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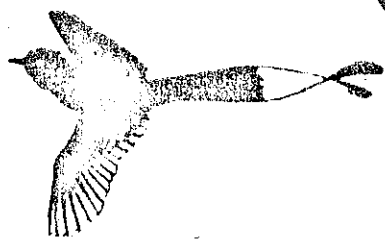

SCIENTIFIC PROGRAMME FOR THE NILGIRI BIOSPHERE RESERVE: REPORT OF A WORKSHOP, BANGALORE MARCH 7-8, 1986

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PREFACE

We are very happy to provide here a report based on a series of discussions culminating in a two day workshop in March 1986 on the scientific investigations that may be taken up over the next several years in the proposed Nilgiri biosphere reserve. We have been very fortunate in receiving the co-operation of a wide range of people in this exercise. The response has been so overwhelming that their names cannot be listed individually in this preface, but are given in an appendix. We are grateful for their support and advice.

Bangalore
Holi Pournima
March 26, 1986

Madhav Gadgil
R. Sukumar

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1. BIOSPHERE RESERVES

1.1 An innovative concept

The concept of biosphere reserves, has now been in operation for a decade with some 250 reserves covering 65 countries being in existence as of early 1986. This network of biosphere reserves aims to protect representatives of the entire spectrum of the ecosystems of the world as well as the genetic diversity of cultivated plants and their wild relatives. It represents a major innovation in the conservation effort in advocating that the undisturbed natural ecosystems cannot be protected simply through attempts to keep all human influences out of it. Rather, it suggests that conservation must be an open system in which undisturbed natural areas can be surrounded by areas of sympathetic and compatible use. It thus embodies the notion of graded control allowing for a flexibility of treatment that is needed under changing circumstances.

The second innovation brought in by the concept of biosphere reserves is that these areas should serve as sites of scientific research directed not only towards immediate needs of managing protected areas. Instead, in view of the inclusion of human element as an integral part of the biosphere reserve, such areas should become sites of scientific investigations and field experimentation of alternative models of development that ensure sustainable use of natural resources. In addition, the

biosphere reserves are expected to form a global network for monitoring of our environment, and serve as loci of research on conservation of biological diversity. The biosphere reserves are also ideal sites for educational and training efforts involving a whole cross-section of the society, including especially the local people.

1.2 Zones of the reserve

In view of this concept, the biosphere reserves are expected to include not only a core zone of undisturbed ecosystems, but a manipulation or buffer zone, a restoration zone, and an undelineated zone of co-operation. The core zone would serve to conserve ecosystems with their whole range of biological diversity. It provides an ideal site for scientific research on determinants of biological diversity and the development of management techniques for conserving diversity. It is also a suitable locale for monitoring long term changes in global climate and environment. The manipulation or buffer zone would include regions with on going human uses, including forestry, agriculture and animal husbandry. They provide sites for developing know how on how best to utilize natural resources in a sustainable fashion for providing a better quality of life for the local people. It is also an ideal repository of traditional knowledge of the people on

prudent use of resources; a place where such knowledge and practices can be fostered and put to good use. The manipulation zone is expected to be a site of in situ preservation of the rich varieties of cultivated plants and domesticated animals, which may be continued to be maintained by providing proper incentives, to the local people and investigated in their natural setting. The restoration zone would be a most appropriate site for research on how to restore productivity and diversity of degraded ecosystems. Finally the larger zone of co-operation, which need not be precisely delineated, could be an area for investigation and experimentation on alternative models of sustainable development for a broader region.

2 A HISTORY OF THE PROPOSED NILGIRI BIOSPHERE RESERVE

2.1 Selection of sites

The environmental regime of the Indian sub-continent is one of the most diverse in the world. We have a rainless desert and the place with the highest rainfall, the hottest place on earth and the permanently snow bound peaks of the Himalayas. Lying at the confluence of Ethiopean, Palaearctic and Indo-Malayan biotas, the region possesses a number of interesting components from each of these realms as well as several peculiarly indigenous forms. The modern classification of Udvardy

(1976) based on joint considerations of biogeography and biome types gives the following twelve biogeographic provinces for India.

1. Himalayan highlands
2. Thar desert
3. Malabar rainforest
4. Indus - Ganges monsoon forest
5. Deccan thorn forest
6. Coromandel
7. Mahanadian
8. Bengalian rain forest
9. Burma monsoon forest
10. Laccadive islands
11. Maldives and Chagos islands
12. Andaman and Nicobar islands

Ideally, at least one representative area from each of the above biogeographic provinces should be set apart as biosphere reserves in order to conserve as much of the country's biological (and associated cultural) heritage as possible.

The Man and Biosphere Committee of the Department of Science and Technology, Government of India initiated preliminary work on identifying biosphere reserves as early as 1976. Subsequently, in 1979 the Indian National MAB Committee constituted a Core Advisory Group of Experts for recommending potential areas as biosphere reserves. Following the standard

criteria for selection of Biosphere Reserves set by UNESCO, the following sites were identified.

Biosphere Reserve	States
1. Nilgiri	Tamilnadu, Karnataka and Kerala
2. Namdapha	Arunachal Pradesh
3. Nanda Devi	Uttara Pradesh
4. Uttarkhand (Valley of Flowers)	Uttar Pradesh
5. North Islands of Andamans	Andamans & Nicobars
6. Gulf of Mannar	Tamil Nadu
7. Kaziranga	Assam
8. Sunderbans	West Bengal
9. Thar desert	Rajasthan
10. Manas	Assam
11. Kanha	Madhya Pradesh
12. Nokrek(Tura range)	Meghalaya

The group also located experts to prepare project documents on these biosphere reserves. Of the above, project documents are now available for five proposed reserves, namely, Nilgiri, Namdapha, Nanda Devi, Gulf of Mannar and Uttarkhand.

2.2 Action so far

The first such document pertained to the proposed Nilgiri Biosphere Reserve, which covers mainly No.3 and partly No.5 of Udvardy's biogeographic provinces. It was prepared in 1980

by Prof. Madhav Gadgil and his team from the Indian Institute of Science, Bangalore, in consultation with the concerned Government authorities. This document gave a broad picture of the various areas, their classification into Zones and recommendations on management and research in the Nilgiri Biosphere Reserve. (abbreviated to NBR from now on). At that time it was expected that the country's first biosphere reserve would be soon established in the Nilgiris. But, unfortunately, no further progress was made in the matter. In March 1982, an Indo-US Workshop on Conservation of Biological Diversity was organized at the Indian Institute of Science. This Workshop went into the matters of (a) Selection of Biosphere Reserves (b) Administration and management of reserves (c) Scientific activities in the reserves and (d) Education and training. The proceedings were issued as a separate document in 1982 and have been reprinted in 1986.

