"Survey, Rapid Assessment and Restoration of Vegetation Diversity within Mukurthi National Park"

Final Report

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Introduction

In June of 2002 the Tamil Nadu Forest Department granted permission to the Gurukula Botanical Sanctuary, in Wayanad, Kerala, to carry out a floristic survey of the grasslands in Mukurthi National Park. The study was aimed at establishing some guidelines for assessing the floristic health of the ecosystem. The fact that the Upper Nilgiris, or the south western areas, 77 sq km of which are protected under the National Park, contain some of the most pristine or least disturbed natural ecosystems in the Western Ghats, offers an excellent chance to examine closely the gradation from healthy or somewhat intact plant communities, to poorer or degraded ones. It also offers a chance to look at how the altered areas might be restored to conditions of ecological 'health' and be encouraged to proceed towards their natural climax. This is particularly important in landscapes where habitat destruction is high. Fragmentation of natural areas into unsustainable pockets of diversity is one of the biggest crises of our times and is the current focus of the huge interdisciplinary effort that is "restoration ecology".

The basis for the study

Although the study area is protected, and has National Park status, it has been worked in the past. One of the first approach paths leading to Ooty from the Kerala coast went through here. Effects of colonial experiments in "afforestation" using wattle and pine, from the 1920s onwards, are still to be seen. As the climate is very harsh in the study area, which is at the south western edge of the Nilgiri plateau, the wattle failed to survive and all one can see of the vast plantations that were made between the 1920s and 1960s are some scattered saplings and rows of empty holes in a few places. These grasslands must have been affected by other factors also. Road cutting, pitting, the gradual spread of exotics, fires and building work altogether would have caused disturbance to the grassland ecology, not to mention the effects of habitat fragmentation and climate change.

Our team had two primary aims when the project was initiated, both of which, we believe, are critical to the task of plant and habitat conservation. Firstly, we wished to try and establish whether or not there has been a change in the composition of plant species in the study area (and its surroundings) over the course of the last say, 200 years. The Nilgiris have been a hotspot for botanists since early colonial times. The MNP area in particular has been well studied; there are references to Sispara, Nadugani and Bangithappal in the records. With the help of references from the past our intention is to build a picture of how the grassland flora may have changed. Species common in the past may have become rare. Some may have disappeared altogether. Frequent fires followed by cattle grazing by Todas may have made it possible for exotic weedy species to take hold. And so on.

The second aim was to conduct a detailed inventory and analysis of the current state of the grassland community. This in itself would be valuable on several counts. For instance, many of our tropical montane plants are highly localized. The Upper Nilgiris are particularly rich in narrow endemics. In any attempt to conserve them it is therefore critical to understand their habitat preferences and distribution patterns within the areas where they are found. In addition, the grassland community (along with the shola) is itself an unusual and fragile ecosystem, a highly endangered one. It is imperative to allow for the return of this system in degraded and fringe areas or even in other parts of the landscape, using an integrated approach of species rehabilitation, restoration, active intervention or changes in rangeland management.

The overarching goal is, of course, to help the Forest Department prepare a detailed conservation action plan for the Park with the plant community in mind. By working out the gradient from pristine to degraded parts of the ecosystem and the possible factors for degradation, as well as establishing some kind of a historical thumb rule for comparison, we hope this provides a better basis for drafting proactive conservation strategies. In particular, and of great significance, it provides an opportunity to work out an ecological benchmark to which degraded areas can be restored or encouraged towards and thereby increase areas under natural ecosystem processes and assemblages.

This report covers the fieldwork of the past year, the results of archival research and discusses some of the findings of this study. It also briefly talks about further work that needs to be done, especially systematic studies that need to be undertaken, in order to draft a comprehensive conservation/restoration plan.

Field Work

General notes

As the months go by, after walking the grass hills between Bangitappal and Sispara, over and over, covering every valley and hilltop, we have become very familiar with the area. When we started in August 2003, it was during the height of the monsoon and it was either raining or covered heavily by mist. We had no other choice; these were the weather conditions that we faced during our initial "familiarizing" with the place. At the time, instead of focusing so much on getting to know the terrain, it would have been more productive to have done plant identification, as a great number of grassland species are annuals, appearing only during the monsoon. By September however we had sufficient knowledge of the study area and began to identify plants in the field, especially those that were in flower. This kept up a good pace until February and after that the addition of new species to our list has slowed down considerably. The dry season is sparse in flowers but we were able to cover large distances and to get to know the place very well.

10 months later, the rainfall is slowly setting in again, the dormant species show their heads above the ground, and seedlings of annuals begin to appear. Nearly a full circle is completed. We hope that this report can give an adequate picture of the work done and the experience made during the period of the last year.

