

How Do I Understand Biodiversity?

India covers about 2 per cent of the land area of the world but possesses more than 8 percent of world's biodiversity. This biodiversity is not evenly distributed in India. It is more concentrated in Western Ghats & in the north-eastern states such as Arunachal Pradesh & Assam. These areas are therefore, called "Biodiversity Hotspots." Andaman & Nicobar Islands also have remarkable biodiversity.

Indian biodiversity is characterized by high endemism. It means a number of species have limited ranges, being confined to particular areas only & not found anywhere else in the world. Such species obviously have high conservation value, should receive highest priority in any conservation programme as their loss implies that the world heritage becomes so much the poorer.

But why should we care to protect and conserve biodiversity, many people would ask. The simplest answer to this question is this: the variety of species provides a gigantic gene bank which becomes an unlimited source of food & fibre, medicines, antibiotics & pesticides and raw materials for different industries, small & large scale. Wild genes are much stronger in resisting diseases & can impart this strength to domesticated plants such as crops to make them pest resistant. Forest food is an important supplement in the diet of many communities in India. Wild plants can also be an additional source of energy as Pongamia (Karanj) and Jetropha have shown.

If biodiversity is so useful, how do we account for it? Do we know how many plants and animals are immediately useful to human beings, how many are likely to be useful in future and how many are not directly useful? To account for each & every species of plants from lichens to trees and of animals from bacteria to larger animals like whales and elephants, is a mind-boggling task. No nation has achieved this feat so far. We have initiated an effort to document biodiversity as much as possible by preparing biodiversity registers for the countryside & for urban areas. But it is feared that a lot of biodiversity is going to be lost by the time we complete this task!

Why is this so? For biodiversity is not only the number & variety of species & sub-species of plants & animals, higher & lower, but also includes the variety of habitats & niches available in a particular area. Habitat is the address & niche is the profession of

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each species. It is extremely difficult to separate out & count each & every habitat & niche as they are connected to each other & to larger divisions like biomes in a maze of linkages. Our ecological knowledge is not adequate to understand all these linkages. In our precipitate haste to industrialize & urbanise, we may be unintentionally destroying a number of habitats & niches. The collapse of linkages must be having a devastating impact on biodiversity!

This way we are destroying forever not only the gene bank but also the very basis of ecological knowledge & understanding.

The reasoning so far makes clear that biodiversity knowledge is not enumeration of species & sub species only. We must also try to understand what habitats & niches species & sub- species represent? The wonderful diversity of attractive flowers that adorns many a lateritic plateau & open area in Western Ghats, during monsoons, is a case in point. These areas are "open" because of unrestricted grazing & trampling by our domestic animals & cutting of wood by human beings. The character of biodiversity on these plateaus when they were not "open" must be quite different from what it is today. If we enclose this area & protect it from grazing & cutting, the present diversity of attractive flowers is likely to be replaced by some other set of plants. Which is important for us? The attractive flowers which is an expression of nature's reaction to a variety of impacts? Or the more sedate variety of plants which emerges when these impacts are removed?

Cast in this mould, the question of biodiversity enumeration & conservation appears to be quite an intricate one. We must understand that biodiversity is nothing but an expression of certain physical conditions. In a country like India, which boasts of human settlements dating back to thousands of years, human beings have been constantly modifying these conditions. Biodiversity must have been modifying too. In the name of preserving certain apparently "natural" areas, we have evolved a system of protected areas like sanctuaries & national parks. Yet they are not completely immune from human interference. It means that the biodiversity that these areas manifest must have been modified over the years. A study in Germany has shown that 65 % of biodiversity is found outside protected areas. It is likely that this biodiversity is the result of human modification of habitats & in a sense "man- made diversity, while the 35 % which

remains within protected areas are an expression of physical conditions which existed some years ago.

The significance of biodiversity then seems to depend on decisions made by human beings in a particular country or nation. People must decide how much area they would continue to modify & how much they would leave to relapse into physical conditions that existed in the past. As such biodiversity is quite a dynamic concept.