Still, the proposal was in cold storage until, in August 1984, Prof. M.G.K.Menon(Member, Planning Commission) called a meeting of representatives of the three concerned state Governments of Kerala, Tamilnadu and Karnataka. At this meeting the representatives agreed in principle to the creation of the Nilgiri Biosphere Reserve. In order to actually demarcate the area, a committee was constituted with the following members:

1. Prof. Madhav Gadgil (Convener of the Committee)
   Indian Institute of Science

2. Shri. S.R.Bhagwat I.F.S.
   Principal Chief Conservator of Forests,
   Karnataka

3. Shri. G. Mukundan I.F.S.
   Chief Conservator of Forests (Wildlife)
   Kerala

4. Shri. John Joseph I.F.S.
   Addl. Chief Conservator of Forests,
   Tamil Nadu

5. Nominee of IG of Forests, Government of India

The Committee was assisted in its work by a team consisting of

1. Dr. R. Sukumar
   Indian Institute of Science

2. Dr. P. Vijaykumaran Nair
   Kerala Forest Research Inst.Peechi

3. Shri. Ullas Karanth
   Centre for Wildlife Studies,Mysore

After a field survey by the team during September-October 1984, the various zones of the biosphere reserve were marked on maps of 1:50,000 scale. This work involved a detailed analysis of additions/deletions from the earlier proposal to make it relevant to the prevailing situation. The committee after a number of meetings (including with representatives of the Department of Environment, New Delhi) submitted the report along with the detailed maps on 14 February 1985.

It was felt that even if the actual establishment of the Nilgiri Biosphere Reserve had not yet been accomplished, the

scientific research programme could begin in this area. This would not only save time in view of the rapid changes taking place in the biosphere area, but also generate data that would be useful in management once the Biosphere Reserve became a reality. So far, three meetings, including representatives of State forest departments, universities and research institutions, have been held on 14 October 1985, 10 January 1986 and 7-8 March 1986 to formulate the scientific programme. A list of the members who attended these meetings is given in Appendix I, while the recommendations on the scientific programme follow in chapter 4.

3. THE PHYSICAL SETTING OF THE NILGIRIS

3.1 Location and Topography

The proposed biosphere reserve is to be constituted around the Nilgiris mountain and adjoining hills of the Western Ghats of Peninsular India (10 45'N to 12 15'N and 76 0'E to 77 15'E). It stretches from the Coorg Wynad plateau just east of the Brahmagiri, south to the Attapadi-Bolampatti hills at the northern edge of the Palghat gap, and east-wards into the Talamalai - Hasanur plateau of the Eastern Ghats. The topography is extremely varied ranging from an attitude of 250m in the Coimbatore and the Calicut plain to over 2500m in the Upper Nilgiris. The highest peak Doddabetta (2636m), however, is excluded from the biosphere reserve.

The Upper Nilgiris range from 2000m to upwards and fall steeply to the surrounding plateaus and plains. To the north are the Wynad, Mysore, Sigur and Talamalai plateaus with associated hills at a general elevation of 700 to 1000m. On the West, the slopes constituting the Nilambur, New Amarambalam and Silent Valley RFs descend to 250m in the Calicut plains. To the south, the Attapadi plateau, Siruvani and Bolampatti hills show their own diverse topography from 1800m down to 150m in the Palghat gap. On the east, the Nilgiri slopes down to 250m in the Coimbatore plains.

Geologically, the entire region is made up of metamorphic Archean (pre-Cambrian) rocks, mainly the Gneisses, Charnockites and Schists.

3.2 Hydrology and Climate

The region is drained both to the west and to the east. On the west the relatively short, swift flowing streams drain into the Chaliyar, Kunthipuzha and Koraiyar rivers .

The eastern portion is drained by the tributaries of the Kabbini, Moyar and Bhavani rivers, which ultimately empty into the Cauvery river.

The Nilgiri area shows "a striking diversity of atmospheric and hydrological conditions" in the words of climatologist von Lengerke. Based on the hydro-thermic conditions he has distinguished the following climatic types:

I Warm and wet tropical (below 1400m)

a. Warm and humid - e.g. lower Coonoor Ghat and southern Eastern slopes

b. Warm and semihumid - Malabar plains, Western parts of Mysore plateau

II Warm and dry tropical (below 1400m)

a. Warm and semiarid - Coimbatore plains, eastern Mysore plateau, northern eastern slopes

III Cold and wet tropical (above 1400m)

a. Cold and humid - upper Coonoor ghat, southern tracts of the eastern and southwestern plateau.

b. Cold and semihumid - Kundah range, Dodabetta range, Wenlock downs.

The region is subject to the influence of both the SW monsoon and the NE monsoon. While it is beyond the scope of this report to give a detailed account of the climate of Nilgiris the diversity can be gleamed from the following facts. On the Western exposed portions of the upper Nilgiris the annual rainfall exceeds 5000mm on an average (maximum of 6330mm on Mukurti Ridge at 2545m elevation),while in the sheltered Moyar valley if is less than 500mm(e.g. 463mm at Mangalpatti), a distance of only 40 km apart. Similarly, the monthly averages of daily temperature reach a minimum of 2°C (Feb) at Korakundah and 37.1° C(Apr) at Bhavanisagar. The absolute minimum and maximum temperatures recorded at these stations are even more extreme, 6.7°C and 41.1° C respectively.

Land-Use Pattern

Though many tribal communities have been living in the Nilgiris for centuries, the systematic large-scale spread of human habitation began only in the 19th century with the establishment of a hill station for Europeans, a cantonment, and then cinchona, tea and coffee plantations.

Today the entire central portion of the upper Nilgiris has been occupied by man and the natural vegetation is restricted to numerous small fragmented pockets of "Sholas". The outer slopes of the Nilgiris, however, retain the natural vegetation cover, and these along with adjacent hills and plateaus constitute the biosphere reserve proper.

The Nilgiris are famous for tea cultivation. Numerous tea estates are spread through the upper Nilgiri plateau. In recent years tea cultivation has also been taken up in the lower Gudalur Cherambadi area, where repatriates from Sri Lanka have been settled. Potato cultivation on the hill slopes has led to devastating soil erosion and failure of subsequent crops. Fruit orchards are scattered over the upper plateau. The forest department has raised plantations of Eucalyptus and wattle (Acacia spp). A government cinchona plantation is situated at Naduvattam. The upper Nilgiris has also been exploited for its hydroelectric potential through the construction of a series of dams on the tributaries of the Moyar and the Bhavani.

Elsewhere human settlements within the forest are especially conspicuous over the Wynad, Talamalai, Sigur and

Attapadi plateau. Millets are cultivated in the drier tracts of Talamalai and Sigur, while paddy is cultivated in the moister Wynad belt. In the Attapadi a transition is seen in the cropping pattern from millets in the dry belt to paddy, areca, betel, banana, etc. in the higher rainfall regions. Tribals in the Attapadi have been practising shifting cultivation on the hill slopes.

In the proposed NBR area there are many traditional ethnic groups.

CHOLANAIKAS are the only genuine hunter gatherers of the Indian peninsula. They were discovered in the New Amarambalam forests only a few years ago.

TODAS are buffalo keepers of the upper Nilgiri Plateau.

BADAGAS are an advanced forming community, cultivating the fertile slopes around Udhagamandalam.

IRULAS are originally hunter gatherers of the drier tracts and are today mostly gatherers of minor forest produce or small cultivators.

KURUBAS AND SOLIGAS are found on the Mysore-Talamalai plateau and are gatherers of minor forest produce or small cultivators

CHETTIES cultivate their own land in the Wynad area.

PANNIAS are landless labourers and work mostly for the Chetties.

