	Associations	Plants : Plants Flora : Fauna e.g. Butterflies – Foodplants			
F	Map of project land	Maintain a map with vegetation classes, species distribution, and habitat distribution			

* Instream habitats are pools, riffles, bars etc.

Suggestions for Ecological Restoration:

1. When the work of ecological restoration begins on a given area, total protection is the key factor.
2. A detailed survey of the existing floral and faunal species and its documentation is necessary. It is useful for comparing data from the future stages of restoration.
3. Removal of any kind of pre-existing native vegetation is not advised. Whatever vegetation cover exists, is useful for conserving moisture as it adds biomass and casts shade.
4. For removal of non-native vegetation, expert advice should be sought.
5. During restoration if biomass is added to the site, documentation of observations regarding species growing on such area is necessary. It will help to decide duplication / repetition of such intervention.
6. Where possible, creation of a small wetland or pond is suggested. This will add to the habitat diversity and help in improving the micro climate.

7. A good habitat diversity can be planned e.g. Patch of scrub and grassland and clumps of trees etc. In case of wetlands, one could plan for shallow sheets of water, sand flats, islands, dykes etc. This will help in increasing biodiversity.
8. Documentation of special observations is necessary to understand the trend of the restoration stages. e.g. Excessive growth of certain herbs along the path or hedges (indicating disturbances to some extent), occurrence of specialist species, flocks of certain species of bugs and beetles.

11. Survey of the Bhimashankar Wildlife Sanctuary

The Bhimashankar Wild life Sanctuary, situated on the crest of Western Ghats, is a Protected Area highly representative of Western Ghats biodiversity. Bhimashankar harbours a large number of endemic & specialised flora & fauna. A diversity of vegetation classes are represented here, including Closed-canopy evergreen forest, stunted or scrub evergreen forest, moist deciduous & deciduous woodlands etc. Sacred groves are an integral part of the Bhimashankar forest. Sacred groves are protected forest patches as a form of Nature worship. They harbor endemic & matured growth species. Climax vegetation is observed in Sacred groves.

During 1998-99, The Ecological Society conducted a detailed Survey of birds of the Bhimashankar Wildlife Sanctuary and formulated guidelines for management of the sanctuary. One of the key observations from that survey was sensitive birds like the Forest Eagle Owl have been displaced from the sanctuary because of increased illumination within its habitat. Birds like the Fairy bluebird, Painted Spurrow, certain Woodpeckers & Hornbills which were recorded earlier are no more seen within the sanctuary.

In this project, an exploratory qualitative survey was conducted to document changes in the type of forest at Bhimashankar. In view of the short timeline of the project, a few sample areas were chosen so as to represent or indicate any change in the forest ecosystem. The research team selected sample areas based on:

1. Representation of vegetative classes as per the survey report by Ecological Society(2000).
2. Representative locations of Forma Alerts given on GFW website
3. Representative locations based on stresses.

Short summary of the status of biodiversity: Bhimashankar Wildlife Sanctuary

Survey Period - September 2014 to December 2014

FLORA	
Total Species – 229	Of which endemic to India- 41 and endemic to Western Ghats- 11 IUCN- 3 (2 VU + 1 NT)
FAUNA	
Birds – 96 species Mammals -7 Reptiles- 12	
Birds-	Mammals-

The report of 2000 has 172 species, whereas this study recorded 96 species in the four month period.

Bar tailed godwit, Common greenshank, Indian blue robin and Stork billed kingfisher were not recorded previously, but recorded in the current survey.

Long billed Vultures & White rumped vultures were abundant & their nesting recorded in 2000, but not observed during our 2014 visits. According to locals, they were not spotted here in the last 4 years.

Grey jungle fowl, Red spur fowl, Night jar, Owls were previously seen commonly & have now declined in numbers. Reasons: illumination & human interference.

House Crow, Jungle crow, and Common Myna were previously very few in numbers but are now abundantly seen near temple areas, bus stand, parking areas & resorts.

Sambar, Black naped Hare -

Previously heard & seen commonly but now declined in numbers due to disturbance & poaching

Barking deer - commonly seen.

Bonnet Macaque- Very few in numbers previously, but now abundantly seen near temple areas, bus stand, parking areas & resorts.

We also noticed several threats to the Bhimashankar Wildlife Sanctuary in spite of it being a Protected Area: Hunting, Road constructions, Dam constructions, Tourists, Garbage dispersal, plastic intake by animals, Road kills, fuel wood collection, construction of resorts, Wind mills, etc

12. Report on Project Outreach

The contents of the GFW website have opened up an invaluable source of information from India & other countries. While doing the project for Global Forest Watch, we realized this is an excellent source of information, how data could be compiled and implementation methodology could be derived from collected data. As part of the project we decided to share the GFW website and findings from our project with

- Our students
- Alumni
- Staff of the Forest Department
- NGO's working in the environmental field

We held three workshops as part of project outreach.

- A. Outreach for Global Forest Watch for alumni and students in post-graduate Diploma program (Natural Resource Management & Sustainable development) conducted by Ecological Society.
 1. Presenting the ongoing project: The students of this course come from various fields, which include working professionals, students, housewives, retired persons, government officials, educators & post-graduate students. A typical mix is advocates, architects, bankers, engineers, corporate managers, journalists, & life science post graduate students. The project data can be incorporated in our course modules of Forest ecosystem, Landscape reading, Restoration practices & Forest use. We intend to use this as a demonstrative model project to be incorporated in the upcoming year in the curricula.
 2. During the program, this information will be used by participants/ students as follows:
 - i. In field work – to collect further data, compare the trends over the years & understand restoration (research requirements)
 - ii. In future as their own initiatives, or opportunities in restoration
- B. A training workshop was conducted on January 11, 2015 for the present students and alumni of Ecological Society. A detailed demonstration of the GFW Website & its various functions was conducted. The data and findings of the ongoing project was shared. Importance of downloading the information from the GFW website for research was explained. They were also shown the story section for uploading individually collected data.

C. Another Workshop was organized on Feb 9, 2015 exclusively for NGOs, researchers, and academics from Pune in environment and life sciences, many of whom are actively working on field projects. We shared with them information about GFW's Small Grants Fund and encouraged them to explore it. A detailed demonstration of the GFW website, the current project, sharing the data and findings under a single platform & its benefits were explained in our presentation. Their doubts were addressed with satisfactory explanations. We experienced a stimulating discussion on GFW and conservation of Western Ghats.

D. Another similar training workshop was conducted on Mar 7, 2015 for staff of Forest Department, Government of Maharashtra.

This workshop also led to a stimulating discussion of the GFW website, its features and benefits, and preservation of Protected Areas like Bhimashankar. Forest Guards, Conservators, and Officers from Maharashtra were present for this workshop.

While The Ecological Society restricts its programs to Pune, its students often work at National & International levels. The indirect impacts therefore spread out. Moreover, the trustees & members are invited to various events, to speak on these topics where this information will be disseminated. The outreach of the society, although small, is influential.