Enumeration of biodiversity cannot be once for all. Each time we enumerate or document we must put a date on it. We should repeat this exercise every 5 or 10 years. In fact we should have a census of biodiversity every 5 or 10 years, as we census human beings. If we can describe & quantify physical conditions of the area, each time we enumerate, we may begin understanding the linkages between biodiversity & physical conditions. An NGO from Pune enumerated the biodiversity of Metropolitan Area at the turn of century. In some cases as in birds, they were able to establish the change in the character of biodiversity as some older records were available. If they repeat the exercise, and also record modifications in physical conditions, linkages between these two can be established with much more certainty. Indeed if somehow the scale of human impact can be quantified, the character of biodiversity can be related to the scale of human impact. This is directly useful in restoration & conservation of biodiversity.

Together with physical conditions, biodiversity also helps to define the character of nature's services. If in an area atmosphere, soil and water are polluted, nature's services such as providing atmospheric balance, soil formation & self-cleansing ability of flowing water, will be affected. The existing biodiversity will be an indicator of such disturbed conditions. The linkage between the degree of disturbance & the character of biodiversity can thus be established.

If the restored area is monitored annually we will understand how physical conditions & biodiversity begin to "relapse" to conditions that existed before they were modified by human beings.

Some people have differentiated between the "natural" & "domesticated" biodiversity. In the above sense, it is extremely difficult to locate & define natural & pristine biodiversity. The better differentiation would be between biodiversity that is only

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indirectly useful to human beings and has more or less intrinsic value and biodiversity which is directly useful & is associated with them.

How then do I understand biodiversity? I feel biodiversity is one of the components of Nature. If we single it out, accord it greater value, try to glorify it, we obtain a distorted view of nature. Biodiversity should be cast in its proper perspective: the time scale, physical conditions & most important, the character & intensity of human impact.

If conservation of biodiversity through protection & elimination of human impact, is planned, one must accept that it will mean a kind of relapse into conditions that existed sometime in the past. If biodiversity is to be taken care of in a human milieu, we must minimize human impact in certain natural processes such as the drainage pattern, the balance of erosion & deposition and stepping stones & corridors for the movement of life forms.