Vegetation Types

An entire spectrum of, vegetation types from wet evergreen forest to dry thorn forest can be found in the Nilgiri Biosphere Reserve area. Though numerous sub types can be recognized

within each major type, only the major vegetation types are briefly described here.

a) Tropical Wet evergreen forest

The wet evergreen forest occurs along the Western slopes with an annual rainfall of over 2000mm, upto an altitude of 1500mm. This is characteristic of Nilambur Kovilakam, New Amarambalam, Silent Valley and parts of Attapadi reserves. The dense multistoried forest reaches a height of 35 m or more, with several gigantic trees of 50m height emerging above the general level of the forest. Lichens, mosses, epiphytes and climbers are common. Due to the closed canopy the ground is usually devoid of grasses. Among the dominant trees the common association is the Dipterocarpus-Mesua-Palaquium series. The common trees include D. indicus, M.ferrea, P.ellipticum, Artocarpus hirsuta, Bischofia javanica, Garcinia indica, Hopea parviflora, H. wightiana, Kingiodendron pinnatum, Michelia nilagirica, Pterospermum reticulatum, Syzygium gardneri, Diospyros spp. and Cinnamomum zeylanicum.

In general, the evergreen forest does not exhibit a gregarious distribution of species. Biologically this community shows a high level of species diversity. In one sense it should be considered as a non-renewable resource, since regeneration to its original climax form is practically impossible once the original vegetation is cleared.

b) Tropical montane evergreen shola-grassland

The shola grassland vegetation is encountered above altitudes of 1500m. It occurs over the greater part of the upper Nilgiri plateau and the higher reaches of Siruvani hills. The shola forests are restricted to the valleys or folds in the hills, while the surrounding hill slopes are covered with grasses. In the shola forests the trees are relatively stunted (below 25m). The principal trees in the shola forests include Cinnamomum Wightii, Elaeocarpus spp., Gordonia obtusa, Meliosma spp, Ligustrum roxburghii, Litsaea spp., Schefflera spp., Symplocos Spp. and Syzygium arnottianum. The undergrowth contains members of Rubiaceae and Acanthaceae, especially Strobilanthes. The grasslands contain species from the genera Cymbopogon, Themeda, Eragrostis, Bothriochloa and Tripogon.

c) Tropical Semi-evergreen forest

This is a transition between the evergreen and the moist deciduous types. It can be found both along the lower western slopes and below the montane shola vegetation along the northern and eastern slopes. Apart from elements of the evergreen forest such as Vitex altissima, Persea macrantha, Holigarna arnottiana and Acrocarpus fraxinifolius can be seen Bombax ceiba, Trewia nudiflora, and Caryota urens. The common deciduous trees are usually Lagerstroemia lanceolata and Xylia xylocarpa. The ground is usually devoid of grasses.

d) Tropical Moist deciduous forest

The best representation of the moist deciduous forest is on the Wynad plateau. The principal trees are Lagerstroemia lanceolata, Terminalia tomentosa, Dalbergia latifolia, Schleichera oleosa, Xylia xylocarpa, Kydia calycina and Tectona grandis. Large clumps of Bambusa arundinacea are often found in the lower storey. The ground may have a good growth of tall grasses such as Themeda and Cymbopogon.

d) Tropical dry deciduous forest

The dry deciduous forest dominates the Mysore plateau, Talamalai plateau and a large portion of the rainshadow slopes of the Nilgiris. Anogeissus latifolia is usually the dominant tree, due to frequent fires. Other trees include Tectona grandis, Terminalia tomentosa, T. Chebula, Albizzia odoratissima, Grewia tiliaefolia, Pterocarpus marsupium, Chloroxylon Swietenia and Adina cordifolia. Dendrocalamus strictus is the common bamboo of the dry forests. The ground layer shows a good grass cover of Themeda, Cymbopogon, Imperata and Heteropogon.

In many areas a modified dry deciduous scrub thicket occurs. This is characterised by the presence of numerous thorny shrubs in the undergrowth. Acacia spp. and Lantana are especially common shrubs. In such areas only short grasses occur.

f) Tropical dry thorn forest

The Moyar valley has the best representation of the dry thorn forest. Acacia leucophloea, A. chundra, A. latronum,

Albizzia amara, Hardwickia binata, Zizyphus xylopyrus, Pterocarpus jacquinii, Dicrostachys cinerea, Xeromphis spinosa, Prosopis monogynum and Capparis sepiaria are the common plants. Short grasses occur on the ground layer. This vegetation type has largely disappeared from the Deccan plateau, where it was once extensive. It is imperative that the remaining patches are protected.

Zones of the Nilgiri Biosphere Reserve

The various zones of the biosphere reserve and broad management principles are given below:

a. CORE ZONES

Primarily the core zones are areas where human activity should be either absent or kept to a minimum out of necessity. There should be no forestry operations, collection of minor forest produce or any development activities such as construction of dams. Regular tourism should not be allowed. Apart from the concerned officials, the entry of other bona-fide people should be strictly through the issue of permits. The only people who may be permitted to reside within the core zones are tribals who have been always statying there. Only non-destructive scientific research should be carried out in the core areas. Obviously, protection of core areas should be given high priority. Realizing that stringent rules also have to be practical, the core zones have been restricted to a basic minimum area for the present. The total area of

the core zones comes to around 1240.3 Km^2. Most of the vegetation types are represented in the core zones. These include:

1. Tropical wet evergreen forest and evergreen shola-grasslands-New Amarambalam (part), Nilambur Kovilakam, silent valley, Nilgiri peak-Kundah plateau (Nilgiri Tahr Sanctuary)
2. Semi-evergreen forest-Siruvani hills (Bolampatty range)
3. Moist and dry deciduous forest-Nagarhole sanctuary(part) Bandipur(part), Mudumalai(part), Nilgiri eastern slopes (Erode division) and Minchikuli valley (Satyamangalam division)
4. Tropical thorn forest: A small portion of the Nilgiri eastern slopes. This vegetation type has not been properly represented in the core zone due to the human activity in such areas. In future, it may be possible to set apart a portion of the Moyar valley (Satyamangalam division) which has a true representation of this vegetation type as a core zone.

b. Buffer zones

While most portions of the core zones are effectively buffered by other zones, in areas where a core zone abuts human settlement, a buffer zone of necessary breadth may be defined. For instance, the core Nilambur Kovilakam abuts settlement to its east. A distance of about 1 km from human settlement may be considered as a buffer zone in such situations to facilitate genuine utilization by the people.

c) Manipulation(Forestry) Zones

These zones should be managed according to sound forestry principles for obtaining a sustained yield of forest produce consistent with the needs of the ecosystem. Clear felling should be permitted only in currently existing plantation areas. Within the natural habitat of the manipulation zones, forestry operations should be restricted to selection felling. No new plantations should be raised in the natural habitat. However, gap planting without any clearing may be done in the more degraded areas. Grazing may be permitted but should be regulated.

The major portion of the biosphere reserve has been included under the manipulation (forestry) zone, primarily because of the current pattern of use by the people for grazing and forestry operations by the department. The manipulation (forestry) zone covers an area of 3233.7 Km^2 and includes all the vegetation types.

d) Manipulation (Tourism) Zones

Regular tourism should be largely restricted to these zones. The infrastructure for tourism should not be expanded beyond the current levels within the forest areas. All new tourism-oriented constructions should be located outside the forest. As a whole tourism within the biosphere reserve should not be developed on a large scale but carefully regulated so as to allow only a minimum disturbance.

The tourism zones covering an area of 335 km^2 are located in the currently used wildlife tourism areas. These are Nagarhole WLS, Bandipur national park and Madumalai Sanctuary. A new tourism area in the Begur range of Bandipur national park has been proposed in order to ensure a regular presence of department staff to ensure better protection.