Methodology

Monthly visits since August, of about a week each. Initial visits were used to familiarize ourselves with the area, with the help of the forest department staff. The whole area was covered and G.P.S points were taken along all the routes. All the G.P.S points are described visually according to grassland type, known plant species and their relative abundance, and any other significant aspect of the area such as the topography.

Plant identification was done from the beginning, in the field with the help of the reference books by P.F Fyson and J.S Gamble and other botanical records. Photographs have been taken of species in flower. Grass species have been identified by Kiran Raj of the Calicut University. Since the presentation of the mid term report, identification of species in flower has continued and a skeleton plan for a quantitative study has been laid out.

Observations and Findings:

Wattle *(Acacia dealbata, mollissima and mearnssii)*

Wattle is found in roughly half the study area. The north and northeastern hills have the most number of wattle trees with very dense full-grown plantations. All the furthest eastern hills have wattle cover of different densities. Towards the west and south they get smaller and less dense. Scattered wattle saplings are found up to the edge of the plateau. The only place that has dense wattle within the core areas of this region is below the south face of Madippumalai, where they are sheltered from the east and west by Madippumalai's side ridges. There are a few small dense

clumps there, and the rest of the hills have scattered medium-sized trees. Places with high wind exposure (along the edge of the plateau, top of Madippumalai) have many dead saplings and the ones that are alive are very small and stunted. No full-grown trees are seen anywhere except on the northeastern hills. The spread of wattle comes to a halt towards the south near Bhavanipuzha bridge on the way to Nadugani. The extent of the area where the wattle has been planted is shown in M. Thyagarajan's Working Plan for the Nilgiris Forest Division (included in this report).

In areas with sparse wattle cover, there is no apparent difference between grasslands with and without wattle, in terms of texture or species diversity. But, this will have to be established with careful study.

The Forest Department has been eradicating around 20 to 30 ha of wattle every winter for the past five years on the northeastern hills – close to the approach road. These are mostly areas that have scattered, full grown trees. Trees have not been cut where the growth is very dense. The eradication is not entirely successful. Many of the stumps are sprouting new shoots and new saplings can be seen. Many of the trees cut are already dead. The cut trees are left where they fall and they are often covered in Bramble *(Rubus moluccana)*. There has been an attempt to plant native shola trees on a few of these wattle-eradicated slopes by digging large holes. Almost none of these saplings have survived.

Other exotics

Other major exotics in the area include Broom *(Cytisus scoparius)* which is spreading on the hills along the approach road, and above the Earthen Dam, along the road going to Western Catchment 1. Gorse *(Ulex europaeus)* can also be found in these areas. *Eupatorium glandulosum* can be found throughout the area on disturbed soils. Pine is planted very densely in at least four places, each plantation being around 5 acres. One is in the Bangitappal valley, and the others in different places along the approach road. There are also several exotic herbs growing in the area. Two examples are, *Calceolaria mexicana* which is spreading around the buildings of Bangitappal and *Erigeron mucronatum* which is spreading on many of the hills.

Among the identified grasses, one of the species appears to be *Andropogon gayanum* which originates in Africa. This might be of great significance, since this species dominates the grassland in the greater part of the study area. Before proceeding further however, the identification needs to be verified by other grass specialists, as the consequences of it being an exotic grass are too large to be taken lightly.

Other exotic grasses are found in small populations only, especially in the Bangithappal area. They are *Brachipodium sylvaticum* and *Anthoxanthum odoratum*.

Fire

Fire has been an important factor affecting the grasslands since before the British arrived. The grasslands were burned for providing fresh fodder, as grass sprouts well after a fire. This was done to provide fodder for both game animals as well as domestic animals. Stretches between Bangitappal and Sispara have been burned within the last ten years, signs of which can be seen on tree stumps or grass clumps. Some areas are very rich in diversity, where it is known that fire

has occurred and the two may well be correlated. Some of the hills that don't get burned, due to natural barriers, have very tall dense grass and are poor in diversity.

Miscellaneous

Apart from the wattle eradication, the only other activity currently undertaken by the forest department is the maintenance of the fire line-cum-border along the edge of the plateau. Contour ditches had been dug around Bangitappal before the place became a National Park. Other work done in the last few years is the construction of the Nadugani Trekking Shed, two small bridges on the way to Nadugani and the bridge opposite Bangitappal.

There are at least four rain gauges in the area, set up many years ago by the Electricity Department. One of these is maintained from which data is collected.

Grassland types – a description

The grasslands can be categorized visually by the following characteristics:

Dense grassland, tall or short, where there is no exposed ground.

This kind of grassland can be quite rich to very poor in diversity, both in grasses (*Themeda tremula*, *A. lividus* and *Eulalea phaeothrix*) and other herbs. There is one species of grass found on most of these areas (*Andropogon gayanum*), and in some places, especially at the base of hills where it's sheltered, this particular species grows very densely. In such areas, the grass cover is very long and dense and almost completely dominated by this one species of grass, allowing no other grasses or herbs to grow there. Flat areas near streams that are not waterlogged have another dominant species of grass that is also tall and dense with hardly any other plant growing among them (*Chrysopogon zeylanicus* and *Helictotrichon virescens)*. Such grasslands are found only in a few places covering small areas. In places where dense grass is short, usually there is a high degree of exposure to wind. These areas are diverse in grasses and other herbs.