Prakash Gole

Envy

A PRELIMINARY NOTE ON THE BIODIVERSITY OF THE DABHOL ESTUARY IN
THE KONKAN REGION OF THE WEST COAST OF INDIA

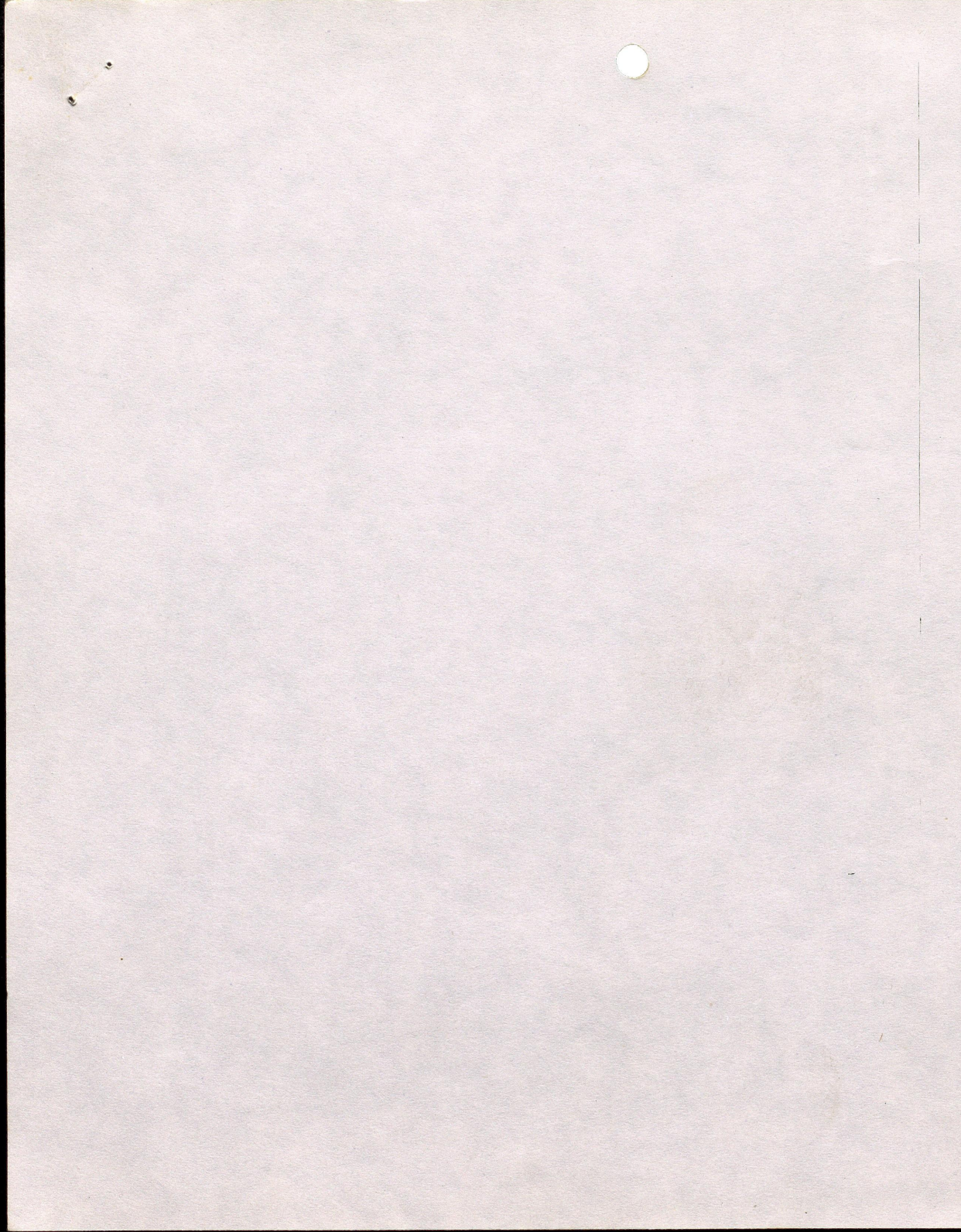
The coastal strip of the Konkna is dissected by many streams and rivers which rise in the Western Ghats and debouch into the Arabian sea. They are reputed to bring significant sediment inputs which provide sustenance to a number of life forms, marine freshwater and terrestrial. Estuaries where these streams and rivers meet the sea, convey the marine influence far inland giving rise to temperature and salinity gradients in their flow. These create specialized ecological conditions conducive to many life forms including commercially important fish. For example, at every high tide the cool waters of the sea produce an undercurrent which flows from the sea inland overridden by nutrient-rich warm water of the stream flowing in the opposite direction. The inter-mixing of the cold and warm waters produce extremely beneficial conditions which are beneficial to freshwater and marine life forms. At neap tide conditions are reversed and nutrient-rich stream waters are quickly conveyed to the sea benefitting the life of the open sea.

Estuaries therefore, are considered to be one of the most productive eco-systems in the world.

This fact was forcefully brought to our notice during the recent reconnaissance we carried out in the Dabhol estuary where the river Vasishti meets the sea. The estuary has a wide though shallow mouth filled up by a sandbar formed probably by the sediment brought by the river. Unless it is dredged the estuary will continue to provide conveyance to small craft only that ply at present from Dabhol near the mouth to Gowalkote almost 50 kms inland. There are over 40 jetties at which the launch stops in its journey to Gowalkote to disembark and take up passengers and small cargo.

As one travels by launch to Gowalkote one encounters small settlements scattered on hills through which the river meanders. They are interspersed with good amount of vegetation on the hills on both sides of the river. Vegetation is denser on the southern slopes than on the northern. Bases of the hills are enveloped in mangroves at many places. At low tide mudflats fronting the mangroves are exposed providing the local people food in terms of molluscs and other shells. Large shoals of fish can be seen by naked eye swimming in the vicinity of mangroves and within them. Mangroves between Pewe and Pangari(dalvi) are more extensive than others covering probably a total of 10 sq kms on both sides of the estuary. On the southern side luxuriant undisturbed forest of semi-evergreen type provides a rich backdrop to the mangrove vegetation. The mangroves stretch again from Pangari to Unhawane on the southern side. To the north also mangrove patches cover the hill bases. again between Sutavi and Chiveli mangroves occupy over 5 sq kms on the southern side.

Near Ketki village good forests cover the southern slopes.



VII

Biodiversity and Manmade Wetlands

In India, natural wetlands are mostly restricted to the Himalayas, the Ganga-Brahmaputra flood plains, and the deltaic and coastal areas. All the other wetlands are manmade or artificial. In Asia, the total volume of reservoir waters has, in the last 30 years, increased by 90 times. "In India infrastructural changes caused by population resettlement and reorganization of the national economy have enveloped the area of 1.5 million sq kms, which makes up nearly half of the territory of India" (Avakyan 1987).