The departmental infrastructure for tourism within these zones may be designated as administrative areas.

c) Manipulation (Agricultural) Zones

One aspect of the biosphere reserve programme should be the conservation of the traditional genetic stock of cultivated plants and domestic animals. For the present, all the cultivated enclaves within the biosphere reserve will constitute this zone. The people here should be encouraged to participate in the biosphere programme by cultivating traditional crop varieties in preference to the new hybrid varieties. Necessary incentives should be provided to subsidize any financial loss incurred by the farmers. Protection of crops from the depredation of wild animals such as elephants and wild pigs should be given high priority in these areas.

f) Restoration Zones

Areas in a highly degraded stage adjacent to the other zones of the proposed biosphere reserve should be brought under vegetation cover by scientific afforestation programmes. Soil conservation measures may be undertaken on hill slopes and the banks of reservoirs. Any human settlement in vulnerable

areas should be translocated. It is strongly recommended that all revenue forests in the biosphere area should be taken over by the forest department and declared as reserve forests. Since most of these revenue forests are highly degraded they may be suitably afforested.

The maintenance of continuity of natural vegetation cover throughout the biosphere reserve is extremely important. In areas where such continuity is threatened or has been severed, suitable link zones may be identified to reverse the fragmentation process. If necessary, suitable afforestation programmes may be undertaken in such link zones by incorporating these areas in the restoration zone.

Zone of Co-operation

In order to involve the people in the vicinity with the biosphere programme, one might think of an undefined zone of co-operation around the NBR area. Education and training programmes on environmental issues as well as ecorestoration efforts may be taken up in this zone. The co-operation of the people may be solicited so that they do not come into conflict with the objectives of the biosphere programme. This may be especially relevant to people along the borders of the NBR who are currently utilizing the fringe areas for their livelihood.

The total area under the various zones of the Nilgiri Biosphere Reserve of the 3 states is given below:

	Area in NBR Km^2	Core Km^2	Manip. Forestry Km^2	Tourism Km^2	Restoration Km^2
Tamilnadu	2537.6	274.0	2031.5	65.8	116.3
Kerala	1455.4	264.5	945.0	0.0	245.9
Karnataka	1527.4	701.8	212.2	269.2	344.2
Total	5520.4	1240.3	3238.7	335.0	706.4

3.6 Localities of the Nilgiri Biosphere Reserve

Keeping the Forest Division/National Park/Reserve Forest as the basic unit, the major localities of the proposed Nilgiri Biosphere Reserve are described below. Some of the minor localities have been merged with the major ones. The detailed areas of each zone in these divisions are given in Appendix II.

3.6.1 Nagarhole National Park(Karnataka)

Southeast of the Brahmagiri hills, separated from them by coffee plantations of the Coorg region, the forests of the Hunsur and Mysore Division stretch south until the Kabbini river. The Nagarhole National Park (area 571 Km^2) has been constituted here. The vegetation is moist deciduous forest interspersed with swamps in the Western portion and dry deciduous to scrub forest towards the east. Extensive teak plantations occur in the present tourism area of Nagarhole National Park. Principal streams are the Lakshmanthirtha

and Nagarhole. This region is noted for its large numbers of mammals such as elephant, gaur, chital, sambar, muntjac and wild pig. The large prey base supports a good number of carnivores such as tiger, leopard and wild dog.

All the zones of the biosphere reserve are represented in this region. A core zone has been constituted in the Nalkeri, Hatgat, Nettikuppe and Kakankote RFs. In view of the extensive teak plantations, portions of the Arkeri, Hatgat, Nalkeri and Kakankote RFs have been designated as a manipulation forestry zone. A new tourism zone has been proposed in the above areas, while the degraded areas to the east comprising Kachuvanahalli, Viranahosalli, Katwal, Alaganchi and Nagarapura SFs may be treated as restoration zone.

3.6.2 Bandipur National Park (Karnataka)

The waters of the Kabbini reservoir have restricted the link between the Kakankote range of Nagarhole NP with the Begur range of Bandipur NP (area 874 km^2) to a narrow 6 km stretch. South of the Kabbini, the forests of Bandipur Project Tiger extend southeast upto the Kakanhalla-Moyar river gorge. While a belt of moist deciduous forest is found towards the west, the dry deciduous vegetation predominates elsewhere. The Moyar RF to the east has deciduous-scrub vegetation. Large numbers of all the mammals characteristic of deciduous vegetation are seen here.

Since the establishment of Project Tiger in 1973 , the area has been free of commercial exploitation. The existing tourism area of the Bandipur and Kaniyanpur SFs will constitute one tourism zone. A new tourism zone has also been proposed in the Ainurmarigudi SF to maintain some patrolling by staff for protection. The entire Beerambadi SF will form a cone zone, while the Moyar SF can be designated a restoration zone.

3.6.3 Wynad Wildlife Sanctuary (Kerala)

Natural vegetation over much of the Kerala Wynad has disappeared, leaving only two discontinuous portions (created by the Pulpalli encroachments) along the border with Karnataka and Tamilnadu. These have been declared as the Wynad Wildlife Sanctuary (area 344 km^2). The northern segment adjoining Nagarhole NP includes the Begur and Kudrakote RFs, while the southern sector adjoining Bandipur NP and Mudumalai WLS includes the Kurichiyat, Kuppady, Mavinhalla and Rampur RFs. The natural vegetation is mostly moist deciduous forest with swamps. A large proportion of this has been converted to teak and Eucalyptus plantations. Swampy enclaves are cultivated by Chetties. The Wynad plateau has the largest tribal population in Kerala (91267 according to the 1971 census). While this tract must have been rich in large mammals, these have now reduced considerably due to the human interference.

The entire Wynad sanctuary has been designated as manipulation forestry zone.

3.6.4 Mudumalai Wildlife Sanctuary (Tamilnadu)

Adjoining the Wynad WLS and Bandipur NP at the trijunction of the 3 southern states, is the Mudumalai sanctuary (area 321 km^2) of Tamilnadu. The floristics are similar with moist deciduous forest interspersed with swamps in the western Benne RF and dry deciduous forest elsewhere. Chetties cultivate some of the swamps within Benne and Mudumalai RFs. The perennial Moyar river flows through the sanctuary. The fauna is as rich and varied as the adjoining Bandipur NP.

A portion of the Mudumalai-Kumbarakolli RF has been proposed as a core zone. This would adjoin the core zone of Bandipur NP. The tourism zone is centred around the existing infrastructure at Theppakadu. The remaining areas would constitute the manipulation forestry zone.

3.6.5 Nilgiris North Division (Tamilnadu)

To the east of Mudumalai lies the rain shadow region of the Nilgiris northern eastern slopes and the Sigur plateau. The plateau is bound on the north by the deep Moyar river gorge. Vegetation on the plateau is mostly dry deciduous - scrub of a Xerophytic nature. Along the steep Nilgiri slopes the vegetation changes from scrub

along the base through dry deciduous forest to semi-evergreen and stunted evergreen sholas on the crest. Overlooking the Moyar valley the Nilgiri slopes fall steeply to 250 m, where dry thorn vegetation occurs. On the northern bank of the Moyar the principal settlements are Thengumarada, Hallimoyar and Kallampalayam. There are numerous enclaves of cultivation on the plateau, Principal villages are Masingagudi, Moyar, Mavinhalla, Sirur, Anaikatti and a power station at Singara. In addition, there are a number of cattle pattis ; thus the plateau is extensively grazed by domestic livestock. All the large mammals characteristic of the deciduous forest are found here though at lower densities (except for chital). Mention must be made of the striped hyena restricted to such dry tracts.

