Biodiversity and Planning Support Programme

Zimbabwe Case Study

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1.0 STATE OF NATIONAL FOREST MANAGEMENT IN ZIMBABWE

1.1 Relative importance of forestry to Zimbabwe's economy

Zimbabwe is a developing country with a per capita income of US$718 (in 1996) based on a total Gross Domestic Product (GDP) of Z$85.5 billion (in nominal terms) and a total population of approximately 12.5 million. However, the GDP per capita has declined from US$271 in 1980 to US$201 in 1996 in real terms largely due to high inflation and the depreciation of the Zimbabwe dollar. The country's economy depends heavily on natural resources for generating employment, income and foreign exchange. The dominant sectors and their contribution to Zimbabwe's GDP in 1996 were as follows: manufacturing, 17%; agriculture, forestry and fishing, 18%; mining, 5%, and distribution, hotels and restaurants (which includes tourism), 18%.

The forestry sector contributes about 3% to the GDP largely from exotic plantations and commercial indigenous timber. However, this figure grossly misrepresents the contribution of forests and woodlands to the country's economy as most of their products and services are not captured in the national level statistics. Such a scenario partly explains why the forestry sector tends to get lower priority in terms of national resource allocation.

1. Exotic plantations

The exotic plantation forestry industry accounts for most of the 3% contributed by forestry sector to the GDP. It is highly vertically integrated into timber production, processing, packaging and marketing and employs some 16,000 people. The industry has put considerable investment into plantation development, sawmill and value addition during the last decade. The last four years have seen the emergence of small private sawmills to cater for the lower end of the market.

The wood supply and demand picture in exotic plantations is mixed (Arnold and Easton, 1993). Average annual timber consumption in the sector was 656,000m^3 between 1987 and 1990 and 541,333m^3 between 1989 and 1991. When the most optimistic wood supply scenario of low economic growth, expanded plantation areas and high yields is used, no timber deficits are projected for both pine and eucalypts up to year 2020. The most pessimistic scenario of high economic growth, no expansion of plantation areas and low growth and yield would result in serious wood supply deficits over the same period. However, the most likely scenario lies between the two extremes.

2. Indigenous forests and woodlands

Commercial timber production from indigenous forests and woodlands is based on *Pterocarpus angolensis and Baikiaea plurijuga.* Forests with these species are confined to the western part of the country and occupy only about 5% of the country's total land area. The rest of the country's forests and woodlands have little to no timber of commercial value. The total demand for indigenous roundwood timber in 1989/90 was approximately 50,000m^3, while the 1991/92 supplies of high value indigenous hardwoods from concessions in western Zimbabwe was less than

22,000m^3. This means that current demand for such timber cannot be met from the local resource alone. The situation will definitely worsen in future. This gave rise to the recent gazetting of an instrument that bans the export of indigenous timber in the "round". The instrument is also meant to promote local timber processing and employment creation.

Apart from commercial timber which is limited to one geographical area, the country's indigenous forests and woodlands generate a wide range of products which include fuelwood, small artisan crafts, fodder, fruits, honey, mushrooms, insects, bark for rope, medicines, leaf litter and gum. Services provided by these forests include watershed conservation; carbon fixation; and the provision of windbreaks, shade, soil stability and wildlife habitat. No exact economic value has been established for these goods and services but specific studies can produce some point estimates. For example, a modified contingent valuation study that estimated the mean direct and incorrect values of a range of timber and non timber products in Miombo woodlands gave an average value of Z$200/ha per year (Campbell *et al*., 1991). Based on this figure (and mindful of many caveats about extrapolating the very specific Campbell results), the total stock value of indigenous woodlands (occupying about 21 million ha of the country can be estimated at Z$4.2 billion per year. Unfortunately, such contributions do not feature in the national accounting system.

1.2 Main forest production areas

1.2.1 Overview of Zimbabwe's forest resources

Zimbabwe is characterised by savannah woodlands interspersed with open grassed drainage lines or dambos. Impeded drainage gives rise to limited areas of open grassland and a few patches of sub-tropical forests occur in the eastern districts. The country's forest resources fall into four main categories namely: woodlands, forests and trees in communal and resettlement areas; woodlands and trees in large scale commercial farming areas; woodlands and forests on state lands and in protected areas; and exotic forest plantations. These forest resources are described in this section.

1. Woodlands, forests and trees in communal and resettlement areas

Forests in communal and resettlement farming areas cover some 10 million hectares and provide rural households with supplies of construction timber and fuelwood. The quality of this woodland is very variable and largely consists of remnants of scattered trees in what has effectively become open grassland. The trees are important sources of wild fruits and other foods and thus contribute to the improvement of human nutrition in rural areas. In addition, they provide livestock fodder which is very critical during the dry season.

2. Woodlands and trees in large scale commercial farming areas

Woodlands and trees on the large scale commercial farms cover about 7 million ha. They function as an important wildlife habitat and account for a significant area of the country's commercially productive indigenous forests.

3. Woodlands and forests on State lands and in protected areas

Woodlands on State lands and in protected areas occupy about 6 million ha. The gazetted forests cover some 0.8 million ha and the national parks and other protected areas are on 5.4 million ha.

4. Exotic forest plantations

Exotic plantations cover 110,000 hectares of land. These forests are of great commercial importance and produce a range of timber-based products for the domestic and export markets. Table 1.1 gives estimates of wood stocks of indigenous forests and woodlands by land tenure category in the country. Of the total estimated stock of 636 million tonnes, 42%, 40% and 16% are found in the wildlife estates, commercial farming areas and communal areas, respectively. It must be noted that despite having the largest land area (about half of the country), communal lands have the least wood stock levels compared to the other two sectors. This can be attributed to the rampant deforestation that has taken place in the former sector.