Patchy grassland, tall or short or both together, with different degrees of exposed ground.

Most of these grasslands show signs of burning. Some of these areas range from being very diverse (Nadugani), to very poor (Kingerundi area where there is a lot of exposed ground probably due to excessive burning). Hilltops have patchy grassland with or without evidence of fire.

The two types of grasslands namely, dense grassland and patchy grassland, have many species of plants in common. Some common examples are: *Leucas suffruticosa, Anaphalis wightiana, Andrographis lobelioides, Impatiens diversifolia, Swertia corymbosa and Smithia blanda*.

Shrub-dominated grassland, where different species of shrubs are dominating an area.

Examples of shrubs that do this are: Strobilanthes *kuntianus, Strobilanthes wightianus, Hedyotis stylosa, Hedyotis articularis, Anaphalis neelgheriana, Helichrysum wightii, Helichrysum buddleoides, Gaultheria fragrantissima, Eurya nitida and Rhodomyrtus tomentosa.*

The most common and widespread shrubs are *Strobilanthes kuntianus*, which is growing abundantly around Nadugani and Kingerundi area, and *Strobilanthes wightianus* is found in most of the valleys, growing very densely along the streams.

All the other shrubs are less widespread and are not found in such large numbers. *Helichrysum wighti* is found only in a few places, and *Gaultheria fragrantissima* is found as small clumps all over the area.

Herb- dominated grassland, where different species of herbs are dominating an area.

Examples of dominating herbs are*: Pteridium aquilinum, Hedyotis verticillaris and Alchemilla indica.*

The most common and widespread of these herbs is *Pteridium aquilinum* which can be seen growing in scattered clumps of different sizes, on almost all the slopes. *Hedyotis verticillaris* is found mostly on wet places in the valleys, in small clumps to large masses. *Alchemilla indica* is growing only in two places: the Bangitappal valley near the guesthouse and on the way to Nadugani near the "Labour shed."

Rocky grassland, where grasses and other herbs are growing on rocks or among rocks and boulders.

Many of the hillsides have large rock faces sometimes covering the whole slope. They may be a single face or jagged. Boulders are found clumped on top of a few hills. Some of the grasses *(Garnottia puchiparensis, Chrysopogon asper* and *Agrostis stolonifera*) and herbs found in rocky grassland are not found in other types of grasslands. Some examples of herbs are *Pedicularis perrottettii, Impatiens acaulis, Leucas rosemarinifolia* and epilithic orchids such as *Aerides crispa* and *Ceologyne glandulosa.*

Marshy grassland, found near streams or before the starting of streams.

These are usually quite small and diverse and have some species of plants that are special to this type of grassland like *Impatiens rufescens, Parnassia wightiana, Senecio wighti and Juncus glaucus.*

Shola edge grassland

Some plants can be found only along the periphery of sholas, common examples are *Impatiens leschenaulti, Helichrysum buddleoides, Senecio intermedius* and *Rubus ellipticus*. Grasses such as *Ischaemum commutatum, Agrostis pilosula* and *Isachne kunthiana* are found here.

Some of the most common families represented in the grassland

Acanthaceae, Asteraceae, Balsaminaceae, Cyperaceae, Eriocaulaceae, Poaceae, Lamiaceae, Melastomataceae, Orchidaceae, Papilionaceae and *Rubiaceae.*

Some of the common species

Anaphalis wightiana, Erigeron mucronatum, Eupatorium glandulosum, Hedyotis stylosa, H. articularis, Helichrysum buddleoides, Impatiens clavicornu, I. diversifolia, Justicia simplex, Leucas suffruticosa, Pteridium aquilinim, Rubus mollucana, R. neveus, Senecio lavandulifolius, Smithia blanda, S. kunthianus, S. wightianus.

Rare species found in the area

Anaphalis leptophylla, A. notonia, A. fysonii, Centratherum reticulatum, Crotalaria formosa, Geranium nepalense, Habenaria barnesii, Hypericum hookerianum, Impatiens rufescens, Kalanchoe grandiflora, Pedicularis perottetti, Picris hieracioides, Pimpinella leschenaultii, Plectranthus barbatus, Pogostemon atropurpureum, P. mollis. P. speciosus, R. subpinnatus, S. lawsonii, S. lessingianus, Sonerila grandiflora, S. rotundifolia, Striga lutea, Wehlenbergia gracilis.