In view of the current human activity, the major portion has been designated as a manipulation forestry zone. A core zone has been constituted along the Nilgiri Eastern Slopes RF overlooking the Lower Bhavani Reservoir, and a restoration zone along the barren shores of the reservoir.

3.6.6 Satyamangalam Division (Tamilnadu)

The Talamalai-Hasanur plateau to the southwest of the Biligirirangan hills forms one extremity of the Eastern Ghat chain of peninsular India. It meets the Nilgiris of the Western Ghats across the Moyar valley or Gazalhatti pass (250-350 m). A gallery forest is prominent along the

banks of the Moyar river. Elsewhere, the dry thorn forest is perhaps one of the few authentic representations of this vegetation type in peninsular India. A large population of blackbuck is found to the north of the Moyar in the Talamalai range. A herd of feral buffalo also inhabits the valley.

The hills of the Eastern Ghats rise steeply to the Talamalai plateau (750-1000 m) and are covered with dry deciduous-scrub forest. The plateau itself is largely covered with dry deciduous forests which have degraded into scrub in the vicinity of villages. Eucalyptus plantations have been raised in the Talamalai and Guthialathur RFs. In the Guthialathur RF a few hills forming part of the Biligiri-rangan chain have montane evergreen shola-grassland above 1500 m. Moist deciduous forest is found in the sheltered Minchikuli valley. The large enclaves of cultivation here are Chikkahalli, Neydalapuram, Mudiyanur, Talamalai and Hasanur. While all the large mammals of the region are represented here, the elephant is by far the most predominant.

The Minchikuli valley has been constituted as a core zone. The degraded hills to the west of Talamalai RF and a strip of thorn forest in the southern foothills form the restoration zones. The remaining portions constitute a manipulation forestry zone in view of the current human presence.

3.6.7 Coimbatore Division (Tamilnadu)

The forested southeastern slopes of the Nilgiris along with a portion of the Siruvani hills and Bolampatti hills, stretching south upto the Palghat gap, constitute the Coimbatore Division. Along the Mettupalayam-Coonoor highway, the forest cover narrows to a very small strip between the Jaccanare slopes RF and Hulical Drug RF. Extension of this corridor is necessary if forest continuity is to be maintained over the biosphere reserve. Further south, the Bhavani river flows through the forested slopes of Nellithurai, Kandiyur, Pillur and Melur slopes RFs. The Pillur Dam has been constructed across the Bhavani. The vegetation in this rainshadow region shows the usual transition from scrub jungle at the foothills through deciduous forest to stunted evergreen patches at the higher elevations. There are a number of small settlements along the Bhavani.

Further south are the dry deciduous-scrub forests of Gopinari, Anaikatty north and south and Thadagam RFs. The Anaikatty plateau is again largely under cultivation. The hills to the extreme east are practically devoid of vegetation and have been excluded from the biosphere reserve. To the south of Anaikatty is the eastern portion of the Siruvani hills (Bolampatty Block II) which contain good patches of semi-evergreen and evergreen forest on the higher slopes, going upto 1800 m in places. In this region, even the vegetation on the plains (300-400 m) tends towards

a mixed deciduous type instead of the usual scrub, due to the higher rainfall. The extreme southeastern spur of Bolampatty Block II rising upto 1200 m has largely deciduous-scrub, which is highly degraded in places.

Though all the large mammals are seen here, their numbers are relatively low due to the steep terrain.

A core zone has been constituted around the semi-evergreen, evergreen patch on Bolampatty Block II (Siruvani hills), The Odanthurai RF of Mettupalayam range and the degraded extreme southeastern portion of Bolampatty Block II go to make the restoration zones. The rest of the Division constitutes a manipulation forestry zone.

3.3.8 Nilgiris south Division (upper Nilgiri Plateau-Tamilnadu)

While the major portion of the Upper Nilgiris has come under human habitation, the natural vegetation is present along its western and southern crestline. This includes the Nilgiri Peak, Pichalbettu, Porthimund, Mukurti Peak, Kundah, Mikkerubettu and Thaishola RFs ranging in elevation from about 2000 to 2550 m. The Nilgiri Tahr sanctuary (area = 78 km^2) has been constituted in this region. The Upper Nilgiri crestline overlooks the New Amarambalam, Silent Valley and Attapadi Reserves of Kerala. Natural vegetation is the characteristic montane evergreen shola-grassland which is extensive throughout the region. However, a large area

has also been brought under bluegum and wattle plantations. There are a series of reservoirs on the plateau, including Pykara, Mukurti lake, Porthimund, Parson's valley, Emerald and Upper Bhavani reservoirs. As far as the wildlife is concerned, a mention must be made about the large number of Nilgiri tahr (about 400) in addition to lower densities of elephant, gaur, sambar, muntjac, leopard, tiger and wild dog.

The newly carved Nilgiri Tahr Sanctuary which retains most of the natural vegetation forms the core zone, while the remaining plantation areas constitute the manipulation forestry zone.

3.6.9 Palghat Division (Attapadi Blocks I to VI - Kerala)

Adjacent to the Bolampatty hills of the Tamilnadu Coimbatore Division, the Attapadi Blocks I to VI constitute the Palghat Division. The outer slopes have patches of natural vegetation and on the plateau (Siruvani plateau) enclosed by the ridges there is an extensive wet evergreen forest tract - the Attapadi Block VI, also known as the Muthikulam Reserve (1000 m elevation). The forests on the northern slopes of Siruvani plateau are heavily disturbed, whereas towards the northwest it continues along the lip of the plateau towards Silent Valley. There is a small dam on the Siruvani river and a larger dam is nearing completion. To the south of the Siruvani plateau lies the

Chenatnayar RF (excluded from the biosphere reserve), separated from it by a ridge. The Chenatnayar and Siruvani plateaus descend very steeply down to the Palghat plains and heavy encorachments of forest (have taken place on the western slopes from around Kanjirampuzha where an irrigation dam is under construction. Densities of large mammals are relatively low. The lion-tailed monkey and Nilgiri tahr are seen in the evergreen parts of Siruvani hills.

The Muthikulam RF and Valayar RF have been constituted as manipulation forestry zones, while the remaining areas have been designated as a restoration zone.

3.6.10 Nilambur Division (Kerala)

The Nilambur Division consists of five reserve forests - New Amarambalam (249 km^2), Karimpuzha (16 km^2), Silent valley (90 km^2), Attapadi (140 km^2) and Siruvani hills (23 km^2), of which three are large enough to warrant special mehtion.

(a) Attapadi RF

The Attapadi RF is bound to the north by the Korakundahs of the Upper Nilgiris, to the west by the Silent valley, to the south by the Muthikulam-Chenatnayar RF and to the east by the Siruvani hills - Bolampatti block of Coimbatore Division. The Bhavani river flows south and then northeast through this region. The main Attapadi valley is largely under cultivation. There are about 16000 tribals (40 percent of population) in the valley. They have been practising

slash and burn cultivation for a long time and as a consequence practically all the forest in the valleys and lower hills have disappeared. Evergreen forest is now restricted to the Silent valley - Attapadi divide and along the northern slopes of the reserve bordering the Korakundahs. Elsewhere the vegetation is deciduous to scrub. Plantations of teak and mixed plantations of fruit trees for tribals have been raised in the accessible portions of the valley.