Table 1.1 Estimates of total wood stocks of indigenous forests and woodlands (excluding exotic plantations) in Zimbabwe

Land tenure category	Land area (000 ha)	Wood stock (M tons)
Communal land	16,350	104
Resettlement areas	3,290	11
Commercial farming areas	12,600	252
Wildlife estate	5,406	269
Gazetted forest land	800	1
Total	38,446	636

1.2.2 Commercial indigenous timber resources

Commercial timber exploitation from indigenous woodlands largely comes from *B. plurijuga, P. angolensis* and *G. coleosperma.* These species grow in association on the fragile and infertile Kalahari sands of western Zimbabwe. The woodlands cover an area of 2 million ha. Of this area, 638,000 ha is in communal areas; 343,000 ha is on private lands (especially the large scale commercial farms); 568,000 ha is in National Parks and Wildlife areas (where commercial logging is prohibited); and 439,000 is on gazetted forest areas. Exploitation of timber from these indigenous woodlands began in the 1890s to supply the mines and railways. However, this operation became so extensive that regulation became necessary, leading to the birth of the Forest Act in 1949 (McGregor, 1991). Despite a lack of adequate data, it is clear that these woodlands have been over exploited and by 1977 timber demand had already exceeded supply.

1.3 National forest programme

Zimbabwe does not have a National Forest Programme (NFP). This is largely because when most African nations were developing their NFPs during the late 1980s and early 1990s, the country opted for a forestry sector review that was undertaken with financial support from the World Bank in 1991 (Bradley and McNamara, 1993). At that time it was felt that the provision of policy options and guidelines for the management of forest resources was a more urgent issue. Notwithstanding, a NFP is important for developing a national consensus on the forestry sector; for translating forest policies into implementable plans; for guiding the implementers of forest initiatives; and for mobilising domestic and external funds for sustainable forest management.

1.4 History of forest management in Zimbabwe

Formal forest management in Zimbabwe started around 1926 on the gazetted commercial indigenous forests located in the western part of the country. The major impetus for this was to ensure that these forests continued to provide timber for railway sleepers, mining and high quality flooring for which they were being logged since the turn of the twentieth century. This coincided with the period of European settlement in the country and the subsequent industrial development that followed. However, such forests cover less than 5% of the country's total land area.

Over 90% of the country's indigenous forests have little or no commercial timber but provide a wide range of timber and non timber forest products and services whose economic values are not captured in the nation's Gross Domestic Product. However, because of their limited commercial value and multi-faceted uses, no clear management strategies are in place for such forests.

1.4.1 Exotic timber plantations

The impetus for exotic plantation forestry in Zimbabwe was the need to increase the commercial timber resource base. As the demand for timber increased in the 1930s, considerable pressure was placed on the slow growing indigenous tree species resulting in the need for research on fast growing exotic tree species for plantation development. This led to the establishment, in the 1960s and 1970s, of a series of forest research stations in the eastern part of the country and the sourcing, evaluation and subsequent improvement of pine and eucalypt germplasm for production under Zimbabwean climatic and edaphic conditions. This has resulted in a vibrant exotic plantation timber industry which produces for both the domestic and export markets. Certification has been done in order to comply with the needs of the latter market.

Given the high level of management being applied to the exotic plantations, this section only focuses on indigenous forests which face serious challenges in terms of biodiversity conservation and sustainable use at the ecosystems, species and genetic levels.

1.4.2 Management of commercial indigenous timber forests

The indigenous forests of western Zimbabwe are vital for environmental protection (as they are located on very sandy soils and a low rainfall environment) and for containing exploitable commercial timber species namely, *Baikiaea plurijuga*, *Guibortia coleosperma* and *Pterocarpus angolensis*. Because of their strategic importance in terms of environmental conservation and commercial timber exploitation, 800,000 ha of these forests were gazetted in the 1970s while another 700,000 ha is being managed as communal forestland. When the former was gazetted, some of the original inhabitants were left in situ as tenants who also provided labour to the State Forest Authority.

The need to manage these forests arose from observations that they were not being sustainably logged from 1903 to 1925. The first priority measures taken after that time were to:

- Control felling and minimise wastage.
- Prevent or minimise the obvious ravages of fire which are more devastating following a timber logging concession.

No direct felling control was exercised on privately owned land but systematic pre-exploitation surveys combined with growth study derived estimates of increments enabled a minimum diameter limit to be imposed on the gazetted forests, vacant State land and communal land. The limit was 35 cm diameter at breast height. Growth studies indicated that such a diameter could be achieved in 160 years, while a 40-year cutting cycle was considered adequate for economic exploitation.

Active fire protection was confined to the gazetted and communal land forests by clearing a conventional rectangular system of major external and internal fireguards. In order to mitigate the intensity of unpreventable late fires, a system of extensive burning early in the dry season (to reduce or remove fuel loads) was introduced in 1932. By the late 1960s it had become clear that "early" burning was causing more damage to commercial timber species than it was preventing, hence it was discontinued in 1970. Emphasis was then shifted to early detection, rapid access and direct suppression. This was aided by the introduction of radio communication.

In classic forest tradition, reliance was placed on natural regeneration to replenish the stock of commercial species following exploitation.