Species inventory

A list of plants identified by our team during the course of the study has been given in the Appendix. 198 species have been identified so far, including Angiosperms and Pteridophytes. We expect to find at least another 20 if the study continues, plants that we had missed in the first phase of the study.

Other Research

Archival Visits

We made a visit to Chennai in January to search various Libraries for historical information on the area between Bangittappal and Sispara. We visited the Connemara Library, the library of the Forest Department, where we obtained a copy of the Working Plans for the area (T. R. Ranganathan's) and the Tamil Nadu Archives. At the Tamil Nadu Archives, we were only able to process the permission to access the historical documents so the research will be done on another visit. One more place to visit in Chennai would be The Presidency College where P.F Fyson was the Director during the time he was writing The Flora of The South Indian Hill Stations. We have been told that his diaries are still kept there.

Team visit with scientists from Foundation for Ecological Security and Ashoka Trust for Research in Environment and Ecology.

For the December trip, we visited the study area with members of ATREE and FES. We were keen to share our observations with them and to establish a research protocol for the field with them. We spent two days out walking, going over Madippumala, Nadugani and Sispara areas. We then discussed our collective observations. We all agreed that the main disturbances in the area were wattle and fire and that both these could affect floral diversity. In areas with low intensity burns, diversity was possibly enhanced. We then agreed to set up some experiments (if the study were to continue) to establish quantitative data that would enable us to compare the effects of these disturbances. Plots could be marked out along two gradients at least, to start with, across areas with different densities of wattle, fire frequencies and compared with areas that we know to be relatively undisturbed.

Historical information

1835- completion of path from Avalanchi to Sispara, via Bangitappal.

Information from working plans of the forest department

Dyson's working plan (1928 to 1938) for the Eucalyptus plantations and Hick's working plan (1927-1936) for the Mudumalai range forests gave place to the working plan of C. R. Ranganathan which was the first comprehensive plan covering the entire forest areas of the Nilgiris division. It was introduced in the year 1938 and was in force till 1948 with certain changes towards the later years. This plan was not revised till 1953 and hence works were carried on generally on the lines prescribed therein from 1948 to 1954 when the revised Working Plan took place.

: M. Thyagarajan, In the Working Plan for the Nilgiris Division (1964-1974)

From C.R. Ranganathan's Working Plan for the Nilgiris Division (1938 to 1948):

0411. *Experiments in afforestation on the Kundahs:* "1,433 pits 6 feet apart were dug in1922 at Bangi Tappal and *Acacia dealbata* seedlings were planted which had been raised in a nursery at Avalanche. In addition to this the soil was broken up to a depth of 3 to 4 inches and some seeds were sown. The work was fairly successful."

413. 1923: "A nursery was formed near the first stream on the Bangi Tappal path after the Bangi Tappal–Bison Swamp bifurcations. Alnus seeds obtained from the Naduvattam Cinchona Plantations were sown in the nursery and shaded by means of a pandal."

422. "No further work was done in the locality till 1932 when under the instructions of the Chief Conservator reafforestation of important catchment areas in the Kundas was resumed on a very small scale. The species tried were *Hakea saligna*, *Calitris* and Cypress. The work was done much late in the season, as no preparations were made in advance. *Hakea* had done best of all, but it was decided not to continue with the species, since what was wanted was a species that could be expected to spread by itself. The areas treated in 1932 were two plots at Bangi Tappal (one of them was called the Bhavani plantation) and the margin of the Avalanche-Lakkidi bridle path."

424. " In 1934 casualties were replaced in the 1932 and 1933 areas by the same methods."

426. "No new regeneration plots were opened in the Kundahs in 1935. Casualties in all existing plots were replaced with *basketed* plants in all cases, Calitris and Cypress being used in the Lakkidi plots, Calitris alone on the Avalanche bridle path and in the Bangi Tappal plots…"

427. "The following statement shows the small degree of success achieved in the new regeneration operations. The enumeration was made in 1935."

	Total number of patches	Number of failed Patches
Bangi Tappal (Bhavani plantation)	268	139
Bangi Tappal (Rest- house plantation)	48	7

430. "In 1936 replacement of casualties was made with mossed plants. No replacements were made in the Bangi Tappal and Mukurti plantations."

703."*Burning by the Nilgiri Game Association.*- As already stated, Shikaris are responsible for a certain number of fires annually. The motive is to promote the growth of fresh grass during the hot weather for the game to feed upon. The best method of putting an end to such unauthorized burning is to anticipate it by official burning and the Nilgiri Game Association has in recent years been burning grass over appreciable areas at its own expense. It is suggested that the Association should continue this good work on a definite plan, especially in the areas north of the watershed between Bangi Tappal and Mukurti peak and in the country southwest of Bangi Tappal up to Sispara."