13. ANNEXURE I : Biodiversity lists for Panshet Catchment

A. List of ecologically special flora

Abbreviations & Terms:
E - Evergreen
D - Deciduous
BD - Brevideciduous
IUCN- International Union for Conservation of Nature
EN - Endangered; VU - Vulnerable
NT - Near Threatened; LC - Least Concern
S = Specialist species - Sensitive species requiring specific habitat. Such species may disappear if habitat is destroyed.
R = Rare species - Species rarely found in Panshet catchment

Sr.No.	Scientific name	Local name / Common name	E/D/BD	S / R	Endemism	IUCN Status
	<i>TREES</i>					
1	<i>Actinodaphne angustifolia</i>	Pisa	E		Endemic to Western ghats	
2	<i>Aglaia lawii</i>	...	E		Endemic to Western ghats	
3	<i>Bombax insigne</i>	Devsavar	BD	R		
4	<i>Bridelia retusa</i>	Asana	BD		Endemic to India	
5	<i>Carallia brachiata</i>	Phanshi	E	R		
6	<i>Cassine paniculata</i>	Bhutya (Thikra)	E	S		
7	<i>Celtis tetrandia</i>	Brumaj	BD	R		
8	<i>Celtis timorensis</i>		BD	R		
9	<i>Dalbergia sissoo</i>	Sisoo	D			VU
10	<i>Dimocarpus longan</i>	Umb	E	S		
11	<i>Dimorphocalyx lawianus</i>	Jodpakli	E	S	Endemic to Western ghats	NT
12	<i>Diospyros sylvatica</i>		E	S		
13	<i>Elaeocarpus glandulosus</i>	Rudraksh	E	S		
14	<i>Ficus nervosa</i>	Löth	E	S		
15	<i>Flacourtia latifolia</i>	Taambat	D		Endemic to India	
16	<i>Garcinia talbotii</i>	Phansada	E	S	Endemic to Western ghats	
17	<i>Glochidion ellipticum</i>	Bhoma	E		Endemic to Western ghats	

Sr.No.	Scientific name	Local name / Common name	E/D/BD	S / R	Endemism	IUCN Status
18	<i>Holigarna grahamii</i>	Raan biba	E	S	Endemic to Western ghats	
19	<i>Hymenodictyon obovatum</i>	kadva sirid	BD		Endemic to India	
20	<i>Lagerstroemia microcarpa</i>	Nana	D		Endemic to India	
21	<i>Litsea ghatica</i>		E	S		
22	<i>Mallotus aureopunctatus</i>		E	S	Endemic to Western ghats	
23	<i>Memecylon talbotianum</i>		E	S	Endemic to Western ghats	
24	<i>Neolitsea zeylanica</i>		E	S		
25	<i>Persea macrantha</i>	Gulum	E	S		
26	<i>Phoenix loureiroi</i> var. <i>pedunculata</i> / <i>Phoenix</i> <i>robusta</i>	Shelu	E	R	Endemic to India	
27	<i>Sapium insigne</i> / <i>Falconeria insignis</i>	Hura	D			VU
28	<i>Sterculia guttata</i>	Kukar	BD	R		
29	<i>Symplocos racemosa</i>		E	S		
30	<i>Terminalia paniculata</i>	Kindal	BD		Endemic to India	
31	<i>Tetrameles nudiflora</i>		BD	R		
32	<i>Trichilia connaroides</i>	Limbara	E	R		
33	<i>Xylia xylocarpa</i>	Zambha	D	R		
	SHRUB					
34	<i>Abutilon persicum</i>	Madam		R		
35	<i>Agrostistachys indica</i>	Agasti		R		
36	<i>Anisomeles heyneana</i>	Gopali			Endemic to India	
37	<i>Artemisia nilagirica</i>	Dhor Davana			Endemic to India	
38	<i>Cajanus lineatus</i>	Ran tur			endemic to India	
39	<i>Calacanthus grandiflorus</i>			R	Endemic to India	
40	<i>Capparis parviflora</i>	Kabar		S		
41	<i>Carvia callosa</i> / <i>Strobilanthes callosus</i>	Karwi			Endemic to India	
42	<i>Cissus woodrowii</i>	Girnul			Endemic to India	
43	<i>Desmodium laxiflorum</i>	Asud		R		
44	<i>Ecbolium ligustrinum</i>	Hirvi aboli		R		

Sr.No.	Scientific name	Local name / Common name	E/D/BD	S / R	Endemism	IUCN Status
45	<i>Glycosmis pentaphylla</i>	Kirmira / Maenaki(Ban Limbu)		S	Endemic to India	
46	<i>Ixora brachiata</i>	Gorbale	E		Endemic to Western ghats	
47	<i>Ixora nigricans</i>			S		
48	<i>Maytenus rothiana/Gymnosporia rothiana</i>	Bhalwand			Endemic to Western ghats	
49	<i>Nilgirianthus heyneanus</i>	Akra			Endemic to India	
50	<i>Rauwolfia verticillata</i>	Alpagandha		R		
51	<i>Thelepaepale ixiocephala</i>	Patri			Endemic to India	
52	<i>Calamus pseudotenuis</i>	Vet		S		
	HERBS					
53	<i>Adelocaryum coelestinum/ Paracaryopsis coelestina</i>	Nisurdi			Endemic to India	
54	<i>Aeginetia indica</i>			S		
55	<i>Aerides crispum / Aerides crispa</i>	Panshing		S	Endemic to Western ghats	
56	<i>Aerides maculosum</i>				Endemic to peninsular India	
57	<i>Asystasia dalzelliana</i>	Neelkanth			Endemic to India	
58	<i>Balanophora abbreviata</i>	Alimbi bandgul		S		
59	<i>Begonia crenata</i>	Kapru			Endemic to India	
60	<i>Chlorophytum glaucum</i>				Endemic to India	
61	<i>Crinum latifolium</i>	Gulabi karnaful		R		
62	<i>Crotalaria filipes var. filipes</i>	Phatphati			Endemic to India	
63	<i>Curcuma caulina / Hitchenia caulina</i>	Chavar		S	Endemic to Northern Western Ghats	
64	<i>Curcuma pseudomontana</i>	Raanhalad			Endemic to India	
65	<i>Cynarospermum asperrimum</i>	Dikna			Endemic to India	
66	<i>Desmodium ritchei</i>			Endemic to India	
67	<i>Ensete superbum</i>	Rankeli			Endemic to	