The forest block adjacent to the Silent Valley has been constituted as a manipulation forestry zone, while the remaining fragmentary and degraded forests around the cultivation have been designated as a restoration zone. In view of the wide variety of cultivated crops in the Attapadi region ranging from dry crops such as jowar, ragi and other millets to plantation crops such as cardamom, pepper, betel, arecanut and plantation in the wetter areas, this region would especially qualify for programmes of the manipulation agriculture zone.

(b) Silent Valley RF

The Kundahs of the Upper Nilgiri descend on their southwest relatively gradually to the Silent Valley plateau which has a mean elevation of 1000 m. The western and southern margins of Silent Valley descend precipitously to the Karuvarakundu - Mannarghat plain. These slopes are covered by forests of the Tenkara range. The Silent valley

plateau itself is shielded from extremes of climate and has its own special mesoclimate. It is drained by the Kunthipuzha flowing south and joining Bharatpuzha. The plateau is covered mostly by wet evergreen forest, while the shola-grassland system replaces the wet evergreens on the higher reaches. This area is devoid of any human settlements including tribals. It is one of the least disturbed evergreen forests in peninsular India. The characteristic wildlife of the evergreen habitat can be seen, including lion-tailed monkey, nilgiri marten, and Nilgiri tahr. Apart from being one of the richest tracts in terms of biological diversity, the Silent Valley is also known to harbour many endemic and rare species of Angiosperms, amphibians, fishes and invertebrates. A proposal to dam the Kunthipuzha has been abandoned.

The entire Silent Valley RF has been constituted as a core zone, while the outer slopes of the Tenkara range acting as a buffer may be designated as a manipulation forestry zone.

(c) New Amarambalam RF

The western slopes of the Nilgiris, drained by the tributaries of the Chalinyar, constitute a huge amphitheatre of deeply dissected valleys and sharp westerly ridges. Part of the valley (Karimpuzha RF) and the entire slopes (New Amarambalam RF) are forested. Though all of the Karimpuzha and the lower, outer foothills of New Amarambalam which

ere clothed by moist deciduous forest were converted to teak plantations, the evergreen and semi-evergreen areas of New Amarambalam remain undisturbed. This is the only known habitat of Cholanaikas, the least modified hunting gathering cummunity of tribals in subcontinental India, now numbering less than 150.

Areas above 1200 m or so have been constituted as a core zone, adjoining the core zone of the Nilgiri Tohr sanctuary. The remaining areas make up a manipulation forestry zone.

3.6.11 Nilambur Vested Forests (Kerala)

From near Kalpetta in the South Wynad, a high north-south ridge comes down to the Nilambur plains. The highest point is Kurathimala (2339 m). The southeastern face of this ridge is drained by the Chaliyar and the western face by tributaries of the Byporepuzha. This ridge is clothed by an extensive, relative undisturbed wet evergreen and semi-evergreen forest (Nilambur Kovilakam). Apart from New Amarambalam this is perhaps the largest single patch of wet evergreen forest in the proposed Nilgiri biosphere reserve. This forest on its northeast is linked up to the New Amarambalam RF through the slopes adjoining Gudalur Division of Tamilnadu. The vegetation here is highly disturbed. There are extensive Eucalyptus plantations on the slopes cultivated by the Gwalior Rayons. This plantation known

as the Birlavanam has been vested with the state government by a court judgement in 1979. Over 1500 tribals inhabit the Nilambur vested forests.

The Nilambur Kovilakam has been proposed as a core zone, while the remaining disturbed rorests as a manipulation forestry zone.

4. THRUSTS OF THE SCIENTIFIC PROGRAMME

The ultimate objective of the scientific programme associated with the biosphere reserves would be to generate the understanding necessary for mankind to maintain an environment supportive of the great diversity of life on earth, while pursuing a path of sustainable development. This is possible only through a holistic view of the system of population/resource consumption/capital stock of natural resources. Ideally such a view should encompass the entire planet earth. But earth is a highly complex system, made of a whole range of varied environments. The biosphere reserve programme attempts to set up reserves representative of all the different terrestrial and coastal ecosystems of the earth around a core of natural undisturbed areas, surrounded by areas with varied of human influences. It is hoped that such a network biosphere reserves encirclin the globe would together furnish us with the scientific knowledge we are looking for. This network should also provides sites for action research in field involving alternative models of development that use natural resources

sustainable and permit maintainance of our heritage biological diversity.

The three major thrusts of the scientific programmes at the biosphere reserves follow from this basic approach. These include:

(i) Long term monitoring of changes in environment in relation to various levels and forms of human impacts, both in the undisturbed core zone and the manipulation zone.

(ii) Action research involving alternative models of sustainable development in the manipulation, restoration and co-operation zones.

(iii) Developing a scientific understanding of what determines levels of biological diversity (including that of cultivated plants and domesticated animals) in natural as well as disturbed ecosystems, and the management techniques for long term maintanance of this diversity.

5. LONG RANGE MONITORING

5.1 Selection of study sites

Biosphere reserves provide ideal sites for benchmark studies on the environment of undisturbed, natural ecosystems and the changes brought about by various levels and kinds of human impacts on a long range time scale. A series of such studies must be launched at the Nilgiri biosphere reserve in core, manipulation as well as restoration zones. It would be necessary to carefully select sites for these

studies to represent the whole spectrum of changes in environmental regime as well as human impacts encountered over its 5500 km^2. It is suggested that the element of such studies should be a microcatchment of a few, about 10 km^2. We may select about 18 such microcatchments, representing three levels - minimal, moderate, large - of human impact in each of the six broad vegetation types, namely low altitude wet evergreen, high altitude sholas/ grasslands, semi-evergreen, moist deciduous, dry deciduous and thorn scrub. Within each of these microcatchments, we may further select study sites of differing sizes, appropriate to each kind of investigation detailed below.

The selection of the actual microcatchments and study sites will have to be based on a prior survey of the total area. Such a survey is also needed for drawing up a management plan for the biosphere reserve. This is particularly relevant in parts of wetter western slopes of the biosphere reserve falling within the state of Kerala where there has been pressure of continuing human encroachments over the last two decades and where no clear picture of the status of human settlements is available.

5.2 Surveys

The first element of such a survey will be the topographic survey. As of today Survey of India toposheets exist on 1:50,000 and 1:250,000 scale based on aerial photography and ground surveys conducted 10 to 20 years ago.

The Survey of India is currently mapping the entire country at 1:25,000 scale. It is suggested that the NBR area be taken up as a priority for mapping at this scale. Ultimately, it should be possible to map the area at a 1:10,000 scale. However, it would take several years to cover the entire region on such a scale and priorities will have to be set. Highest priority should then be given to the areas where human settlements have been growing rapidly in recent years, and to other selected representative areas that may be chosen as microcatchments for study purposes. The Surveys would include both fresh aerial photography and ground verification.

The topographic surveys should be supplemented by geomorphological and vegetational surveys. The scale of such surveys could be cruder. Initially they may best be completed on 1:2,50,000 scale, to be subsequently elaborated on 1:50,000 scale. The French Institute, Pondicherry has in fact published one vegetational map on 1:2,50,000 scale covering parts of the Nilgiri Biosphere Reserve, and completed part of a second map. They should be immediately commissioned to prepare the two other maps that would be required to cover the whole of the biosphere reserve. The Geological Survey would be involved in preparation of the geomorphological maps.

The human settlements would of course be mapped on the topographic sheets of Survey of India. However, a separate

resurvey of all human settlements and associated land use should be initiated with the base of existing revenue records. This has to be conducted on an emergency basis in areas subject to rapid human encorachments.