The gazetted forest areas historically included a number of indigenous farmer families resident in the valley and vale areas. These people became forest tenants. Various efforts were made to control and rationalise their farming activities. However, such efforts were negated by political events of the late 1970s. After 1980, there was an uncontrollable influx of unauthorised occupants into some of the forest areas in numbers far greater than their carrying capacity. The impact of this on the valleys and adjacent woodlands through land clearing, hut building, illegal hunting and accidental and illegal fires has been considerable and is still to be resolved.

The mid 1960s saw the introduction of commercial wildlife exploitation within the forest areas. This has since expanded into a major source of foreign currency.

Early forestry research in Zimbabwe focused on those indigenous forests which have commercial timber species. The impetus for such research (which started evolving around the 1930s) was the need to sustainably manage and utilise the valuable tree species in particular and to conserve the fragile ecosystem in general.

1.4.3 Management of other indigenous forests of no commercial timber value

Over 90% of the country's land area is occupied by indigenous forests with no or limited commercial timber. The bulk of such forests are found in both the communally owned farmlands and on large scale commercial farms. These forests provide both timber and non timber forest products to the local inhabitants both for own use and for resale. However, because of their limited commercial timber value and the multiplicity of products and services they provide, there has not been much effort to deliberately manage them in the past.

Notwithstanding the foregoing, most cultural and ethnic values of local communities had the effect of maintaining or increasing forest biodiversity in communal areas. These were largely related to selective tree harvesting through the felling of old and dying trees. In situations where healthy trees were cut, this was done in such a way that rapid coppicing would occur. African tradition also prohibited the cutting of certain tree species such as *Parinari curatellifolia*, *Julbenardia globiflora* and *Warburgia salutaris* which were considered "sacred". Certain indigenous fruit tree species such as *Strychnos* and *Uapaca* could not be cut under any circumstances. People were also prohibited from cutting trees growing around grave yards as they were considered to be sacred groves. Unfortunately, the erosion of the powers of traditional leaders, loss of cultural values and economic hardships have led to the breakdown of some of these positive biodiversity conserving practices.

With respect to land use, local people used to practise agroforestry which involved growing annual crops in fields with "standing trees". This practice reduced the extent of deforestation associated with agriculture. However, the extension of "modern" agricultural production technologies which encourage monocropping has led to the wholesale removal of trees to give way to agriculture.

1.5 Policy framework and institutional structure for timber exploitation

The exploitation of timber from indigenous forests is carried out by private concessionaires and is regulated by the Forestry Commission under the Forest Act (for gazetted forests) and the Communal Land Forest Produce Act (for communal areas).

1.5.1 Timber harvesting in gazetted forests

The gazetted indigenous forests fall under the jurisdiction of the Forestry Commission. The Commission periodically conducts timber inventories to establish the viability or otherwise of harvesting from these forests. Once viability is established, the landowner calls for tenders (through the press) to ensure that harvesting is done in as efficient a manner as possible. Conditions pertaining to the bids, including the production of a logging plan and the prices to be paid for the timber are specified in the tender documents. After all bids are received, they are

opened in public and evaluated by the Commission's tender committee. Once a company has won a tender, it is required to carry out an environmental impact assessment and then harvest as per its logging plan. The logging operation is monitored by Forestry Commission personnel who are based on site. Revenue generated from these timber concessions is ploughed back into the management of the forests.

1.5.2 Timber harvesting in communal areas

Commercial timber that occurs in communal areas is owned by the Rural District Councils (RDCs), who are the local authority, on behalf of government. The RDCs are therefore responsible for the management and utilisation of such resources. With respect to timber harvesting, the local authority first commissions a timber inventory to establish the presence of sufficient quantities and quality of timber. Once this has been established, the landowner then approaches the Forestry Commission to verify the information. If the inventory results are positive, the RDC calls for tenders through the press and evaluates them. The Forestry Commission sits on the evaluation committee as the official advisor to the local authority. The Commission's advice centres around the areas of pricing, the credibility of tenderers and the realism of their logging plans. The winning tenderer signs a contract with the RDC to which the Forestry Commission is also a signatory. The tenderer carries out an environmental impact assessment before harvesting starts as per logging plan. The assessment report is approved by the Department of Natural Resources with technical input from the Forestry Commission. The latter is responsible for monitoring the logging operation.

The Forestry Commission gets a monthly supervision fee from the concessionaire as well as a management fee of 5% of royalties payable to the landowner. The concessionaire is normally given a quota of timber to cut per year (normally about 4,000 cubic metres). Whether or not he finishes that quota earlier, he is still liable to pay the supervision fee throughout the agreed period of the concession. The supervision fee contributes to the development of forest management plans and research work on the forest estate.

Another fee, termed a stakeholders' fee of 10% of the royalties payable to the RDC, is passed on to the local communities from which the logged timber emanates. This fee acts as an incentive to the local community to sustainably manage and utilise their forest resource. The Forestry Commission has established Resource Management Committees which co-ordinate forestry resource management at the local level. The stakeholder fee is ploughed into community projects such as schools and clinics through these committees.

2.0 OVERVIEW OF THE PRESENT STATE OF BIODIVERSITY IN ZIMBABWE

2.1 Status of forest biodiversity

This section highlights the status of forest biodiversity at the ecosystem, species and genetic levels in Zimbabwe.

2.1.1 Forest ecosystems

The dominant forest ecosystems in Zimbabwe can be loosely grouped into the Flora Zambeziaca and Afromontane phyto-regions and the exotic plantations.

1. Flora Zambeziacca phyto-region

The Flora Zambeziaca phyto-region has five woodland types namely, miombo, mopane, teak, acacia and terminalia/combretum. It has about 8,500 plant species of which 4,600 are endemic (white, 1983). Most tree species in this phyto-region are economically important and are used for timber, poles, firewood, fruit and medicines. They also have high browse value and support a rich diversity of faunal species.