Sr.No.	Scientific name	Local name / Common name	E/D/BD	S/ R	Endemism	IUCN Status
					India	
68	<i>Eranthemum roseum</i>	Dashmuli			Endemic to India	
69	<i>Eria dalzelii</i>			R	Endemic to Western Ghats	
70	<i>Exacum lawii</i>	Lahan chirayat			Endemic to India	
71	<i>Exacum pumilum</i>	Jambhli chirayat			Endemic to India	
72	<i>Geissaspis tenella</i>	Lahan barki			Endemic to India	
73	<i>Habenaria grandifloriformis</i>				Endemic to Western Ghats	
74	<i>Habenaria longicorniculata</i>				Endemic to Peninsular India	
75	<i>Haplanthodes verticillatus</i>	Jakara			Endemic to India	
76	<i>Hemigraphis latebrosa</i>	Morpankhi			Endemic to India	
77	<i>Impatiens acaulis</i>				Endemic to India	
78	<i>Impatiens minor</i>				Endemic to India	
79	<i>Impatiens pulcherrima</i>	Dhal - Terda			Endemic to India	
80	<i>Kalanchoe olivacea</i>	Paanphuti			Endemic to India	
81	<i>Lavandula gibsonii</i>				Endemic to India	
82	<i>Malaxis rheedii</i>	Mala amri		S		
83	<i>Pecteilis gigantea</i>	Waghchora		S		
84	<i>Phyllocephalum tenue</i>	Parnagumphi			Endemic to India	
85	<i>Pimpinella adscendens</i>				Endemic to India	
86	<i>Pinda concanensis</i>	Panda/Pinda			Endemic to Northern Western Ghats	
87	<i>Rhamphicarpa fistulosa / R. longiflora</i>	Tutari			Endemic to India	
88	<i>Senecio bombayensis</i>	Sonki			Endemic to India	
89	<i>Smithia bigemina</i>	Kawla			Endemic to India	
90	<i>Smithia hirsuta</i>				Endemic to India	

Sr.No.	Scientific name	Local name / Common name	E/D/BD	S / R	Endemism	IUCN Status
91	<i>Smithia purpurea</i>	Barka			Endemic to India	
92	<i>Swertia minor</i>				Endemic to India	
93	<i>Tectaria cicutaria</i>	Kombadnakhi		R		
94	<i>Trachyspermum roxburghianum</i>	Pinela			Endemic to India	
95	<i>Zingiber neesatum</i>	Nisam			Endemic to India	
	CLIMEBRS					
96	<i>Ancistrocladus heyneanus</i>	Kardal		S	Endemic to India	
97	<i>Dalbergia horrida</i> var. <i>horrida</i>	Pedgul			Endemic to India	
98	<i>Caesalpinia cucullata</i>	Ragi		R		
99	<i>Gnetum scandens</i>	Umbli		S		
100	<i>Pristimera grahamii</i> / <i>Hippocratea grahamii</i>	Lokhandi/daushir		S		
101	<i>Argyreia involucrata</i>				Endemic to India	
102	<i>Argyreia sericea</i>	Gavel			Endemic to India	
103	<i>Asparagus racemosus</i>	Shatavari			Endemic to India	
104	<i>Ceropegia huberi</i>				Endemic to northern Western Ghats	
105	<i>Ceropegia oculata</i>	Mor kharchudi			Endemic to India	
106	<i>Clematis heynei</i>	Raanjai			Endemic to India	
107	<i>Cynanchum tunicatum</i>	Panchali		R		
108	<i>Dioscorea belophylla</i>			R	Endemic to India	
109	<i>Entada rheedei</i>	Garambi		S		
110	<i>Gymnema khandalense</i> /Bidaria <i>khandalense</i>			S	Endemic to Northern Western Ghats	
111	<i>Hoya wightii</i>	Ambari		S	Endemic to India	
112	<i>Jasminum malabaricum</i>	Kusar			Endemic to India	
113	<i>Piper spp.</i>			S		
114	<i>Toddalia asiatica</i>	jungli mirchi		S		

B. List of Ecologically Special fauna

Sr.No.	Scientific name	Common name	Endemism	IUCN	WPA Schedule
	Birds				
1	<i>Acritillas indica / Iole indica</i>	Yellow browed bulbul	endemic to the Indian Subcontinent (India & Shrilanka)	LC	
2	<i>Aethopyga vigorsii</i>	Vigors's sunbird	endemic to northern western ghats and western satpuda.	LC	
3	<i>Ammomanes phoenicura</i>	Rufous-tailed lark	endemic to the Indian Subcontinent (India & Pakistan)	LC	
4	<i>Cacomantis passerinus</i>	Grey bellied cuckoo	endemic to the Indian Subcontinent	LC	
5	<i>Cinnyris lotenia</i>	Loten's sunbird	endemic to the Indian Subcontinent (India & shrilanka)	LC	
6	<i>Columba elphinstonii</i>	Nilgiri woodpigeon	endemic to peninsular India	VU	
7	<i>Copsychus fulicatus / Saxicoloides fulicatus</i>	Indian Robin	endemic to the Indian Subcontinent	LC	
8	<i>Corvus macrorhynchos</i>	Jungle Crow	endemic to the Indian Subcontinent	LC	
9	<i>Cyornis pallipes</i>	White-bellied blue flycatcher	endemic to Western ghats & west Tamilnadu hills	LC	
10	<i>Dicaeum concolor</i>	Nilgiri flowerpecker	endemic to Western ghats & Tamilnadu	LC	
11	<i>Dicaeum erythrorhynchos</i>	Pale billed flowerpecker	endemic to the Indian Subcontinent	LC	
12	<i>Dumetia hyperythra</i>	Tawny bellied babbler	endemic to the Indian Subcontinent	LC	
13	<i>Edolius caerulescens / Dicrurus caerulescens</i>	White bellied Drongo	endemic to the Indian Subcontinent	LC	
14	<i>Falco jugger</i>	Laggar Falcon		NT	
15	<i>Galerida malabarica</i>	Malabar lark	endemic to western ghats	LC	
16	<i>Galloperdix spadicea</i>	Red Spurfowl	endemic to India	LC	
17	<i>Gallus sonneratii</i>	Grey junglefowl	endemic to India	LC	II
18	<i>Gyps indicus</i>	Indian Vulture		CR	I
19	<i>Hierococcyx varius</i>	Common hawk cuckoo	endemic to the Indian Subcontinent	LC	
20	<i>Hypsipetes ganeesa</i>	Square-tailed Bulbul	endemic to India & Shrilanka		

Sr.No.	Scientific name	Common name	Endemism	IUCN	WPA Schedule
21	<i>Leptocoma zeylonica</i>	Purple-rumped Sunbird	endemic to the Indian Subcontinent	LC	
22	<i>Megalaima viridis</i>	White cheeked barbet	endemic to peninsular India	LC	
23	<i>Megalaima zeylanica</i>	Brown headed barbet	endemic to the Indian Subcontinent	LC	
24	<i>Motacilla madaraspatensis</i>	White-browed wagtail	endemic to the Indian Subcontinent	LC	
25	<i>Myophonus horsfieldii</i>	Malabar whistling thrush	endemic to peninsular India	LC	
26	<i>Parus aplonotus</i>	Indian Yellow Tit / Black lored tit	endemic to peninsular India	LC	
27	<i>Pavo cristatus</i>	Indian peafowl	endemic to the Indian Subcontinent	LC	I
28	<i>Perdica argoondah</i>	Rock Bush-Quail	endemic to India	LC	
29	<i>Perdica asiatica</i>	Jungle Bush-Quail	endemic to India & Shrilanka	LC	
30	<i>Pericrocotus flammeus</i>	Orange Minivet	endemic to India & Shrilanka	LC	
31	<i>Pomatorhinus horsfieldii</i>	Indian Scimitar-Babbler	endemic to India	LC	
32	<i>Prinia socialis</i>	Ashy prinia	endemic to the Indian Subcontinent	LC	
33	<i>Psittacula cyanocephala</i>	Plum headed parakeet	endemic to the Indian Subcontinent	LC	
34	<i>Rhipidura albogularis</i>	white spotted fantail	endemic to peninsular India	LC	
35	<i>Sterna aurantia</i>	River tern		NT	
36	<i>Sturnia pagodarum</i>	Brahminy Starling	endemic to the Indian Subcontinent	LC	
37	<i>Taccocua leschenaultii</i>	Sirkeer malkoha	endemic to the Indian Subcontinent	LC	
38	<i>Turdoides malcolmi</i>	Large grey babbler	endemic to the Indian Subcontinent	LC	
39	<i>Turdoides striata</i>	Jungle babbler	endemic to the Indian Subcontinent	LC	
	Butterflies				
1	<i>Acytolepis puspa</i>	Common hedge blue			I
2	<i>Castalius rosimon</i>	Common pierrot			I
3	<i>Euchrysops cnejus</i>	Gram blue			II
4	<i>Euploea core</i>	Common crow		LC	IV
5	<i>Hypolimnas misippus</i>	Danaid eggfly			I
6	<i>Pachliopta hector</i>	Crimson rose			I