5.3 Inventories

In parallel with the mapping, we should take up the task of inventorying the flora, fauna, cultivated plants, domesticated animals, and human cultures of the region. Obviously, this is an enormous task that would have to be shouldered primarily by the Botanical Survey of India, Forest Survey of India, Zoological Survey of India, National Bureau of Plant Genetic Resources, and the Anthropological Survey of India in collaboration with Academic and Scientific institutions with appropriate expertise. Priorities will obviously have to be set in view of the enormity of the task. The Forest Survey of India could rapidly prepare a forest plantations and natural forests map for the entire region on a 1:250,000 scale, to be followed by 1:50,000 scale with indication of the growing stock. The floristic and faunistic surveys should give priority to localities little explored .so far, especially on the steep western slopes in Kerala. The floristic and faunistic surveys should also begin to take account of little explored groups of lower organisms. A few such groups should be identified for focus. These may include : fresh water algae and fishes, soil fungi including mycorrhizae , and soil annelids and

arthropods. In addition work will have to continue on flowering plants, birds and mammals.

The surveys of cultivated plants and domesticated animals should take up on priority basis as area like Attapadi with its tremendous diversity of soil and climate and large tribal populations. It could then continue with other areas.

The inventory of cultural diversity by the Anthropological Survey of India and Tribal Research Institutes should especially focus on man-nature relationship. This would include traditions of natural resource use and conservation, and traditional knowledge of ecological processes and biological diversity. Again priority should be given to little known tribes, as well as newly settled population as in Gudalur areas.

5.4 Monitoring

The task of inventory will have to be followed by long term monitoring of a variety of environmental parameters and ecological processes. For the area as a whole, such monitoring may be based on satellite imagery acquired every year at about 4 months interval through the National Remote Sensing Agency. The 18 or so identified microcatchments could provide sites for a co-ordinated programme of such monitoring. The parameters to be monitored will include:
(a) Meteorological parameters such as rainfall, temperature,

humidity, solar radiation, wind and evapotranspiration. In addition one station should participate in global monitoring of air quality with parameters such as CO_2 and pollutant concentration. Some of the stations in more remote areas may relay the data telemetrically.

(b) Hydrological parameters including surface runoff and percolation, stream flows, silt loads, water quality, especially in relation to use of pesticides and fertilizers in the Nilgiris.

(c) Land use patterns in terms of human settlements, cultivation and plantations, grazing by livestock, incidence of fires.

(d) Soil erosion and soil pollution.

(e) Primary production and cycling of minerals such as N and P in natural as well as man-made vegetation.

(f) Influence of different birds of forestry practices including monoculture and polyculture plantations, selection and clear felling, minor forest produce collection.

(g) Ecology of invasion by exotic weeds. Human demands on biological production of the locality in terms of fuel, fodder, construction material, green manure, timber, softwood railway sleepers etc.

(h) Monitoring of biological diversity levels is detailed below in Section 7.

6. ECODEVELOPMENT ACTION RESEARCH

The second thrust of the scientific programme at the Nilgiri biosphere reserve will be to devise and experiment in field with alternative models of sustainable development. These models will have to address themselves to a whole range of issues including land and water use, agriculture and horticulture, animal husbandry, forestry, human settlements and transport and communication.

(i) Land and water use : A major issue in a tract like the Western Ghats is adjusting land use to land capability, for instance phasing out cultivation of steep slopes under crops such as potato and tapioca. The water use too has to be regulated including through measures of soil and water conservation, proper drainage etc.

(ii) Agriculture : Apart from adjusting cropping pattern to land capability, there are issues like efficient use of green manure and its production on fields. Another critical issue is protection of crops against attacks by wild animals such as elephant which is responsible for considerable antipathy of the local population towards conservation. We must also develop ways of conserving local cultivars.

(iii) Horticulture : There are currently several environmentally unsound horticultural practices such as excessive use of pesticides in tea plantations, and gradual decimation of shade trees in cardamom plantations. More sustainable and environmentally sound practices obviously need to be developed. We must also develop ways of conserving local cultivars.

(iv) Animal husbandry: There is an incredibly high pressure of grazing by livestock in some areas such as the Sigur plateau. Alternative practices of stall or paddock feeding of a smaller number of genetically improved animals accompanied by fodder development needs to be tried out. We must also develop ways of conserving local strains of domesticated animals.

(v) Forestry : A whole range of forestry practices needs to be carefully monitored and new experiments initiated to come up with sustainable, environmentally sound practices that would help conserve diversity. For instance, we need to create corridors of natural vegetation throughout areas of plantation to serve as links for the natural biota. We also need to emphasize and develop techniques of revegetation of degraded areas in the restoration zone.

(vi) Human settlements: We need to look at the design of human settlements, and their resource demands. Experiments need to be tried out for conserving fuel use for a variety of purposes, to guard water sources against contamination etc.

(vii) Transport and communication: We need to take a hard look at the real needs of people for transport and communication and how to meet in a way least destructive to the environment.

Such action research would be best initiated in some of the microcatchments identified for monitoring the environment

7. CONSERVING BIOLOGICAL DIVERSITY

7.1 Community level studies

Conserving the entire spectrum of biological diversity including that of cultivated plants and domesticated animals, is of course an important purpose of a biosphere reserve. Our scientific understanding of processes governing trends of biological diversity is very inadequate, and investigations elucidating these processes will have to form a major component of work at the biosphere reserves.

This programme will have two components: studies at the level of communities, and studies of populations of individual species. Our particular interest lies in how various environmental factors as well as human impacts, including fragmentation of natural habitats affect diversity levels. It would therefore be most appropriate to site these diversity studies on plots in the eighteen microcatchments selected to represent the whole range of environmental regimes and human impacts.

The investigations will have to focus on estimating levels of ecological species packing (or α-diversity) as well as ecological species turnover (or β-diversity). Standard methods will have to be developed to estimate these diversity levels for different groups of organisms. We suggest that this be attempted for: fresh water algae, soil fungi, flowering plants, fresh water fishes, annelids, soil arthropods, birds and larger mammals. A number of sample plots of appropriate sizes will then have to be

chosen to represent the habitat gradient in each micro-catchment to carry out estimations of α- and β-diversity with comparable, standardized methodologies. The diversity levels will have to be monitored both seasonally and year after year on an appropriate time schedule.

7.2 Population studies

The community level studies will have to be supplemented by population studies on a few species to understand in detail the processes leading to local or large scale extinctions. The species so selected will come from taxa intended to be monitored at the level of communities. The selection of species may be related to our lack of knowledge of their biology, their endemicity, being endangered, and being dominant in the community. For the species so selected, we should encourage thorough investigations of population biology, including levels of genetic variability, fertility, mortality, dispersal and interactions with other species.

Examples of species we may thus select could include soil mycorrhizae, dominant tree species, freshwater fish species endemic to hill streams of Nilgiris, endemic birds like laughing thrushes, endangered mammalian species like Nilgiri tahr and tiger and dominant mammalian species like the elephant. The total number of population studies that can be so tackled would evidently depend on the scientific expertise available; but we should ensure standardization

of methods of estimating various populational parameters.

7.3 Genetic resources

Special attention will have to be paid to looking at the genetic resources of cultuvated plants and domesticated animals. Biochemical techniques will have to be employed to look further at intrapopulational genetic variabilities. A number of issues arise in how to encourage in situ conservation of this resource by encouraging their continued us by local people. Obviously this will have to be done through incentives such as appropriate subsidies for making up the economic loss in not going in for more productive varieties.