Bharatpur's famous Keoladeo Ghana National Park (KGNP) near Bharatpur (Rajasthan) is a manmade wetland, the source of its water being a dam upstream. A combination of favourable factors has made it a world famous bird park, which provides birds with breeding and wintering sites. The KGNP has been in existence for over a 100 years now, when many of today's artificial wetlands were not in the picture and most of our rivers flowed naturally providing numerous habitats to a variety of fauna along their course. Dam building and natural obstruction to the courses of streams began in the second half of the last century, gathered momentum in the first half of the present century and reached devastating proportions after

independence. River courses were transformed beyond all recognition resulting in the destruction of natural habitats for numerous life forms, including many plants.

In particular, the state of Maharashtra where the author lives and works, is foremost in India in constructing manmade reservoirs with over 4,000 medium and large water bodies built all over the state. At one time the landscape of Maharashtra must have been bereft of water bodies. Migratory waterfowl like ducks and geese used to avoid this region and fly over it to land in Karnataka which was well endowed with tank irrigation. For example, Bar-headed geese (*Anser indicus*) were seldom recorded in Maharashtra before independence. Now, this rare and handsome goose is increasingly visiting our state to spend the winter on some irrigation reservoirs. In recent years their number has gone up from 80 to 500 (Yardi et al 1997). I have been observing birds on a string of manmade wetlands along the Pune-Solapur road, east of Pune city. In winter these shallow-water bodies offer a spectacle of huge assemblages consisting of a variety of species—herons, storks, spoonbills, ibises, ducks, cranes, waders and flamingos. The manmade reservoirs of Saurashtra, Rajasthan, Haryana, Punjab, MP, right down to Tamil Nadu, Karnataka and Kerala offer refuge to thousands of birds (Perennou et al 1994). Among them there are some pelicans, black-necked stork and snakebird which are on the list of globally threatened species.

It is the shallow water bodies that attract birds and numerous other life forms including a variety of plants. The deep reservoirs and deeper portions of lakes are not rich in biodiversity. This is because with increasing water depth light penetration decreases rapidly and so does mixing of oxygen. As anaerobic conditions are created, plants and animals find it difficult to get food and survive. Like deeper parts of oceans,

deep lakes tend to be biological deserts. Food chains fail to develop from simple to complex organisms. Efforts to establish a fishery in such lakes are not generally successful.

On the other hand, light penetration and supply of oxygen are both adequate in shallow lakes for the development of complex food chains. These react constantly with abiotic elements leading to changes in water chemistry and edaphic factors. Their water inputs and outputs, their water level fluctuations and their water residence time makes these water bodies biologically very active. However, these ideal conditions are fulfilled at very few manmade water bodies. The purpose of manmade reservoirs is to provide the needs of human beings for irrigation, for drinking water, etc. Their input-output regime is geared to human needs. In effect, when water storage is created by obstructing the course of a stream or river, flows and floods are stored and not allowed to perform their natural functions. Natural aquatic ecosystems through their most important characteristics of flow and flood maintain a stream-flow, attenuate floods, replenish and recycle nutrients, recharge groundwater and provide habitats to many life forms. When flows are converted to stagnation and floods are not allowed to perform their functions of cleaning and replenishing the river basins, the normal natural regime of an aquatic ecosystem changes, affecting water quality, channel geometry and riparian zone, flood plains and even deltas. This drastically transforms riparian and in-stream habitat conditions destroying their life support systems, especially vegetation and creating different temperature gradients. If such changes are drastic the aquatic ecosystem fails to support biodiversity. Manmade water bodies then do not attract waterfowl and other fauna. All over the world, therefore, efforts are afoot to bring the aquatic ecosystems back to their natural regimes and functions as far as possible (Eiseltova 1995).

All our aquatic ecosystems are now under increasing human impact. If we examine them from their region of source in the mountains to their ultimate dissipation in the sea, there is hardly any kilometre distance where some kind of human activity is not impacting them. The source region of rivers and streams, where the stream picks up nutrients and sediments, and has a high velocity and erosive force, needs to be covered with dense vegetation to gather precipitation and take it down underground and release it throughout the year through springs. This is the region where wildlife values are high and is a breeding ground for many life forms. Forest cutting, shifting cultivation, grazing have impoverished these zones, dried up perennial springs, increased run-off and have led to silting of reservoirs built near borders of hills and plains.