Ranganathan's working plan was revised in 1953 by T. Jayadev whose working plan was introduced in the year 1954. Like its predecessor, Jayadev's plan was a comprehensive one covering every aspect of management of the entire forest area. Apart from the various working circles, it provided for afforestation of the Wenlock Downs and the Kundahs which was the forerunner for raising of large scale plantations on the plateau under the successive five- year plans during the same period."

: M.Thyagarajan, in the Working Plan for the Nilgiris Division (1964 to 1974)

From T.Jaydev's Working Plan for the Nilgiris Forest Division (1954 to 1964)

271. "Wattle plantations. - The creation of wattle plantations is one of the special works undertaken in the Nilgiris Division during the past decade. The work had not been covered by any working plan. It was started on an experimental scale and it gained impetus as the trade relations with South Africa became strained and the import of wattle bark dwindled. The wattle planting commenced in the year 1939 and small plantations were raised in scattered acres all over the plateau. The compact regeneration areas on a large scale lie at present near Mukurti."

272. "In G.O. Ms. No 3097, Development, dated 14th December 1949, the Chief Conservator of forests was asked to investigate into the possibility of growing wattle on a large scale in selected areas in the Nilgiris and Palnis. Accordingly a scheme was drawn up in 1939 by Browne which provided for the starting of experimental plantations over small areas from 1939 to 1942; and in the event of the plantations proving successful it was proposed to undertake regular plantations on a large scale."

372. "The future extension of wattle plantations will be confined to compact and large blocks near Mukurti and towards Avalanche."

373. "The total area of the working circle is 3,434.81 acres, the area already under wattle plantations at present (1953) being 1,834.81 acres. The balance of the area in this working circle will be brought under wattle during the period of this plan."

386. *"Choice of species.*-The black wattle (*Acacia mollissima)* will be the only species used for raising the future wattle plantations."

From M. Thyagarajan's Working Plan for the Nilgiris Forest Division (1964 to 1974)

346. "Burning of grassland.- regular burning of grass is a characteristic feature of the grazing in the Nilgiri plateau… The grasslands in the downs and the Kundahs are burned annually in order to obtain a fresh sprout of tender grass. This is an ancient custom of these pastoral people on the hills and had been officially recognized by the Government. In recent years the burning has been done under strict control so that the shola vegetation may not be endangered. Apart from the usual advantages claimed by the grazers for regular burning before the pre-monsoon showers, the Todas allege that the burning has the affect of destroying insects and fungi harmful to cattle and that it causes the general sterilization of the grasslands. If annual burning is not done they feel that over grown grass apart from being infested with pests injurious to cattle will be so over grown that the firing of it would cause a more intense fire damaging the rhizomes. It has been observed by the author of this working plan that areas which are not subject to periodic fires carry mostly tall and coarse grasses which are not palatable and not relished by cattle while those

grasslands which are subject to annual fires carry shorter and palatable grasses of different species."

360. "Under Jaydev's working plan plantations of wattle were raised in the Kundahs and under the five year plan schemes large scale wattle plantations came in to being covering extensive areas of grassland. By the end of 1963 about 30,000 acres had been brought under wattle."

Appendix XII
Upper Bhavani Series

Description

These plantations are situated on the western and northwestern side of Upper Bhavani Dam and Billithada Halla River and it ends beyond Bangithappal in its southern portion. These plantations were located up to the Kerala boundary i.e. the State boundary between Madras and Kerala. These areas were all undulated grasslands with stunted Rhododendron trees here and there and apart from the above there are numerous patches of natural sholas in the depressions and in the valleys. These areas are very steep in some places and occur in all aspects.

Past management

These areas were selected and surveyed and demarcated leaving out the patches of sholas and aligned, pitted and planted with Acacia *mearnsii* at an espacement of 11x11 feet. The latest plantations which were planted with *Acacia mearnsii* in the same locality where the grass patches were vacant in between the older plantations, the espacement adopted was 8 ½ x 8 ½ feet. All the standard technique for planting was adopted by mixing 56. 70 grams of wattle fertilizer to each pit before planting to accelerate the growth of the seedlings. The plantations raised by the Kundah Soil Conservation Unit are also included in this compartment. There are wind belts along the ridges and spurs raised by the Kundah Soil Conservation Unit in these plantations to protect the plants from wind.

This is what we have been able to gather in the past year. To get a clearer picture of the work done in the study area more detailed working plans from the range office would be of great help, to determine which of the areas have been worked and how the plantations have fared in the initial years.

Botanical History

Since the settlement of the area by the British in the early 19th century, the flora of the Nilgiris has been well researched and documented. In fact, for that period, the Nilgiris were probably one of the most carefully botanized places in the tropics. Many of the 19th century botanical giants have worked here: Beddome, Wight, Bourne followed later on by Fyson and Gamble. This gives us an unequalled picture of the flora of the Nilgiris before major human interventions occurred.