Sr.No.	Scientific name	Common name	Endemism	IUCN	WPA Schedule
Amphibians					
1	<i>Indirana sp.</i>		Endemic to Western Ghats		
2	<i>Nyctibatrachus sp.</i>	Night frogs	Endemic to Western Ghats		
Snakes					
1	<i>Bungarus caeruleus</i>	Common krait			IV
2	<i>Macropisthodon plumbicolor</i>	Green keelback			IV
3	<i>Naja naja</i>	Spectacled cobra			II
4	<i>Uropeltis macrolepis</i>	Bombay shieldtail	Endemic to Western Ghats		IV
5	<i>Uropeltis phipsonii</i>	Phipson's Shieldtail	Endemic to Western Ghats		IV
6	<i>Xenochrophis piscator</i>	Checkered keelback			IV
Mammals					
1	<i>Hystrix indica</i>	Indian crested porcupine			IV
2	<i>Macaca radiata</i>	Bonnet macaque	Endemic to peninsular India		II
3	<i>Muntiacus muntjak</i>	Barking deer			III
4	<i>Ratufa indica</i>	Malabar giant squirrel	Endemic to India		II
5	<i>Semnopithecus entellus</i>	Hanuman langur			II
6	<i>Sus scrofa</i>	Wild boar			III

14. ANNEXURE II : Restoration techniques and its results

Photographic representation of the Panshet restoration site, by Ecological Society

Landscape before restoration (1986)



Landscape after the protection provided to site during Year 1



Landscape after the restoration effort during Year 2



Biomass (grass) produced as a result of restoration effort. The grasses were distributed as cattle fodder to nearby villages.

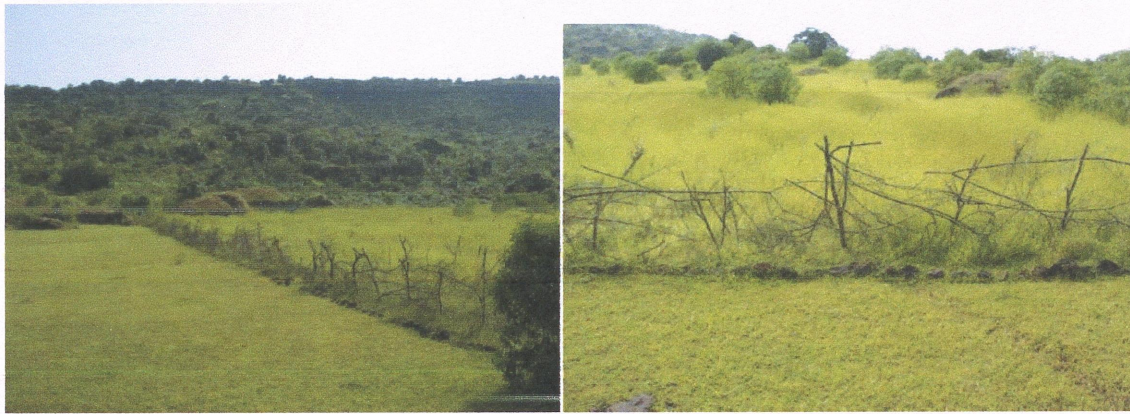


Landscape after the restoration effort during Year 3



Photographic representation of various restoration techniques executed on sites by Oikos for ecological services, Pune.

Protection: Dry Fence and Live fence (Area with vegetation clusters and good quality grasses shows protected area as against the inferior quality grass area outside the fence)