Some communities, however, have wisely protected this region where one can still see good biodiversity. I know a village, about 60 km west of Pune in the Western Ghats where they protect the source of stream. The sacred groves surrounding it is a wonderful gene pool albeit surrounded by a biological desert due to the cutting down of forests for shifting cultivation (Gole 1990). On the hill slope below the grove, the villagers have excavated a pool impounding the crystal clear water of the stream. This pool supplies the drinking water needs of the village year-round. No one is allowed to use this water for other purposes such as bathing, washing, irrigation, etc. The water is not stagnant. It trickles down the slope through a small outlet. The pool's surroundings are forested, providing the waters with ample supply of fallen leaves and twigs and soil nutrients. The shade of trees keeps down the water temperature. Such conditions are extremely conducive to biodiversity regeneration and the pool is home to large-sized Mahseer (Ibid.), the renowned game fish of our hills. Villagers do not allow fishing in the pools. The biological control over the fish population is exercised by a pair of Brown fishing owl (*Bubo*

zeylonensis) which lives in a large *Ficus* tree overarching the pool.

This village lies in a remote corner of the catchment area of Panshet dam, 48 km west of Pune city. The other villages, however, have not followed this wise example and have cut down the forest on hilltops for shifting cultivation, which became widespread when the dam submerged their fertile lands in the valley. Now, when some NGOs are trying to help these dam-affected people under the catchment area development schemes, they should try to emulate these wise villagers by restricting cultivation and grazing on hill tops, allowing regeneration of vegetation there which will help make the springs perennial and alleviate the acute drinking water shortage from which they suffer today. The community level protection will enhance biodiversity also.

Once the communities ensure protection to hill slopes, state irrigation departments can excavate small pools to impound streams. This cost-effective measure will go a long way in supplying drinking water to our hill residents. It will lighten the load of women who have to trudge long distances especially in summer to get drinking water.

To conserve and enhance biodiversity, it is basically important to wisely manage our streams and rivers. Manmade water bodies are an important tool in the hands of management of our rivers and streams. Wetlands, manmade and natural, should therefore become an integral part of our water management. Today, examples of biologically rich wetlands and water bodies are considered for conservation and protection in isolation, giving little importance or without recognizing the linkages they have with streams and water systems, e.g., KGNP, Harike, Logtak, Chilika, etc. These conservation efforts are not coordinated with the work of managers of our rivers, i.e., the irrigation departments of our state governments. Unless cooperation and coordination between different government

departments are achieved, it is difficult to reconcile biodiversity needs with the needs of man. Let us see how this can be brought about.

At the end of this paper a detailed table is appended which describes how wetlands and manmade water bodies are an integral part of our aquatic ecosystems, their location, their biological and other uses and what measures are required to protect and conserve them and enhance their value. This is based on the author's own experience and some work that he has been able to carry out.

We have already seen how, even near the stream's source water can be wisely harvested. As the stream goes down the slope towards the plains, it gives rise to a number of habitats including rapids, pools, crevices in rocks, boulder strewn basins and the cover of typical bank vegetation. They are a home to numerous life forms from tiny invertebrates to reptiles and mammals. They are their breeding areas also. It is, therefore, necessary that these habitats and bank vegetation be scrupulously protected. Their importance is hardly understood today. There is no government agency, which is entrusted with this task. Local communities and NGOs working for the catchment area development should recognize their importance and afford them the necessary protection. Sanctuaries and other wildlife protection areas may harbour such habitats within their boundaries. Forest and wildlife departments should also recognize their importance and manage them accordingly.

As the stream proceeds towards the plain it now increasingly meets manmade obstacles. The stream's velocity decreases and sediment deposition rates increase. Human settlements grow alongside it, collecting its water and sediment in village ponds. In many states the old traditional management of village ponds has broken down. Percolation tanks have replaced old tanks in some places. Even large tanks are built at

appropriate neck-points. They store floods and release them in dry months. They submerge the narrow alluvial flood plains of these streams and spread their tentacles far and wide, deep into adjacent valleys. The far-flung reservoirs present a magnificent spectacle during and after the monsoon period. But, in summer, with all water drained out, the valley submergence area is a biological desert with not a blade of grass seen growing anywhere. If shifting cultivation is practised in the catchment, the rate of siltation increases in the reservoir. The silt, however, quickly degenerates in the anaerobic conditions created by these deep reservoirs and becomes useless for regeneration. These reservoirs have very little biodiversity value as a result.