2. Afromontane phyto-region

The Afromontane phyto-region is confined to the eastern highlands of Zimbabwe, mainly on the windward side of mountains along the border with Mozambique, where about 740 vascular plant species are found. The phyto-region has four distinct vegetation types. Some of its forests have remained fairly intact due to inaccessible location, legal protection (through the Forest Act and the National Parks and Wildlife Act) and the presence of botanical gardens. However, a number of the forests are being threatened by exotic plantation forest development, agricultural expansion and invasion by alien plant species such as jacaranda and wattle.

3. Exotic plantations

Zimbabwe has a well-developed plantation forest resource base covering some 155,353 ha (about 0.4% of the country's total land area). Some 71% of the planted area is under softwoods (pines), 13% under hardwoods (eucalyptus) and 16% under wattle. With respect to the plantation ownership pattern, about 42% belongs to the State, 54% to private companies and the remainder to small private growers who include co-operatives.

2.1.2 Species diversity

Species diversity in Zimbabwe is described within the context of the five woodland types of the Zambeziacca phyto-region, the four vegetation types of the Afromontane phyto-region; and the exotic plantations. These are elaborated in this section.

1. Zambeziaca phyto-region species

The five woodland types under the Zambeziaca phyto-region are: miombo, mopane, teak, acacia and terminalia/combetrum.

Miombo woodlands

The miombo woodlands are the most extensive woodland type covering most parts of the central watershed of the country. A number of sub-types are found within this woodland based on the dominant species. The most common is the *Brachystegia spiciformis* type, found in association with *Julbenardia globiflora* and *Brachystegia boehmii.* On the Kalahari sands, *B. spiciformis* is often associated with *Baikiaea plurijuga* and *Pterocarpus angolensis*. The second type is *B. boehmii* which commonly occurs on escarpments at higher altitudes. Common tree associates under warm and drier conditions include *Afzelia quanzensis, Kikia acuminata* and *Acacia spp*. This sub-type often merges with mopane woodlands at lower altitudes. The third type is *Julbenardia globiflora* which is adapted to wide altitudinal ranges. It is often found as pine stands, but also occurs in association with *Colophospermum mopane, K. acuminata* and *Sclerocarya birrea* at lower altitudes. The fourth type is *Parinari curatellifolia* occurring as pure unstratified stands on sandy soils with a high water table. It postulated that the whole central plateau of the country was once covered by *P. curatellifolia* which was invaded by *Brachystegia* spp. This woodland type is now very limited in extent and has generally been degraded to grasslands and savana as a result of clearing and burning. The fifth type is *Uapaca kirkiana* which occurs as pure stands generally situated on well-drained soils in frost-free areas.

Miombo woodlands have diverse uses ranging from watershed protection, provision of soil fertility (through leaf litter), grazing and browsing, firewood, edible fruits, mushrooms, caterpillars and timber. Thickets of miombo woodland hold little merchantable timber except for small areas in demarcated forests such as Mafungautsi Forest Reserve. Furthermore, most of the forests have been converted into intensive agricultural areas, hence it is difficult to locate pristine woodlands.

Teak or Baikiaea woodlands

The teak woodland, which is exclusive to kalahari sands, is predominantly found in the demarcated forests of western Zimbabwe and parts of Hwange National Park. *Baikiaea plurijuga* is the dominant species and is usually found in association with *Pterocarpus angolensis* and *Guibourtia coleosperma*. Other associates include *Afzelia quanzensis, Kirkia acuminata, B. spiciformis* and *J. globiflora.* The woodland has a long history of management for commercial timber exploitation, wildlife utilisation, cattle grazing and water catchment.

Mopane woodlands

Mopane woodlands are quite widespread in Zimbabwe and are often associated with low altitudes and hot areas with sodic and alluvial soils. The woodlands are often adjacent to the miombo or lowland woodlands dominated by *Combretum* or *Terminalia spp*. and are known for their low alpha diversity (fewer number of associated species). *Colosphospermum* mopane is the dominant species.

C. mopane has economic importance especially as a source of browse for both domestic and wild animals. It is also a source of timber for craftwork, small household items, fence posts, hut poles, mine props, railway sleepers, and sometimes parquet floors. It is also a very good firewood.

Acacia woodlands

Acacia woodlands occupy sizeable tracts of land in the dry areas and grow on eutrophic soils. Available woodland sub-types include: *Acacia erioloba* on kalahari sands; *A nilotica* on black clays; *A. gerradii* on basement schist in association with *A. karroo* and *A. tortilis* on the alluvial sands of the Zambezi valley, *A. albida* (syn. *Faidherbia albida*) on alluvial soils in the major river systems in the lowveld areas; and *A. nigrescens* on the Permian sands of the Save valley.

Tree species associated with Acacia woodlands are quite varied. Because of their soil enriching properties, the woodlands are often associated with a rich grass under storey. They are therefore important in pastoral systems as the trees provide browse (leaves, flowers and pods) and grasses are used for grazing.

Terminalia/Combretum woodlands

The *Terminalia/combretum* woodlands are often found as tree shrub combinations. In its natural state, *Terminalia* tends to be associated with other species but it becomes dominant when it colonises burnt sites. However, this woodland type has been severely cut and most of the existing vegetation is secondary. It also tends to be the recruitment species in areas affected by elephant damage. It provides firewood, poles for construction and tool making, and diesel brooms. *Combretum* is an important component of this woodland type and provides similar products to *Terminalia*.