Although these early botanists were thorough field workers and taxonomists they left little data on plant ecology, few notes with exact distributions or locale information. To build up a detailed image of an area in terms of plant communities is therefore quite difficult, especially at the resolution we require. But those notes that do exist are invaluable, and the purpose of this study is to unearth whatever they left behind, their commonplace observations, or annotations, and even just to compare past lists with our own observations. Much more exhaustive work needs to be done on this front, but the beginnings have already been fascinating.

Given below is a list of a few species whose botanical history we were able to trace so far. We have structured the information into two sections – the first comparing historical records with our field information and the second, a species list of plants found then but not by us.

Species found then and now

Impatiens clavicornu- Endemic to the Nilgiris. Wight in his Icones Plantarum Indiae Orientalis, calls it a very beautiful and unusual form of balsam which he had observed all over the upper ranges of the Nilgiris. Nowadays its distribution is exclusively restricted to the south-western edge of the Nilgiris, with the centre of distribution within the Mukurti National Park.

Impatiens laticornis- Endemic to the Nilgiris. Fisher in the Kew Bulletin 1930 calls it a common species in the Kundahs. It still grows abundantly in the National Park.

Impatiens rufescens- Endemic to the Nilgiris. Wight calls it frequent in swampy grounds. At present only a few isolated populations have been observed.

Crotalaria formosa- Endemic to the Nilgiris. Wight says it is it frequent on the hillsides. In the present survey it was found only in a few spots.

Hedyotis verticillaris- Endemic to the Nilgiris. This species was observed by Wight, Fyson and Gamble to grow abundantly in wet areas from Pykara to Sispara. At present the species is restricted to the area from Avalanchi to Sispara.

Anaphalis notonia- In his Icones Plantarum Wight considers this to be a rare species. Only a few specimens were found in the present survey.

Helichrysum wightii- Wight, Hooker, Fyson and Gamble report the species in dense masses from Sispara area. It can still be seen growing abundantly in the same area.

Andrographis lobelioides- Endemic to the Nilgiris. Has been reported by several workers to be commonly seen. It still can be observed frequently in the research area.

Leucas rosemarinifolia- Endemic to the Nilgiris. Wight reports this species to grow abundantly at Kaitie, Fyson says it is to be found near Ootacamund and Kotagiri. Nowadays it can be observed commonly in the National Park.

Species found then but not now

Senecio neelgherryanus- Reported by Fyson and Gamble from the Kundahs.

Oldenlandia sisparensis- Reported by Gamble from above Sispara.

Anisochilus suffruticosa - Reported by Wight on rocky places near Sispara.

Pogostemon paludosus- Reported by Fyson and Gamble from Sispara at 6000-7000ft.

Vernonia malabarica- Reported by Gamble from Sispara

Does Mukurthi National Park require restoration?

There is no easy and straightforward answer to the above question as yet. An answer requires firstly an understanding of two critical issues. One is the notion of what is pristine or natural in terms of landscapes, ecosystems and habitats. Second, is the notion of restoration itself. Both are fraught with contentiousness and debate worldwide. However, there is no doubt at all about whether natural habitats should be increased in scale or whether species should be conserved. The debate is only about *how* and *whether* humanity can be so presumptuous as to give nature a helping hand by actively taking part in the healing process.

If the meaning of the word 'pristine' is taken to be 'the most natural' – then by all means MNP is the most pristine area in the Nilgiris. This interpretation can contain issues of human presence or alterations, the assumption being that these are relatively more benign that those elsewhere. If however, 'pristine' is to be read as 'untouched, unaltered or undisturbed whatsoever by human beings', then MNP does not qualify as 'pristine'. The alterations to this landscape have been quite significant even if only relatively so. The question therefore is - should something be done to ameliorate the consequences of these, considering the unprecedented loss of ecosystem services due to habitat destruction and species extirpation?

But first, to start the discussion off, let us look at some of the tentative observations we have made from our field experiences in MNP, over the year.

Specific observations

If it is indeed true that the dominant grass species in many areas of the Park is *Andropogon gayanum*, then the grassland flora has been more invaded than we had originally assumed. Whereas we had been thinking in terms of the problems associated with woody exotics we may now have to include a grass species of a coarse and aggressive nature. Our picture of the nature and composition of the grasslands could change quite drastically. How and when it came about that this species took over is still not known. This may be relatively easy to establish, as we know that *A. gayanum* was deliberately introduced from its native Africa to Asia, perhaps due to its frost resistance and drought hardiness. It is also effective in controlling soil erosion. It has forage value only in its tender sprouting phase, and this may affect the densities of grazers. But, enough said at this point, as we must reserve further judgement until we get a second round of identification done.

Fire, at the right intensities and intervals, may be a positive disturbance in the ecosystem in terms of promoting higher species diversity. Wherever we could infer that fire had occurred in the near past (1-3 years), species diversity appeared to be high. Where no fire had occurred for longer than this period, usually the grassland was dominated by one or two species of large grass. Usually, there appeared to be a paucity of other herbaceous plants. Again, this needs to be verified with controlled experiments or by establishing a fire history of the study area from which a quantitative sampling analysis could be made.