Fire line

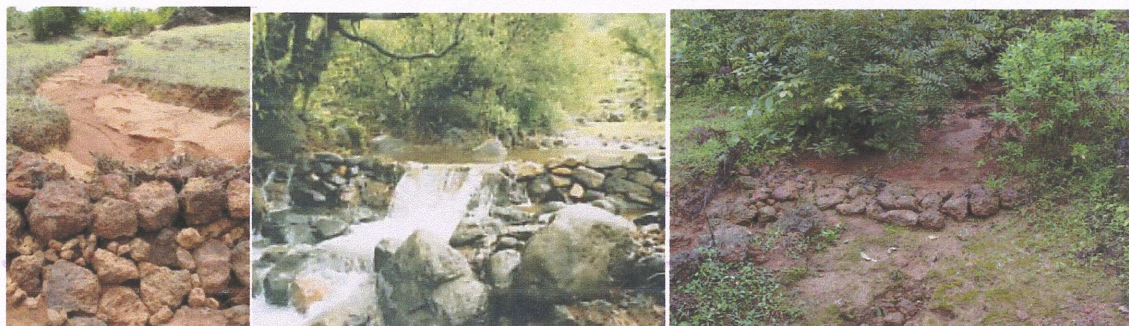


Soil and Water Conservation Measures

Stone Lines



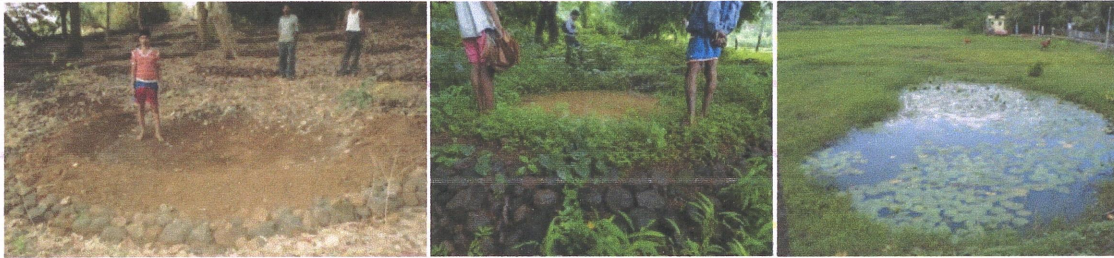
Gully plugging



Trenches



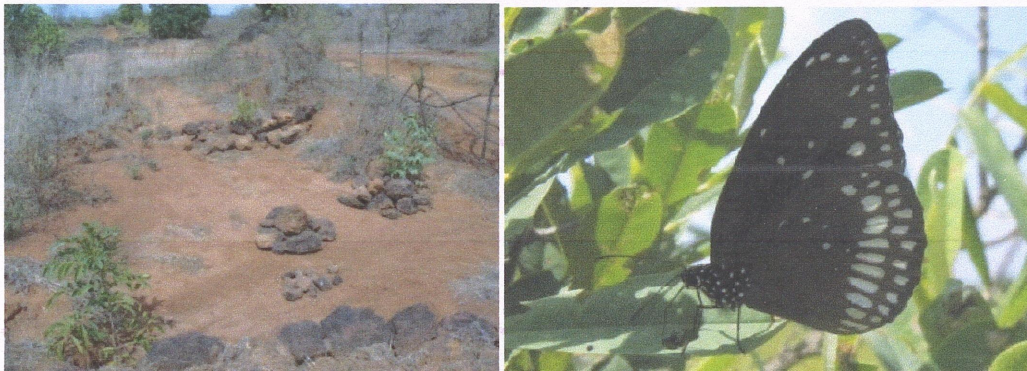
Creation of small wetlands or percolation ponds



Stone work at erosional features



Habitat development: Stone pile, Log piles, plantation of larval host plants and food plants etc.



Microbial reserve: Addition of biomass like crop residue, grasses from outside



Enclosures



Plantation of natives



Removal of non-natives



15. Annexure III - Socioeconomic Study - Interview Notes (Please refer to excel sheet attached)

16. Annexure IV: Short summary of biodiversity data at 32 patches in the Panshet catchment representative of vegetation classes in Northern Western Ghats (Please refer to PDF files attached)

17. Annexure V: Images based on GIS mapping of Panshet catchment, wetland at Ecological Society's restoration site, and Bhimashankar Wildlife Sanctuary (Please refer to jpg images based on GIS mapping attached)

18. Annexure VI: Draft Story for GFW website - "Ecological Society's ecological restoration project could be a model for Northern Western Ghats, India "

Ecological Society's ecological restoration project could be a model for Northern Western Ghats, India

Due to high rainfall and high elevation, the Western Ghats range in India supports "Tropical semi evergreen type of forest". Special physical features have created unique habitats which support endemic biodiversity. The region was declared as a biodiversity hotspot by British Environmentalist Normann Myers in year 1988.

The Ecological Society is an NGO based in Pune, India, founded by ornithologist-ecologist Prakash Gole. In 1985-86, the Society conducted a detailed ecological and socio-economic survey of the catchment area of Panshet dam, which is part of Western Ghats forests. The survey was repeated in 2014 as part of a Small Grants project from GFW. The video below details degradation in the Western Ghats forests over this long period.

<<< VIDEO LINK >>>

The current status of the landscape of Western Ghats is the outcome of years of use by local people since last two centuries, as well as modern developmental pressures within the last few decades. The continuous degradation of the landscape has changed the character of the original forest ecosystem. Due to this, Nature's Services from region, whether water for the Deccan peninsula or production of soil, are severely affected. The case of the Panshet dam tells us that for short-term benefits of water supply to the city of Pune, long-term future of an ecosystem and its services was compromised.

Our 1985 survey showed a depressed resource situation. The villagers had little access to water, little fertile land, and faced several livelihood issues. Their lifestyle was dependent on natural resources, but because of the forest's degradation, grass and forest produce availability was not abundant.

As a solution both to the ecological and socio-economic problems, the Ecological Society suggested nature restoration. The high rainfall in this region is a true 'nature's subsidy'. We felt that with a little extra effort of restoration, resource availability may increase significantly.

The overall objective of the restoration project was to demonstrate how nature can be revived and local people can get natural resources. Specifically,

- Restoration of indigenous flora on denuded and eroded surfaces
- Planting of species that will help satisfy the basic needs of the residents
- Cultivation of plants that would help generate income and should induce people to give up the practice of shifting cultivation.

The overall chronology of the project is as under:

In 1986, a patch of a hill slope in forest land was leased from the Department of Irrigation, State of Maharashtra. This land was adjacent to the Panshet dam wall. The land was degraded due to burning, trampling, wind, sheet erosion, and physical removal of soil.

During the planning phase, three stages were envisioned:

1. Protecting the area from outside interference, making provision for water for the dry season, and carrying out soil conservation measures. This was expected to result in natural regeneration of grasses, weeds, and hardy local species.
2. This was to be followed by a plantation program, primarily species that resist grazing and drought conditions.
3. Finally, fruit species like Mango, Jambhul, and Jackfruit were to be planted, along with other delicate species. Grass was expected in abundance by this stage. The saplings, fruit, and grass would be provided to local people.

When the restoration work started in 1986, protection of the land was emphasized. The area was given protection by thorn fencing and trench-cum-mound barricades against grazing and trespassing. Other activities like gully-plugging, contouring, and ploughing along the contours were carried out to break run-off and control erosion. In May-June 1986, 600 saplings were planted. The 1986 monsoon season had a normal rainfall and 76% of the saplings survived. The check dams erected to stop soil erosion held on during the monsoon season, protecting an accumulation of soil 20-60 cm in depth.

However, beyond this point, grazing proved to be a major disturbance. Trampling by cattle and eating of sprouted tender leaves destroyed many a plant. During the 1986-87 dry period, there was no continuous supply of water for the plants. As a result, out of the 600+ saplings planted originally, only 296 remained to see the monsoon of 1987. During the dry season, trenches lined with plastic sheets were dug to accumulate water, seeds of native species were collected from neighboring forests, and a plant nursery was initiated.

The 1987 monsoon was very weak, with only 25 rainy days during the 4-month season. New plantation was executed as per the plan but due to the weak monsoon, out of 7690 saplings planted, only 5104 survived by October, 1987. Eucalyptus and Agave species were planted in majority to strengthen fencing around the boundaries of the project area. A positive outcome of reduction in grazing was natural regeneration of several native trees, shrubs, climbers, herbs, and grasses during this monsoon period. By October, 28 species of trees were growing in the area as opposed to 8 during the 1986 inventory. Similarly, climbers species grew from 2 to 15 and herbs from 10 to 75. A large area (48000 sq. mt.) now had grass and herb cover. This attracted bird (12) and butterfly (11) species as well.

During the 1987-88 dry period, various methods were tried to bring water to the project area but most proved expensive or cumbersome. As a result, plants had to mostly withstand the season without irrigation. However, the grasses grew tall and luxuriant (70 cm to 115 cm depending on species). When all the grass was cut, it measured 2.5 metric ton – 100 bundles each valued at Rs. 25-40.

By May 1988, 3836 saplings had survived. At this time, 5 ha was added to the project area, making the total area 12 ha, but spreading the project resources thin. But it was thought that a larger area will support higher species diversity and be more robust for conservation. At this time, the nursery had completed one year, with many plants available.