2. Afromontane phyto-region

Four distinct vegetation types have been described for the Afromontane phyto-region based on the following altitude zones: high to medium (1400 m to 1800 m); medium to high (1350 m to 1650 m); medium to low (1000 m) and low (<1000 m).

The high to medium altitude zone has six sub-zones which occur in the Nyanga and Chimanimani mountains and the fringing rain forests and streams in the rain shadow areas. Because of the high altitude, there is very little activity in some of the sub-zones and the forests are still intact. Examples of key species in the sub-zones are *Syzigium masukuense, Afrocania volkensii, Widdringtonia nodiflora, Illex mitis* and *Syzigium guineense*.

The medium to high altitude forests can be considered as an eco-tonal zone consisting of a mixture of montane and medium altitude species. It has four forest sub-types. The dominant tree species include *Syzigium* spp., *Craiba brevicaudata, Albiza schimperiana* and *A. gummifera*.

Chirinda forest, a gazetted forest area near Chipinge town, is the best example for a medium to low altitude rain forest still remaining in Zimbabwe. The forest is still in the near pristine state and contains the full array of species typical of medium altitude forests. They include *Chrysophyllum gorungosanum, Craiba brevicaudata, Khaya anthotheca, Ficus chirindensis* and *Strychnos mellodora*. Limited harvesting of some of these tree species was carried out in the forest until 1956 when all timber harvesting rights were terminated. The forest, which hosts unique and rare faunal species, is now being conserved for its aesthetic value, watershed protection function and scientific, educational and historical values.

The remaining lowland rainforest is found in the Rusitu valley and covers about two square kilometres. The dominant tree species include *Maranthes goetziana*, *Newtonia buchananii* and *K. anthotheca*. Some outliers of rainforests are also found on the windward gullies on a number of mountains located on the southern side of the central watershed. These include the Nyoni Range, which contains the only population *Bivinia jalbertii* in Zimbabwe.

Exotic plantation species

The Tree Breeding Programme of the Zimbabwe Forestry Commission has been principally concerned with the introduction and development of exotic tree species for industrial and domestic use. The main genera introduced are *Pinus* and *Eucalyptus* and a number of ornamentally important species. The presence of this exotic forest biodiversity has made it possible for Zimbabwe to develop a forestry industry which contributes about 3% of the Gross Domestic Product.

Pine species

The introduction of *Pinus* species into Zimbabwe may have started around 1903 when seed requirements were met by imports from South Africa. The major commercial species is *P. patula.* It is well adopted to most afforestation areas of eastern Zimbabwe that are above 1,500 m above sea level and receive not less than 1,000 m of annual rainfall with mean annual temperatures below 18^{o} C. Species diversity is represented as sub populations. Currently there are 12 populations selected on the basis of general combining ability, suitability to high and low altitudes and the best trees in family selections. New provenances have been introduced into the country from Mexico and other Central American countries through the Central and Mexican Coniferous Resources Co-operative (CAMCORE) of which the Zimbabwe Forestry Commission was a member until 1999.

The second commercially important pine species is *P. elliottii* which has ten sub-populations (four from Zimbabwean selections, one from South Africa, one from Malawi, three from the USA and one from Queensland in Australia). This species is adapted to lower altitudes of the eastern highlands. The third species is *P. taeda* which is adapted to the better sites over a wide range of altitudes in the eastern highlands. The breeding status of the species consists of two Zimbabwean selections, two from the USA and one from Malawi. The fourth species is *P. kesiya* which has shown potential on marginal sites. It is represented by seven populations from Zimbabwe, Zambia, Madagascar, Thailand, China, Vietnam and the Philippines.

Two promising pine species have been introduced and these are *P. tecunumanii* (with four populations from Guatemala, Honduras, Nicaragua and South Africa) and *P. maximinoii*.
Other important pine species introduced into Zimbabwe are *P. caribaea*, *P. chiapensis*, *P. pseudostrobus* and *P. greggii*.

Eucalyptus species

Eucalypts were introduced into the country to meet the demand for hardwood timber, poles and firewood. The major species are *E. grandis*, *E. camaldulensis* and *E. tereticornis*. *E. grandis*, which originally came from eastern Australia, has proved to be a versatile species in eastern Zimbabwe and the highveld. *E. camaldulensis* is regarded as the most reliable species for the drier parts of the country. The diversity of this species in the country is very broad and includes materials from Australia and Zimbabwean landraces (selections from commercial stands). *E. tereticornis* is also well represented in the country with populations from Australia.

Australian acacias

Other than eucalypts and pines, Australian acacias form an important component of exotic introductions into Zimbabwe. *Acacia mearnsii* is an important commercial tree species for the production of tannin and charcoal. Other Australian acacia species being evaluated in the country are *A. holosericia*, *A. auriculiformis*, *A. cowleana* and *A. tumida*.

Other exotic species

A whole range of other exotic tree species have been introduced into the country for various uses ranging from ornamental to medicinal, and have changed the tree landscape of the country as most of the original vegetation in urban centres has been removed and replaced by exotic species. For example, *Jacaranda mimosifolia*, from Brazil, now dominates the streets of Harare, Zimbabwe's capital city.

2.1.3 Genetic diversity

Genetic diversity or variation at the gene level has not been extensively studied for most indigenous tree species in Zimbabwe. However, emphasis is now being placed on determining the geographical and morphological variation of key commercial species for improvement purposes in the case of indigenous fruit trees such as *Uapaca kirkiana* and *Sclerocarya birrea* and for genetic conservation in the case of timber species such as *Pterocarpus angolensis* and *Colophospermum mopane*.