8. LOGISTICS

8.1 A complex task

Organizing such a major programme with a variety of elements is obviously an undertaking that calls for long range careful planning. Such planning is all the more important as biosphere reserves should be sites for monitoring that will necessarily have to continue over time spans of decades. Furthermore, some of the sites of scientific investigation will be very difficult to approach requiring special facilities. We are also envisioning here bringing together of many different elements, not only scientists and technical people, but administrators and local population as well. All of this adds to the complexity of issues that will have to be tackled.

We may offer here a few preliminary suggestions:

(a) No new separate institution needs to be set up for this task.

(b) Instead existing institutions may be properly strengthened to take on this task. In particular, research funds made available to these institutions should provide for overheads.

(c) The Government surveys and other organizations will have to be provided additional staff and other infrastructural facilities.

(d) Voluntary agencies should be especially encouraged to participate in action research.

(e) There should be excellent facilities for proper co-ordination of the activities of different groups involved and open sharing of information. A central, computerized data centre may have to be developed at one of the participating institutions for this purpose.

(f) There should be assurance of long term support. It may be noted that the National Science Foundation in U.S.A. has made special provision of assurance of 20-year support for biosphere research programmes in that country.

(g) Facilities will have to be provided in the field for personnel engaged in research. Wherever possible the existing buildings of the forest departments or other agencies may be used. For instance, the unused buildings at the

shelved dam site in Silent Valley could be utilized. The Kerala Forest Research Institute has a field station at Nilambur, which may be shared. New facilities could be created where absolutely necessary.

(g) Special multidisciplinary expeditions will have to be organized in particularly inaccessible areas.

8.2 Organizations

We may cite here a few of the many organizations that may be involved in such an endeavour. This list is preliminary, and by no means implies exclusion of other organizations:

(i) Survey organizations with location of one of the major offices. Survey of India, Bangalore; Forest Survey of India, Bangalore; Geological Survey of India, Bangalore ; Botanical Survey of India, Coimbatore; Zoological Survey of India, Calicut; Anthropological Survey of India, Mysore ; Soil Survey and Land Use Bureau, Bangalore; Indian Meteorological Department.

(ii) Research institutions : Forest Research Institute, Coimbatore; Kerala Forest Research Institute, Peechi; Central Water and Soil Conservation Research and Training Institute, Ooty; Indian Institute of Tropical Meteorology, Pune; French Institute, Pondichery; Tribal Research Institute, Calicut; Central Water Resources Development and Management Centre, Calicut; International Institute of Ayurveda,

Coimbatore; Institute for Social and Economic Change, Bangalore; Centre for Development Studies, Trivandrum; Centre for Earth Sciences, Trivandrum.

(iii) Universities: Indian Institute of Science, Bangalore, Bangalore University, Bangalore; Mysore University, Mysore; Mangalore University, Mangalore; University of Agricultural Sciences, Bangalore; Tamilnadu Agriculture University, Coimbatore; Bharatiyar University, Coimbatore; Madurai Kamaraj University, Madurai; Tribal Research Institute of Tamil University, Ooty; Calicut University, Calicut; Kerala Agricultural University, Trichur.

(iv) Voluntary Agencies: Vivekanand Girijan Kalyan Kendra, B.R.T. Hills, Mysore District; Kerala Sastra Sahitya Parishat, Trivandrum; Prakriti Samrakshana Samithi, Trivandrum; Myrada, Bangalore.

(v) Government Forest Departments.

APPENDIX I

List of participants in the meetings held to formulate the scientific programme of the Nilgiri Biosphere Reserve

The meetings attended by each participant are shown in brackets as follows

O - 14th October 1985

J - 10th January 1986

M - 7-8th March 1986

1. Dr. Mukhtar Ahmed (O)
Forest Research Centre
Coimbatore -2

2. Shri. M.K.Appayya I.F.S. (O,J)
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3. Dr. B.S. Attri (J)
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4. Dr. S. Avinash (O)
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5. Dr. Kedar Baidya I.F.S. (O)
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6. Shri. K.A.Belliappa I.F.S. (J,M)
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Aranya Bhavan,
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7. Mrs. Jayshree Balachander, (M)
Dy. Secretary,
Planning and Development,
Government of Tamilnadu,
Fort St., George, Madras

8. Shri. C.H. Basappanavar, (O)
Director
Project Tiger
Mysore

9. Dr. Jacob Cheeran (M)
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11. Dr. J.C. Daniel (O)
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12. Sri. Ranjit Daniels (M)
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Indian Institute of Science
Bangalore

13. Shri. M.K. Francis (M)
Survey of India Richmond Road
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14. Prof. Madhav Gadgil (O,J,M)
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15. Dr. R. Gadagkar (M)
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16. Dr. K.N. Ganeshaiah (M)
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17. Shri. K.B. Iyer (J)
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18. Dr. J.I.V. Jeyapaul (O,M)
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19. Shri. Ullas Karanth (O,J,M)
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20. Shri. S. Kondas I.F.S. (M)
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21. Shri. K.A.Kushalappa I.F.S. (M)
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22. Dr. S. Moudgal (J)
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23. Shri. G. Mukundhan I.F.S. (M,J)
Chief Conservator of Forests
Trivandrum

24. Shri. K.S. Murali (M)
University Agril. Science
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APPENDIX II

SUMMARY OF AREA UNDER VARIOUS ZONES OF THE NILGIRI BIOSPHERE RESERVE

All areas are given in square kilometers

State: Tamil Nadu

Forest Division	Area in NBR	Core	Manip. Forestry	Tourism	Restoration
1	2	3	4	5	6
Mudumalai Wildlife Sanctuary	321.1	96.0	163.1	62.0	0
Satyamangalam Division	745.9	40.0	660.9	0	45.0
Erode Division	49.3	30.0	-	-	19.3
Nilgiris North Division	448.3	0	444.5	3.8	0
Nilgiris South Division including Nilgiri Tahr santuary	276.8	78.0	198.8	0	0
Coimbatore Division	696.2	30.0	614.2	0	52.0
Total area for Tamilnadu	2537.6	274.0	2081.5	65.8	116.3

In addition some area in the Gudalur Division may also be considered for inclusion in the restoration zone

STATE : KERALA

Forest Division	Area in NBR	Core	Manip Forestry	Tourism	Restoration
1	2	3	4	5	6
Wynad Sanctuary	344.4	0	0	0	0
Nilambur Division	517.5	164.5	313	0	40.0
Nilambur Vested Forests	277.6	100.0	177.6	0	0
Kozhikode Vested Forests	110.0	-	110.0	-	-
Palghat Division	205.9	0	0	0	205.9

The Valayar RF is to be included in the manipulation (Forestry) Zone.

Total area for KERALA	1455.4	264.5	945.0	0	245.9

STATE: KARNATAKA

Forest Division	Area in NBR	Core	Manip. Forestry	Tourism	Restoration
1	2	3	4	5	6
Hunsur Division	354.4	60.1	182.0	46.4	65.9
Mysore Division	462.7	168.6	30.2	67.1	196.8
Project Tiger-Bandipur	689.5	473.1	0	155.7	60.7
Chamarajanagar Division	20.8	-	-	-	20.8
Total area in Karnataka	1527.4	701.8	212.2	269.2	344.2