The 1988 monsoon was normal, with abundant rain in July and August (60 rainy days through the season). The grass and herb cover from previous years helped control the soil erosion, so did the check dams. Around 1985 saplings were planted in this year, and this time, they included many fruit trees, wherever the soil depth was good. As before, natural regeneration was in full swing. By now, the number of grass species had increased to 16, from 3 in 1986 and 4 in 1987. As moisture accumulated near rocks, presence of herbs also continued to increase. Soil quality had improved, as earthworms were noticed while digging pits (there was no such occurrence in 1986 or 1987). More bird and butterfly species were attracted. Mammals like blacknaped hare were now residents while barking deer and wild boar also frequented the area.

During the dry season of 1988-89, grasses in several locations achieve height greater than 1 m. This time, the grasses were not cut to help protect the soil from wind and sun and to retain moisture.

Due to lack of irrigation, many of the more recent saplings, particularly the fruit trees of mango and jackfruit could not survive. Around 1051 saplings survived by May 1989.

The 1989 monsoon was the last of the planned 3-year first phase. Hence plantation of trees catering to fuel wood and timber was a priority, to help meet energy needs of local population. E.g. Lucanea, teak, and Gliricidia. A total of 1130 trees were planted. The rainfall during this season was normal and most of the saplings survived. Moreover, natural regeneration continued profusely. Grasses in particular experienced healthy growth again. Themeda reached a maximum height of 2.5 m while Heteropogon reached 1.75 m.

The tangible outcomes of these restoration efforts over three years were: 1. increase in improvement in soil PH (from an average of 5.7 in June 1986 to an average of 6.8 in Sept 1989), 2. control of soil erosion (25.8 cu.m. silt collected over 993 sq. m. due to bunds i.e. 1 cu.cm /year/ sq. m.), 3. increase in quantity and quality of vegetative cover, increase in naturally growing plants, 4. an improvement in the Index of Diversity (from 125 in Sept'87 to 185 in Sept '89, and from 22.5 in June'87 to 81 in June'89) 5. Significant supply of grass to support local peoples' needs, 6. Increase in faunal diversity of bird, butterflies, and mammals.

For several years after the initial phase, a 'pact' was put in place with local people, where they will not send cattle for grazing in the project site, and in return, they will get ready grass as cattle feed during the dry season. This arrangement was mutually beneficial and it provided grass in quantities of about 20 ton/year to local people.

It was seen that ecological restoration, where protection is provided and nature is allowed to take its own course, was a more reliable and less expensive process than horticulture. The project expenses were Rs. 5952 / ha / year, vs. an estimated Rs. 30000 / ha/ year if traditional horticulture were to be used.

A planned and cooperative effort, led by local community was recommended. This is necessary to

1. Reduce destructive practices like shifting cultivation,
2. Spread the costs of restoration across the community, and
3. Reap the benefits of restoration collectively

The project showcases ideal restoration techniques to restore biodiversity at a very low cost. Even the local community has benefitted in terms of nutritious fodder for their cattle. This project is an

excellent example of passive restoration which can be replicated almost anywhere else in the Northern Western Ghats.

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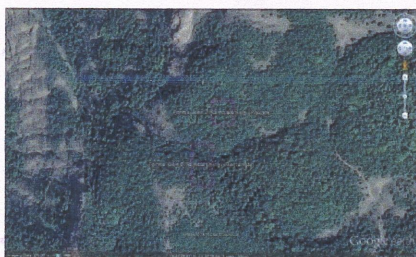
19. Annexure VII - Bhimashankar Wildlife Sanctuary - Survey of Forma Alert and Stress Areas

Location 1:



Forma Alert 1	Bhakadevi	Date of survey 18.12.2014
	Parameters	Description
GPS Position	Coordinates	19.080452 N, 73.540549 E
	Altitude	1022 m
Weather	Temperature	23.9°C
	Humidity	42 %
Physical features	Location	Flat Mountain top
	Area of alert	0.43 ha
	Slope	Less than 5°
	Substratum	A mixture of cobbles, pebbles, occasional boulders and gravely soil, brought up to the surface by earthworm activity in 90% of area and surface looks like lower part of the regolith; layer of leaf litter is relatively thin.
	Streams	First order streams without channel was recorded along one slope
Canopy	Height	Approx. 40 ft.
	Canopy cover	Approx. 65%
Stresses	Forest Cutting	Cutting about 15 % (± 1 %) for household purposes and mainly for fuel wood
	Fire	No
	Grazing	No
	Human Interference	Thrown Plastic Water bottles
Vegetation	Composition	<i>Memecylon</i> – <i>Olea</i> – <i>Syzygium</i> – <i>Ficus racemosa</i> forming canopy associated with <i>Mallotus philippensis</i> and lianas like <i>Diploclisia glaucescens</i>
	Undergrowth	Trees: <i>Xantolis tomentosa</i> , <i>Actinodaphne angustifolia</i> , <i>Symplocos racemosus</i> , <i>Atalantia racemosa</i> , <i>Diospyros</i>

		<p><i>sylvatica</i>, <i>Dimorphocalyx lawianus</i>, <i>Lepisanthus tetraphylla</i>, <i>Cryptocarya burdolinii</i>, <i>Murraya koenigi</i></p> <p>Shrubs: <i>Maytenus rothiana</i>, <i>Ixora brachiata</i>, <i>Mallotus stenanthus</i>, <i>Mallotus aureopunctatus</i></p> <p>Climbers: <i>Oxyceros rugulosus</i></p>
	Regeneration	<p><i>Cryptocarya burdolinii</i>, <i>Mallotus philippensis</i>, <i>Diospyros sylvatica</i>, <i>Lepisanthes tetraphylla</i>, <i>Symplocos racemosa</i>, <i>Murraya koenigi</i>, <i>Actinodaphne angustifolia</i>, <i>Memecylon umbellatum</i>, <i>Syzygium cumini</i></p>
	Ground Cover	No weeds, no grasses, no herbs.
Faunal Observations		<p>Two Indian Giant Squirrel (<i>Ratufa indica</i>) nests on <i>Olea dioica</i>.</p> <p>Barking deer droppings at two places. Presence of Wild Boar.</p>
Adjacent Area Status	Physical features	Moderate Slope (10-15 °) Leaf litter relatively more, dead wood logs observed in significant amount (15 to 30 cm diameter).
	Vegetation	<p>Overall Diversity was in good condition with good natural regeneration. It was a combination of Old Growth Trees like <i>Olea dioica</i>, <i>Syzygium cumini</i>, <i>Symplocos spp.</i> <i>Ficus racemosa</i> formed top canopy with 2nd layer consisting of <i>Actinodaphne</i>, <i>Xantolis</i>, <i>Memecylon</i>, <i>Cryptocarya</i>.</p> <p>Undergrowth consists of regeneration predominantly of <i>Actinodaphne</i> and <i>Memecylon</i> along with <i>Cryptocarya</i> (in all 4 stages), <i>Diospyros</i>, <i>Lepisanthes</i>, <i>Symplocos</i> with lianas - <i>Diploclisia glaucescens</i>, <i>Oxyceros rugulosu</i>.</p> <p>Ground Cover predominantly consisted of <i>Piper spp.</i></p>

Location 2:

Forma Alert 2	Sambarshingi forest patch	Date of survey 18.12.2014
	Parameters	Description
GPS Position	Coordinates	<p>19.080799 N, 73.53647 E</p> <p>19.079969 N, 73.536123 E</p>

	Altitude	954m to 960 m
Weather	Temperature	22.4° C
	Humidity	41%
Physical features	Location	Upper slope of mountain
	Area of alert	Square shaped alert area- 0.15 ha Rectangle shaped alert area - 0.26 ha
	Slope gradient	20-25°
	substratum	Soil gravelly along with pebbles, cobbles and few boulders; no earthworm activity indicating presence of less fine soil; with moderate layer of leaf litter
	Streams	One channeled stream observed along one margin
Canopy	Height	50-60 ft
	Canopy cover	Approx. 75%
Stresses	Forest Cutting	Cutting about 4 % (± 1 %) for honey collection, household purposes and for fuel wood; also recorded natural felling of trees up to 8% due to shallow substratum and wind
	Fire	No fire
	Grazing	No grazing
	Human Interference	Not seen
Vegetation	Composition	<i>Syzygium-Actinodaphne-Olea</i> community associated with <i>Diospyros sylvatica</i> , <i>Xantolis tomentosa</i> , <i>Atlantia racemosa</i> , <i>Symplocos racemosa</i> ; <i>Bridelia racemosa</i> as emergent and liana <i>Diploclisia</i> .
	Undergrowth	Trees: <i>Atalantia racemosa</i> , <i>Cryptocarya burdolinii</i> , <i>Garcinia talboti</i> , , <i>Dimorphocalyx lawianus</i> , <i>Murraya koenigi</i> Shrubs: <i>Ixora brachiata</i> , <i>Mallotus stenanthus</i> , <i>Mallotus aureopunctatus</i> Climbers: <i>Oxyceros rugulosus</i> , <i>Ancistrocladus heyneanus</i>
	Regeneration	<i>Cryptocarya burdolinii</i> , <i>Actinodaphne angustifolia</i> , <i>Syzygium cumini</i> <i>Atlantia racemosa</i> , <i>Diospyros sylvatica</i> , <i>Murraya koenigi</i> , <i>Memecylon umbellatum</i> , <i>Dimorphocalyx lawianus</i> .
	Ground Cover	<i>Piper</i> sp., No weeds, no grasses, no herbs observed
Faunal Observations		Nest of Indian Giant Squirrel (<i>Ratufa indica</i>) on <i>Xantolis tomentosa</i>
Adjacent Area Status	Physical features	Slope is steep (40-45°) towards stream side
	Vegetation	Very similar to the alert area, Old growth trees sparsely located, <i>Ancistrocladus heyneanus</i>

	regeneration dominant and covered the ground
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Location 3:



Forma Alert 3	Bhakadevi area - Tiger point	Date of survey 18.12.2014
	Parameters	Description
GPS Position	Coordinates	19.088562 N, 73.536803 E 19.08808 N, 73.53715 E
	Altitude	964 to 971 m
Weather	Temperature	27.1 ⁰ C
	Humidity	37%
Physical features	Location	Mountain top with slope of 5 ⁰ gradient
	Area of alert	Square shaped alert area- 0.13 ha Rectangle shaped alert area - 0.26 ha
	Slope gradient	5 ⁰
	Substratum	Soil gravely along with pebbles, and cobbles; significant earthworm activity indicating presence of good fine soil; with sparse/low layer of leaf litter
	Streams	No stream in alert area
Canopy	Height	25-30 ft
	Canopy cover	Approx. 70%
Stresses	Cutting	Cutting about 15 % (± 1 %) for household purposes and for fuel wood; chopping of side branches
	Fire	No fire
	Grazing	No grazing
	Human Interference	Not seen
Vegetation	Composition	<i>Memecylon-Actinodaphne-Xantolis</i> community associated with <i>Diospyros sylvatica</i> , <i>Atlantia racemosa</i> , <i>Ficus racemosa</i> , <i>Syzygium cumini</i> , <i>Olea dioica</i> , and <i>Mallotus philippensis</i> .
	Undergrowth	Trees: <i>Callicarpa tomentosa</i> , <i>Glochidion ellepticum</i> ,

		<i>Cryptocary bourdillonii</i> . Climbers: <i>Embelia drupacea</i> .
	Regeneration	First stage regeneration (seedlings) negligible, of <i>Actinodaphne angustifolia</i> , <i>Diospyros sylvatica</i> , , <i>Memecylon umbellatum</i>
	Ground Cover	No groundcover, No weeds, no grasses, no herbs observed
Adjacent Area Status	Physical features	Plain without slope gradient
	Vegetation	Very similar to the alert area

Location 4:

Stress area 1	Vandre-Padarwadi/ Kharpuj windmill area	Date of survey 8.12.2014
	Parameters	Description
GPS Position	Coordinates	Padarwadi -Kharpuj - 18.983782 N, 73.59637 E Wandre windmill - 18.971689 N, 73.530739 E
	Altitude	Padarwadi kharpuj – 1114 m Wandre windmill - 1047 m
Weather	Temperature	--
	Humidity	--
Physical features	Location	Mountain top with undulating peaks
	Area of alert	Padarwadi kharpuj - 22.39 ha Wandre windmill- 6.38 ha
	Slope	45-50°
	Substratum	Most of area of spur top consisted of 3-4 ft deep lateritic soil layer which is continuation of various horizons of weathering profile. At places base rock was exposed.
	Streams	First order streams originate between peaks (saddles)

Canopy	Height	Approx. 25-30 ft.
	Canopy cover	--
Stresses	Development	Road construction up to spur top for Wind mill erection
	Forest Cutting	Forest Cutting for above developments, habitat degradation and landslides due to blasting and JCB activity.
	Fire	No
	Grazing	yes
	Human Interference	No
Vegetation*	Composition	<i>Memecylon</i> – <i>Actinodaphne</i> - <i>Xantolis</i> associated with <i>Olea dioica</i> , <i>Syzygium cumini</i> , <i>Ficus racemosa</i> , <i>Atlantia racemosa</i> <i>Catunaragum spinosa</i> and <i>Ternimalia chebula</i>
	Undergrowth	Trees <i>Meyna laxiflora</i> , <i>Macaranga peltata</i> , <i>calicarpa tomentosa</i> , <i>Glochidion elepticum</i> , <i>Mallotus philippensis</i> Shrubs : <i>Crotalaria retusa</i> , <i>Gnidia glauca</i> , <i>Lobelia nicotifolia</i> (along open degraded area) Climbers : <i>Hippocratia grahamii</i>
	Regeneration	<i>Memecylon umbellatum</i> , <i>Syzygium cumini</i> , <i>Mallotus philippensis</i> , <i>Olea dioica</i>
	Ground Cover	<i>Piper</i> sp. Weeds and other Herbs - <i>Alternanthera tenella</i> , <i>Argemone maxicana</i> , <i>Rungia pectinata</i> , <i>Blumea lacera</i> ; grasses <i>Themeda</i> sp , <i>Eragrostris</i> sp .
Adjacent Area Status		good forest cover in patches
*Area of Kharpud was found more degraded than that of Vandre-Padarwadi area		