1. Genetic diversity in indigenous fruit trees

The miombo woodlands have the greatest diversity in terms of indigenous fruit trees. The gathering and consumption of fruits from wild tree species has always been part of Zimbabwe's rural culture. The fruits are important sources of food in fresh and processed forms and are a ready source of cash when sold on the road side or in urban markets. There is also considerable potential of adding value to such fruits through

further processing. However, there is need to increase the productivity of the trees both *in situ* and *ex situ* if this potential is to be realised.

In order to enhance fruit production, there is need to sample the genetic diversity of the desired species throughout its distribution range. This is of practical importance and economic significance because it provides a way of identifying the most productive seed sources, populations or varieties. The procedure involves collecting seed samples from all the possible stands and determining their genetic variation. In the case of indigenous fruit trees in Zimbabwe, this has been done using simple comparative morphological studies of fruit and seedling characteristics (Table 2.1). According to this table, the Murewa provenance had the biggest and sweetest fruit and a high pulp to rind weight ratio. In general, fruits from the eastern highlands were smaller compared to those from highveld areas. This variation in fruit characteristics could be attributed to the wide geographic distribution of the species and presents an opportunity for productivity improvement through selection and genetic manipulation. However, complex isozyme analyses are required to confirm this variation in fruit characteristics at the gene level.

2. Genetic diversity in commercial indigenous timber species

The teak woodlands found on the Kalahari sand formations of western Zimbabwe have a number of commercially important timber species such as *Baikiaea plurijunga, Pterocarpus angolensis* and *Guibourtia coleosperma*. Since specimens of good form are targeted during commercial harvesting leaving poor trees, logging leads to general genetic impoverishment due to the removal of the best phenotypes. As a way of protecting the gene pool, a number of Strict Natural Reserves (SNRs) were established in areas where commercial logging takes place in the gazetted forest areas only. These SNRs are like "witness" stands, although the genetic variation of the species is unknown. There is, therefore a need to determine the genetic variation of the targeted species if their *in-situ* conservation is to be strengthened. The level of genetic variation will then determine the number and size of the SNRs. For example, if a species shows narrow genetic variation, then only a smaller population will have to be conserved *in-situ*, and if the variation is big, then a large number of SNRs will be required.

Work on the genetic variation in commercial indigenous tree species in Zimbabwe has been focused on *P. ngolensis* and *C. mopane*. Information on variation is being collected from laboratory and glasshouse experiments where seedling traits are being measured. Initial results indicated that seeds of provenances from northwestern Zimbabwe (Fuller, Mzola and Gokwe forests) have bigger seeds than those from other parts of the country (Table 2.2). However, germination rates were consistently high across all provenances. This work will be extended to other commercial indigenous timber tree species and will be complimented by isozyme studies in order to confirm the observed variation at the gene level.

3. Genetic diversity in exotic timber species

The genetic diversity of exotic timber species in Zimbabwe has been extensively studied by the research wing of the Zimbabwe Forestry Commission. Exotic species of *Pinus, Eucalyptus* and *Acacia* were and are still being systematically introduced for

evaluation for growth potential and use for timber production. The original introductions of most exotic species came as bulk seed for plantation establishment. Plus trees were then selected in the commercial stands. These trees form the progenitors of the sub-populations now available in the country's tree improvement programme. In the case of pines and eucalypts, sub-populations are created on the basis of adaptability to specific sites, resistance to drought and pests and their end use (e.g. timber, pulp, poles and firewood). Some sub-populations were created for breeding purposes such as mating experiments; for flowering studies; and for maintaining resource banks.

Table 2.1 Some of the characteristics assessed in the provenances of *Uapaca Kirkiana* fruit

Provenance	Colour	Taste	Diameter (cm)	No. of seeds/fruit	Pulp to rind weight ratio
Nyamukwarara	1.99	2.20	3.19	3.96	2.4 : 1
Murewa	1.00	2.96	3.58	3.88	3.4 : 1
Domboshava	1.80	2.44	3.03	3.96	2.3 : 1
Musana	1.93	2.30	3.31	3.83	2.6 : 1
Mapanzure	2.00	2.76	3.29	3.76	3.2 : 1
Chartsworth	2.00	2.76	3.07	3.88	2.1 : 1
Ndanga	1.78	2.64	3.17	3.86	2.4 : 1
Wedza	2.00	2.60	2.73	4.04	2.6 : 1
Mandeya	1.60	2.76	3.31	4.00	2.2 : 1
Mutarazi	1.80	2.56	3.04	4.12	2.3 : 1
Zimunya	1.80	1.96	2.82	4.34	1.8 : 1

Source: Forestry Commission, 1996

Table 2.2 Seed weight and germination characteristics of provenances of *P. angolensis*

Provenance	1000 seed weight (g)	Germination (%)
Gokwe	191.6	88
Chimanimani	168.7	93
Chinyika (Rusape)	157.7	87
Mtao Forest Reserve	153.5	87
Matopos	154.5	95
Nyamandlovu	159.5	86
Mzola Forest Reserve	230.9	92
Ngamo Forest Reserve	194.6	99
Fuller Forest Reserve	340.7	94
Gwampa Forest Reserve	171.4	86

Source: Forestry Commission, 1996

2.2 The status of biodiversity mapping within forest ecosystems

Although a number of projects incorporating woody vegetation inventories have been carried out by a number of institutions in Zimbabwe, there have been no biodiversity specific monitoring programmes in the forestry sector. However, such studies are necessary for the design of effective utilisation programmes.