The pitting that was done across the whole landscape till Nadugani, for the planting of wattle, has left little obvious effect. But how would we know this is so unless we are able, in some way, to construct a scenario of the grassland flora prior to the 1920s?

We know that *Cyathea crinita*, a rare tree fern, is endemic to the Western Ghats. It is hardly to be seen in the wild anymore, only in a few pockets in the High Ranges and Palnis. Mature individuals are very uncommon. We have found sporelings in good numbers perhaps in three places altogether in the Western Ghats. Bangithappal is one of them. What is to be done for this exceedingly rare species, which we know had a better distribution previously and is not just naturally rare?

Bracken, or *Pteridium aquilinum*, is not strictly speaking an exotic (as its origin is unknown), but rather a pan-global species of significance due to its extremely tenacious nature. It is also usually an indicator of continuous disturbance. It shows a place to be in arrested succession. It is both pioneering and persistent and is not tolerant of other species. Grazers dislike it. MNP has patches of bracken scattered in several zones. What is the significance of this?

We know that the southwestern edge of the Nilgiri horst is richest in diversity for an unusual group of plants, the scapigerous *Impatiens*, which are unique to south India. The distribution for each species is very narrow but was probably wider previously. They are all globally threatened species. We think that this group, along with other unusual plants found in MNP, requires some careful study to examine the viability of their populations.

These are a few of our most interesting observations. We have presented alongside this report a detailed list of all the identified species, and specific observations on the distribution and relative abundance of each. Most are widely distributed in the National Park but some are found in just one or two locations. We have also tabulated their distribution on a wider scale. There are still some species to be identified, as the monsoon flora was not completely covered last year. From these observations and the ones mentioned above, as well as the numerous discussions we have had with each other and with experts in the field of ecology we now have the glimmerings of an understanding of this rare and unusual ecosystem.

In fact, a year's study has yielded us more questions than answers, especially as a good part of the time was spent in just familiarizing ourselves with the terrain and the species as well as the complex issues of disturbance, land use history, and grassland ecology. As a result of the work however the enormity of the task is thrown into sharp relief. It would be of immense value to all concerned to try and follow through the challenges posed to us by this study. Here are some of the questions we have, the examination of which may help us decide one way or another about the floristic "nature' of the National Park.

Points for discussion

How significant is fire to the productivity and diversity of the grassland? How much fire is good? And how frequent? Should fire be used deliberately in areas where woody species are spreading onto the grassland? Why are they spreading?

How invasive are the exotic species? The presence of *Eupatorium glandulosum, Erigeron mucronatum, Calceolaria mexicana* and three species of exotic grass, over and above the scattered populations of straggly wattle in the interior parts of the study area, raises questions about the spread of exotics. In addition, the march of the Scotch broom and gorse on the eastern fronts is aggressive. There are also the huge areas under wattle and pine. These species have already taken over in their areas and are well established and self-propagating, and some are notoriously difficult to eradicate. What is to be done with them?

What would be our measure of 'ecosystem health'? With what other high altitude grassland ecosystem could we draw comparison? Which of our other "pristine" montane ecosystems have suffered a similar complex of disturbances?

For at least 200 years, prior to the formation of the National Park and so far as we know, there have been disturbances. How close is the present state with that of the past, prior to the period of sustained and significant interference? How can we establish a historical picture of the place as it was before human intervention? How relevant is the information from the past? And how can it be used?

The case for Ecological Restoration – in general

With only 4.3% of the planet's land surface under legal protection as National Parks, or Sanctuaries or Reserves (Wilson 91) there is a desperate need to bolster or support these areas with the restoration of altered and degraded landscapes. Habitat fragmentation and the reduction in areas under natural cover into small isolated islands or pockets have a drastic impact on the survival of species, particularly those that are endemic to a region. However, even protected areas can suffer from degradation if they are too small or if the pressures in the surrounding areas are too destructive.

The Centre for Ecological Restoration, USA, states that " the special task of restoration as a science is to develop theory and practices that help to rehabilitate impaired ecosystems to an improved and sustainable state."

While it is clear that we do not have complete and total knowledge about how an ecosystem functions, and that no ecosystem can be completely restored to primary conditions by human intervention in short spans of time, it is perhaps possible to "nudge" or "enhance' rates of succession. Ecological restoration is essentially an integrated and multidisciplinary approach. It is a form of *assisted biotic synthesis* and requires everything from species re-introductions (where near or total extinction in the wild may have occurred) and regeneration, to intervention and active management, as well as "leaving alone". This will aid both the survival of species as well as the improvement of the given habitat. Re-introduction requires detailed knowledge of the presence of species in the area, both in the past and in the present. Re-introduction of keystone species may even help the ecosystem's own processes to set in faster and to create conditions for other species to enter and establish themselves.