It is extremely difficult and expensive to restore the biodiversity of such water bodies. Yet, certain cost-effective measures can be attempted. Generally, reservoir waters extend into the side valley where mountain streams debouch into the reservoir. If a low barrage or cascade dam is built across this re-entrant, it creates a shallow water body (wetland) which remains in existence for a few months after the monsoon. In this period, it can help fish spawning and rearing which can then enter the reservoir. At these side valley wetlands these fish can get some food which the deeper portions of the reservoir cannot provide. This has happened on the Koyna reservoir in Maharashtra. On the advice of the author, the Irrigation Department of Government of Maharashtra has built a cascade dam in a side valley of Chaskaman reservoir (about 70 km north-west of Pune city) which has become a proven breeding site for indigenous stream fish.

Bank stabilization measures are also essential on these valley reservoirs. Caving-in of banks due to cutting of vegetation is ever present. Small trench and contour bunds along the submergence periphery, planting of grasses and shrubs to hold soil and above the high flood level tree planting will stabilize banks, and by shading, reduce open-water temperature and

provide a basis for biodiversity regeneration. Again such work does not form a part of the present system of reservoir management. Bank stabilization should form an essential part of management and funds should be allocated for this work. This will reduce siltation and protect the life of the water body besides helping biodiversity. The author has taken up such work on the periphery of the Panshet reservoir. In the last 12 years a mini-forest has developed there on the reservoir bank. Birds, reptiles and herbivores such as the barking deer have found a refuge there (Gole 1990).

Downstream of the dam the surroundings fall prey to a lot of blasting, digging and excavation. These 'borrow areas' include bare hill slopes, depressions and quarries. By certain simple, cost-effective measures these can be made productive and rich in biodiversity. Whenever digging and excavation take place, it is essential to separate the topsoil layer and keep it apart. This can later be used to cover heaps of rubble and other debris. Even a thin layer of soil spread over these areas is enough to produce conditions in which herbs and grasses, fungus and lichens can germinate. These start their work of decomposition and produce conditions of germination of perennial vegetation. The whole area can be greened in a short time and with a little landscaping can become a visual delight. The author has carried out such measures on the downstream of the Chaskaman dam.

A lot of water oozes out of dam walls either as a leak or through its galleries. This can be diverted to fill depressions and quarries and with inflows and outflows, a viable system of wetlands can be established. The author, with the help of Maharashtra's Irrigation Department, has carried out this experiment on the downstream of Panshet dam. A series of low bunds has created five ponds, which are fed by an outflow from the dam. The water flows into a quarry, which is connected to the river. The whole area is protected from grazing and cutting of vegetation. The wetlands system, over the last three years,

has become a breeding ground for riverine fish and is sustaining a varied habitat pattern. Together with upland vegetation, the area now has over 300 species of plants, only about 20 of them planted as saplings, the rest being natural regeneration. Terrestrial and water snakes, monitor lizards, freshwater turtles and birds such as egrets, pond herons, chestnut bitterns, spotbilled ducks, lesser whistling teals and kingfishers are present. Once a stony, barren valley bottom with its entire soil layer removed for dam building is now rich in biodiversity. The local communities are given the benefit of fishing (tribals) and grass cutting. With protection, the quality of grass has vastly improved compared to times when the area lay unprotected and grazing was unregulated.

The river, as it enters the plains, passes through human settlements from villages to large cities. Pune itself is situated on the confluence of two rivers. As the city started to grow industrially in the seventies, the rise in population and hutments started impacting the rivers. The underground drainage system began to collapse because of sheer weight of the sewage. The rivers began receiving an increasing load of sewage leading to water quality deterioration. Natural vegetation and habitats around the rivers vanished. In 1954, a botanist had collected over 400 species of plants in these river basins. In 1982-83, when I carried out a survey, their number had declined to less than 150. The proportion of plants we call weeds had increased in the total. The BOD of water was far beyond acceptable limits and oxygen content low (Gole 1984). The once thriving river fishery was no more, the aquatic life being mostly invertebrates, which could tolerate low levels of oxygen. Against this background, we prepared a plan to develop the river fronts in Pune. The plan aimed at rejuvenating river habitats along the river and yet providing and streamlining the uses that the citizens made of the rivers. In the plan, space was allocated for bank and other riparian vegetation, parks and