This section highlights some of the on-going projects being carried out by a number of institutions on vegetation inventories in Zimbabwe.

1. The Department of Natural Resources

The Department of Natural Resources which falls under the Ministry of Environment and Tourism has been running an Integrated Resource Information System (IRIS) programme since 1992. IRIS is an information management tool used to describe and access Zimbabwe's natural resources using remote sensing, geographical information system and global positioning systems to collect, analyse, manage, store, model and display data. Inventories which include vegetation at a scale of 1:50,000 have been done in Mashonaland East province using 1992 as a base year. These inventories are based on a floristic framework in which vegetation is divided into 37 vegetation types as depicted in Appendix 2.1. This programme will be implemented nationally once the current pilot project is concluded. Plans are also underway to set up a national ecological land classification to provide a geographic context for monitoring and assessing environmental conditions and for managing natural resources.

2. The Forestry Commission

The Forestry Commission is a parastatal organisation under the Ministry of Environment and Tourism. To help monitor changes in commercial indigenous timber species found on demarcated forestland, the organisation put in place Strict Natural Reserves (SNRs). The concept of SNRs has been elaborated in Section 2.1.3. Eleven SNRs were established between 1992 and 1995 and the species being conserved are *P. angolensis, B. plurijinga, G. coleospermum, C. mopane* and *E. caudatum*. Growth dynamics and genetic variation studies are being carried out in the SNRs.

The Forestry Commission has also been implementing a Vegetation Resources Information System (VegRIS) project since 1993. The project, which utilises remote sensing and geographic information systems technology, has produced national woody cover maps at 1: 250,000 and 1:100,000. Work on developing methodologies for monitoring vegetation changes and woody biomass estimation activities are currently under way.

The organisation recently completed a land cover survey of Zimbabwe based on a visual interpretation of Landsat V satellite imagery for 1992 and identified ten main land cover classes. These are the natural moist forest, plantations of exotic trees (mainly pines, wattle and eucalypts), woodland, bushland, wooded grasslands, grassland, cultivated land, settlement, rock outcrops and water bodies (Table 2.3). According to this table, about 66% of the country's land area is under various forest types compared to 27% which is under cultivation. The heaviest concentrations of

forests occur in the gazetted state forest areas, national parks areas, the eastern highlands and the large scale commercial farms (where individuals hold title to their land). On the other hand, the woody vegetation cover in most communal areas (where inhabitants have no title to land) is low and variable with heavily populated districts having less than 30% cover. Exotic plantations occupy about 156,000 ha of land of which over 90% is in the eastern districts. Also found in the latter areas are the unique tropical rain forests that occupy some 11,500 ha.

Millington and Townsend (1989) suggest the following average biomass densities for the three biomass classes used by the Forestry Commission (1996) in its assessment of land cover in Zimbabwe: woodland – 49.89 t/ha; bushland – 23.36 t/ha; and wooded grassland – 11.42 t/ha. These values are within the general range of 21.2-39.7 t/ha of wood biomass reported for miombo in Zimbabwe by Frost (1996).

Table 2.3 Areas under various land use systems in Zimbabwe

Land use	Area (000 ha)	% of total
Natural forests[1]	11.5	0.03
Exotic plantations	155.8	0.40
Indigenous woodlands	25,771.4	65.92
Grasslands	1,893.9	4.85
Cultivated land	10,738.1	27.47
Settlements	139.1	0.36
Other[2]	379.4	0.97
Total	39,089.2	100.00

[1] *Tropical rain forest*
[2] *Rock outcrops and water bodies*
Source: Forestry Commission, 1996

3. The Department of National Parks and Wildlife Management

The Department of National Parks and Wildlife Management (which falls under the Ministry of Environment and Tourism) conducts periodic surveys to monitor vegetation changes in the National Parks. Some of the work recently completed includes the following:

- An ecology map of the mid Zambezi Valley at 1:250,000 showing nine vegetation units/types; and
- A vegetation survey map of Chirisa Safari area at 1:80,000 showing and describing three vegetation types/map units.

4. National Herbarium and Botanical Garden

The national Herbarium and Botanical Garden (which falls under the Ministry of Lands, Agriculture and Resettlement) has carried out a number of vegetation inventories which include:

- A vegetation survey covering communal areas of the Zambezi and part of the Mazoe drainage basins. As described for the IRIS project under the Department of Natural Resources, the vegetation was divided into eight physiognomic floristic classes and 37 vegetation types. Mapping was done at 1:250,000 and 1: 500,000; and,

- A botanical survey of the rain forest of the eastern highlands was produced at 1: 250,000. Twelve vegetation types including their environmental interactions were described.

The Timber Producers Federation

The Timber Producers Federation (an association of exotic plantation growers and sawmillers in the country) has developed and adopted self regulatory environmental management guidelines. These guidelines commit members to sustainable forest management and requires, among other things, that forest estates enhance, protect and manage all natural historic and cultural assets found within plantation forest areas. Using these guidelines, the Federation, in addition to regular in-house audits by members, facilitates annual environmental audits on the estates' environmental activities. Results of such audits are used to improve on the overall management of plantation forestry resources in the country.

2.3 Rate of change of forest biodiversity components

No detailed technical work has been undertaken on the rate of change of forest biodiversity at the ecosystem, species and gene levels. However, limited data exists on the nature and extent of deforestation in the country. Such information can be used as a proxy for forest biodiversity loss at the various levels and is presented in this section.