Location 5:



Stress area 2	Parking area on way to Bhimashankar temple (5 km away)	18.11.2014
	Parameters	Description
GPS Position	Coordinates	Parking Area 1- 19.078879 N, 73.544095 E Parking Area 2 - 19.077706 N, 73.544163 E
	Altitude	Parking Area 1- 1024 m Parking Area 2 - 1021 m
Weather	Temperature	--
	Humidity	--
Physical features	Location	Flat rocky plateau.
	Area of alert	Parking Area 1- 1.24 ha Parking Area 2 - 2.00 ha
	Slope	5°
	Substratum	An Exposed rocky plateau with thin gravelly soil layer mixed with small pebbles. It consists of microhabitats including rock surfaces and crevices, boulders and soil filled depressions
	Streams	No streams, but ephemeral ditches and ponds found on plateau
Canopy	Height	Tree canopy not present but shows typical rocky plateau vegetation with monsoon herbaceous flushes and grasses and shrubby clusters around
	Canopy cover	--
Stresses	Development	Developed for car parking, Garbage bins installed
	Forest Cutting	Habitat degradation due to road roller and JCB activity.
	Fire	Occasional fires
	Grazing	yes

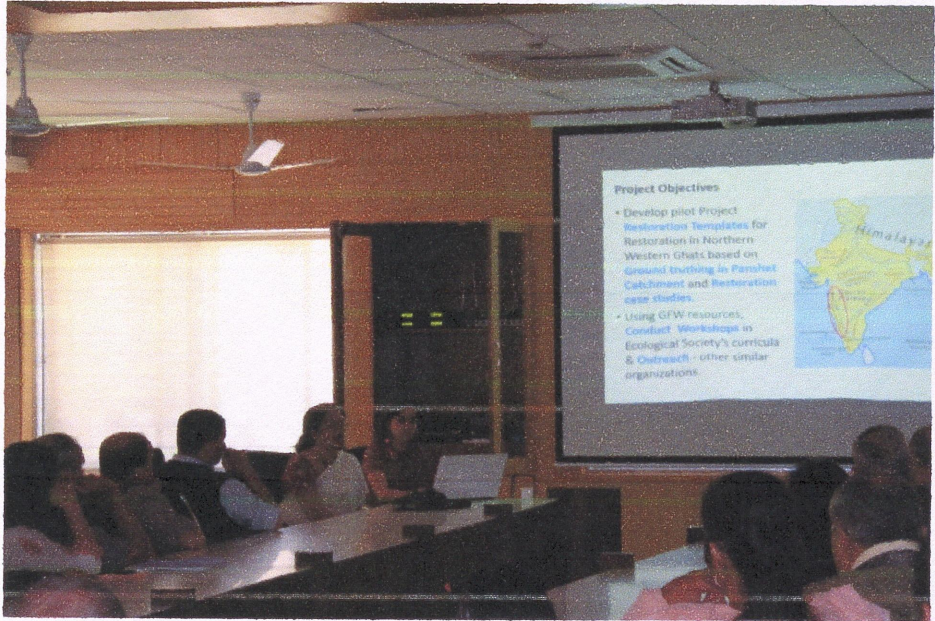
	Human Interference	---
Vegetation	Composition	Typical herbaceous vegetation varies with monsoon. Shows sequential changes in composition – <i>Eriocaulon</i> - <i>Utricularia</i> - <i>Smithia</i> – <i>Senecio</i> associated with number of grasses and sedges.
	Associated shrubby clusters	<i>Gnidia glauca</i> , <i>Catunaragium spinosum</i> , <i>Crotalaria retusa</i>
	Regeneration	--
	Ground Cover	Weeds and other Herbs - <i>Alternanthera tenella</i> , <i>Argemone maxicana</i> , <i>Rungia pectinata</i> , <i>Blumea lacera</i> , <i>Conyza stricta</i> ; grasses <i>Themeda</i> sp , <i>Eragrostis</i> sp. and <i>Heteropogon conturtus</i> (in degraded lands)
Adjacent Area		Open grass lands with good grass composition

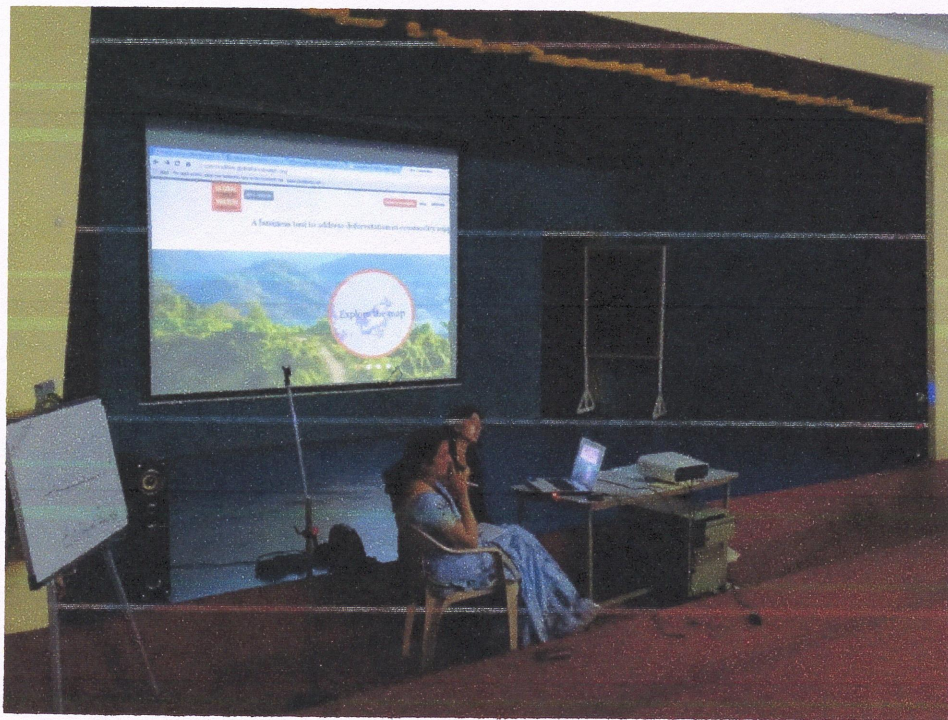
20. Annexure VIII : CD with open files for GIS (delivered separately)

21. Annexure IX: Documentary film – “Saga of a forest: Northern Western Ghats: Then and Now”(delivered separately)

22. Annexure X : Presentation used for Outreach Workshops (attached separately)

23. Annexure XI : Photographs of Outreach Workshops







24. Annexure XII: Digitized copies of Previous Reports prepared by Ecological Society : (delivered separately)

- I. An Enquiry into the status of Animal and plant life in critical areas of Western Ghats in order to evolve a plan to conserve their biological diversity (Vol I & II), 1985
- II. Final technical report - Restoration of Biological diversity, 1989-90
- III. Survey of birds of Bhimashankar wildlife sanctuary and formulation of management guidelines for their protection, 2000