Our study suggests that MNP is an altered landscape, with some areas less affected and others more. The eastern edge (the approach through Upper Bhavani) is of course completely transformed by the plantations of exotic species on what must have originally been rolling grasslands. There appears to be a case for restoration of these areas at least.

The Future

One year is by no means an adequate time period for a thorough study of an ecosystem. We have barely scratched the surface of what is potentially a vast and exciting arena of enquiry. However our study has revealed many unusual and interesting facets of conservation biology. If the forest department is agreeable we envisage the following course of developments:

1) A further period of one year to do a quantitative analysis of the floristic diversity of the Park. Perhaps a sampling protocol could be laid out along different transects through the Park. Much more exhaustive work needs to be done on the historical aspects, which tends to be a slow and time consuming process as access to archival records is not always facilitated with great speed. A Digital Elevation Model (DEM) could be made with the Survey of India topo-sheets that the Forest Department has made available to us.

Recent developments in computerized modeling systems make it possible to piece together a possible scenario of how an ecosytem might have been before human interference. By then including all known interventions or changes in landuse it can also be used to chart its possible trajectory in the future.

One such system called GARP, developed in Australia, uses everything from spot records and old floras to rainfall, disturbance regimes, soils and DEM, which in itself would give you slope, aspect, altitude, concavity and so on. Based on all available information, GARP generates a potential scenario of species distribution for a given landscape at different resolutions. If the FD grants permission for us to continue the study perhaps we could use GARP to construct a scenario of the species that should be found in the park and match it against actual records.

2) A period of one year following the continued study to draft a "Restoration Plan'.

Conclusion

At the end of one year we have even more questions than what we started out with. Ideas are burgeoning as we slowly become familiar with the grassland community of the Mukurti National Park. The learning curve has been swift and steep. We have a few tentative findings, but this is as it should be. The vastness of the subject requires that we are not hasty in our research and in coming to conclusions.

To establish a historical picture of the vegetation community of the Park alone is a complex and challenging exercise. We have to access information, which may be scattered or buried in journals, maps, manuals, working plans and anecdotal observations, as well as the numerous floras. A beginning has been made in this. We need to have a good understanding of the present as well. To enable this we have done a species inventory for the Park. We also need to start establishing the "health" of plant populations. We then have to work out causes for change, if we observe a significant disparity between the past and present. Again a number of clues and pointers have come up that tell us we have stumbled upon a complex issue. For which we need to engage deeply with the topics already initiated: from taxonomy, to land use history, ecology and computer modeling.

Despite the many challenges ahead of us, the study in itself has been richly rewarding. We know that this could be a pioneering effort in restoration. This is a matter of great urgency as this study may give us valuable insights into restoration of degraded areas on a larger scale. We are confident that with the access to expertise and knowledge bases, whatever we do find will be of assistance to the Forest Department in its management policies and practices.

People involved in the study

Field studies and archival work have been conducted by Sandilya T, Field Coordinator, with help from Deviah Aiama and Anuruddha Jaithirtha. From the Gurukula Botanical Sanctuary other members have also participated. Project Coordinator, Suprabha Seshan has visited the field a few times; done a preliminary search in the Kew Library, London for information on Nilgiri Flora and; investigated aspects of restoration ecology in a wider, more global context. Botanical identifications have been cross-checked with Wolfgang Theuerkauf, head of GBS, and Plant Conservation Coordinators, Laly Joseph and Suma. P.

A visit with Suresh Jones and Dr. Subba Rao, members of Foundation for Ecological Security (FES) and Dr. Ankila Hiremath from Ashoka Trust for Research in Environment and Ecology (ATREE) took place to establish a field protocol for gathering quantitative data. Dr. Hiremath has helped immensely with providing a scientific basis for the project, helping us pursue our enquiry with rigour. Pradip Krishen has counseled us from afar, with pertinent and critical questions that have helped greatly to shape the course of the study.

Former Ranger, F. Solomon has helped with many items of information connected to the history and management of the Park and has been the main force behind the original initiative. It is he who knows the Park and its plants with great intimacy. Former P. C. C. F Sri S. Subbarayalu, has provided excellent advice and support all along. Without him this may never have taken off as a full fledged research project. Dr. Paul Raj, former Wildlife Warden, MNP, was the first to debate the subject with us. Our quest began with his encouragement and consent.

In addition, there has been the constant presence of the Mukurthi National Park Forest Department personnel. We would like to acknowledge the Wildlife Warden, Mr. Upreti for his continued support and for picking up where Dr. Paul Raj left off. We thank former Ranger, Sri. Ramakrishnan for all his help. We would also like to mention that the guards and watchers of the Bangithappal – Sispara beat have always been very helpful and kind.

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Appendix 2

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