gardens, open space for school playgrounds and public outdoor relaxation, for an aquatic bird sanctuary as also for bathing, washing, cleaning of vehicles, religious rites, and even for vehicle parking. Care was taken to maintain a flow of fresh air from the west using the river basin as a corridor. This was to reduce atmospheric pollution and disperse vehicle emissions. The riverfronts were designed to revive nature, provide public amenities and encourage healthy recreation.

Unfortunately, such planning was unheard of in those days. Even as the Pune Municipal Corporation debates whether to commercialize river fronts by allotting space to hotels, recreation parks, aquatic sports or to treat them as public amenity by controlling pollution, the rivers and their surroundings continue to deteriorate.

Many reservoirs are built in the plains. They are generally shallow water bodies evoking many functions of wetlands. However, they also act as sinks collecting sediments and point and non-point pollution from their catchments where many human activities are carried out. For example, a lot of untreated sewage and industrial effluents from Pune city flow into the Ujni reservoir 100 kms east of Pune, on the road to Solapur. Ujni not only collects these, but also run-offs from irrigated agriculture (sugarcane and vegetables) and chemical plants located in its immediate vicinity. Vegetation and habitats along the rivers and streams meeting it are mostly destroyed. The reservoir water's BOD and MPN counts are high. The socio-economic survey of peripheral villages indicated high incidence of intestinal diseases. Even water in village wells showed faecal and chemical contamination.

In 1985-87, the Wetland Management Committee of the Government of India selected 10 wetlands from all over India for preparation of master plans for their optimum, multipurpose development. Ujni was one of them. The author

got an opportunity to develop a master plan for this reservoir. The plan aimed at reconciliation of the needs of man and wildlife through habitat development in and around the reservoir (Gole 1993). The villagers would get assured supply of fish, fuel-wood, fodder and timber, while birds and other aquatic animals would be provided habitats for breeding, foraging, roosting, etc.

The reservoir attracts large numbers of waterfowl, as it lay in their migratory flyway (western). It also sustained a fishery but it depended on release of fingerlings brought from Calcutta. The indigenous riverine fish suffered from destruction of their breeding habitats. Resident birds, which thronged the reservoir, lacked breeding sites. Also the availability of foraging habitat varied with water level which fluctuated wildly depending on the irrigation and drinking water demand. Eutrophication of the lakes encouraged proliferation of weeds like *Ipomea carnea*, *Eichhornia crassipes* and *Paspalum sp.* Our plan was based on a study of the needs of the people, of birds and other aquatic life, of water levels and water chemistry. On the basis of their findings we decided to develop a mosaic of habitats at a location on the reservoir periphery as a demonstration project.

We manually removed weeds and prepared a part of the submergence area for natural regeneration, built islands for bird-use, planting saplings on them as future nesting trees. We built small earthen barrages to make shallow ponds with undulating and rough substrate to provide suitable areas for fish spawning, wet and dry meadows, bank vegetation, riverside trees and shrubs and an energy plantation were put in place to satisfy the needs of local people. We planted improved varieties of grass, indigenous trees and even medicinal plants peculiar to the region. The aim was to put the reservoir waters to multiple uses thereby enhancing the quality of nature and human life.

Initially we had excellent local cooperation with control

over grazing and tree cutting. The results were apparent in the first year itself. With the removal of weeds excellent aquatic vegetation regenerated (*Cyperus* and *Scirpus spp.*). The fish ponds attracted so many indigenous riverine fish that villagers had a field day collecting them, when the ponds began to dry out. Islands began to be used by birds for rasting and loafing. Birds that resorted to an island to nest were protected from grazing animals and depredations by pariah dogs. With saplings showing remarkable growth, it looked like the habitat pattern we had in mind was taking shape and would develop on sound lines. However, a misworded government resolution calling for the creation of a bird sanctuary on the reservoir by restricting people's activities and land use, aroused the anger of local communities, who directed their ire on the work of the project. The agitation that followed destroyed this constructive work as local communities went against it.

This was the result of the usual government practice of refusing to take people into confidence!

In any case, we had the satisfaction of witnessing the rejuvenation of nature in and around a large manmade water body. This experience shows that though man has radically transformed the character of aquatic ecosystems in India, the scope of restoring nature is immense. This work is labour-intensive, is compatible with our cultural ethos and if properly handled, will generate a lot of employment for the skilled and unskilled, the educated and uneducated, and also for the professional and non-professional people. It will help rejuvenate natural resources, improve water quality, revive underground sources of water, supply basic necessities of life, bring down prices in the market and enhance biodiversity qualitatively and quantitatively. A national plan to revive and rebuild our streams, rivers and other aquatic ecosystems is urgently needed.

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Table 1
Wetland Information at a Glance

No.	Wetland Type	Location	Wetland Values	Wetland Uses	Measures Required
1.	Glacial lake, Tarn	Glacier	River recharge	Conservation	Protection
2.	Headwater wetlands	River source	High biological, Wildlife values	Maintenance of springs	Restoration of forest
3.	Steep gradient river course	Source region	High biological, flora and fauna	Fish spawning	Maintain flow, forest
4.	Ponds on springs	Near hill settlement	High biological, WL, drinking supply	Drinking water supply	Maintain springs and prevent bathing, washing
5.	Village pond	Below hill slope	Storage, percolation	Water supply, regeneration	Maintain catchment, banks, prevent silt
6.	Barrages/Dams in hills	Valley between 2 hills	Storage	Water supply, Hydroelectricity	As above
7.	Percolation tank	On gentle slopes	Groundwater recharge	Supply to wells	Maintain natural habitats, reduce silt
8.	Adjacent river basin	Level and below hills	GW recharge, Hyporheic zone maintenance	Fish, crabs, riverine vegetation as raw material	Maintain flow, banks and buffers and habitats
9.	Floodplain wetlands	In the floodplain	GW recharge, Flood control	Fish, raw material, tourism	Prevent silt and pollution and maintain habitats
10.	Manmade Reservoirs	In the plains	Storage, fish and wildlife value	Drinking water, Irrigation and hydroelec. and tourism	As above

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	11.	River basin between two reservoirs	Plains	GW recharge, Maintain water quality	Biodiversity, aesthetic, health requirement	Keep buffers and greenways, filters and natural habitats
	12.	Canalside seepage	Plains	Marsh values if properly managed	Fish, crabs aquatic veg.	Prevent pollution
	13.	Canal-fed reservoirs	Canal system	As in No. 10	Fish, thatch production	Prevent silt, pollution
	14.	Deltaic wetlands	River deltas	All wetland values	Water supply and flood and sea ingress control	Maintain quality of water, habitats
	15.	Lagoons	Near the seashore	As above	As above	As above
	16.	Creeks, Mangroves	Near the seashore	High biological, High productivity	Fish, marine animals, fuel wood, timber, fodder	Prevent pollution, streamline shipping
	17.	Nearshore shallow marine areas	Near the sea	As above	Fish, marine life	Maintain buffers, follow CRZ strictly.

Note: Admittedly this is not a comprehensive or complete table. It only shows how the data should be arranged to facilitate understanding of bureaucrats, politicians and indeed all those who have no idea of the wetland concept.

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Assessment of Pune's Biodiversity

The assessment may be carried out at the following sites :

Fully Protected	Partially Protected	Unprotected
CME Campers	Hill slopes near NDA	Mula - Mutha San- Chinary
NDA Campers	Law College Hill	Pashan lake
N facing slopes of Chaturshringi hills	Pachgaon - Parvati lands belonging to Yarwada jail on Airport Road etc.	Koregaon Park Boat club Road Naik's island
ARDE hills.	Empress Garden Botanical Garden Kamla Nehru Park Sinhgad ruins Stretch of Mula - Mutha sw of Aundh Agric. College Campus Khandoba hill Hill E of Bibrewadi Agakhan Palace Compound.	River downstream of Holkar bridge Pune University Campus Large ^{tree} are clusters in the city Katraj valley Bapdev Ghat Dive Ghat

Permission may have to be obtained to enter certain areas. Nearby schools & college students can be involved in collecting information. An orientation course may have to be organised to evolve & instruct about the methodology of collection. Line transects should be an ideal method to collect data. Experts & resource persons who are willing to guide & accompany the students on collection trips need to be identified.

Prakash Gore.