Conventional wisdom, supported by photographic and oral evidence, is that deforestation has been widespread in the country. The only national survey on deforestation that involved a comparative analysis of woodland cover visible on 1: 25 000 scale aerial photographs taken in the early 1960s and early 1970 showed that many areas of the country experienced a more than 3% decrease in woodland canopy cover annually over the ten year period. However, the rate of wood cover change varied with woodland type. For example, the closed and open woodlands decreased by 4% and 16% respectively while woodlands with sparse cover increased by 12%. The aerial extent of woody cover measured by the Forestry Commission (1996) from satellite imagery taken in 1992, and that identified by Millington and Townsend (1989) in their survey of woody biomass using satellite imagery taken in 1985 show similar trends to those reported by Whitlow (Table 2.4). According to this table, Zimbabwe's woodlands were being depleted at an average rate of 3.3% per year between 1985 and 1992.

Table 2.4 Changes in woody cover in Zimbabwe: 1985 and 1992

Woody cover class	Area covered in 1992 (000 ha)	Area covered in 1985 (000 ha)	% change per year
Natural forest & woodland	20 809	25 612	-2.7
Bushland	4 974	9 166	-6.5
Wooded grassland	1 205	665	+11.6
Plantation	156	No data	-
Total	27 144	35 443	-3.3

Source: Forestry Commission (1996) and Millington *et al* (1989)

Although no specific studies have been done to establish the cause and effect relationships in forest biodiversity losses, the general causes of deforestation in the country have been used as proxies. Some of these include agricultural expansion, use of trees as an energy source, infrastructural developments, fire damage, habitat loss to alien species, selective logging and extraction, and elephant damage. They are elaborated in this section.

1. Agricultural expansion

The opening up of forestland for agricultural expansion is the major reason for the loss of the country's forest biodiversity as an estimated 70,000 ha of forestland is lost to agriculture each year. It is now difficult to find pristine miombo woodlands on the central watershed of the country as most have disappeared to give way to cropping and grazing land. This situation is more serious in the communal farming areas where 66% of the country's population lives.

2. Use of trees as an energy source

Natural forests and woodlands are the major source of fuelwood for rural and low income urban households who are unable to access the other sources of energy (e.g. electricity and kerosene) due to their high cost and limited availability. It is estimated that one rural household requires about 6 tons of fuelwood per year.

3. Infrastructural developments

As is the case in other developing countries, Zimbabwe continues to prioritise infrastructure development for economic growth than biodiversity conservation *per se*. Consequently, the rapid population growth and the related urbanisation is exerting pressure on habitats and ecosystems surrounding cities, towns and rural service centres through the provision of infrastructural services such as houses, factories and roads. This is confounded by the drive to attract foreign investment with tourism, agriculture and mining being the most lucrative sectors. Such investments result in infrastructural developments that can crowd out various biological species from their habitats. For example, unless developments in the Victoria Falls area are controlled, they could destroy the ecosystem on which the very existence of the tourism industry depends.

4. Fire damage

The inappropriate use of fire as a forest management tool has caused biodiversity losses in the different farm types and state forests. For example, a study on the effect of fires in the Gwaai Forest Reserve showed that fires have a depressive effect on teak woodlands as they shift species' composition from *Baikiaea* and *Guibourtia* towards non commercial timber species; and from single to multi-stemmed root stocks (Calvert and Timberlake, 1992).

5. Habitat loss to alien species

Exotic species introduced for commercial or ornamental purposes have escaped from target areas and replaced the original tree biodiversity. Specific examples include

Acacia mearnii in the eastern highlands, *Pinus patula* in the Nyanga National Park and *Psidium cattlensis* in Chirinda forest. Some indigenous species such as *A. nilotica* and *Dichostrychus cinerea* are reported to have invaded some degraded sites and pasture lands swamping the natural vegetation.

6. Selective logging and extraction

Commercial timber species found in the teak forests are selectively cut on the basis of diameter (minimum 30 cm) and stem form. This tends to "cream off" the best phenotypes leaving poorly formed trees. If the good phenotypic traits are under genetic control, this leads to gradual genetic impoverishment as superior trees are removed. In addition, selective logging affects species recruitment and dominance. For example, *Baikiaea plurijuga* tends to become the dominant species after logging in teak forests. In other woodland types, selective logging for wood carving leads to a decline in the preferred species such as *Dalbergia melanoxylon* in miombo woodlands.

The selective extraction of trees for various uses by local communities also leads to over exploitation. For example, *Warburgia salutaris*, which is well known for its medicinal properties in the Chipinge area is almost extinct as a result of over harvesting. *Bivinia jalbertii*, a species which yields a pole that can last for many years, and is endemic to the Nyoni Hills near Ngundu in Masvingo Province is also under threat. In addition, harvesting of fruit trees such as *Uapaca kirkiana* for urban markets leads to the removal of potential propagules (seeds) from their natural habitat, thus breaking the regeneration cycle which can lead to some biodiversity loss.

7. Elephant damage

The impact of elephant browsing on forest biodiversity is a function of their population density. In general terms, forest biodiversity is reduced where elephant density is high; not affected at low densities; and increased at intermediate densities. It has been reported that high elephant densities lead to shifts in plant species composition in the teak and mopane woodlands. For example, elephant damage can cause suppression of tree growth resulting in shrub and grass savana in mopane woodlands (Anderson and Walker, 1974). In the Hwange National Park and Mana Pools area, elephant damage is so high that *Terminalia* has become a dominant species in a teak forest.

3.0 STATUS OF FOREST BIODIVERSITY CONSERVATION AND PLANNING

3.1 Importance of biodiversity conservation in the country

Zimbabwe is a signatory to several important international and national policy frameworks for sustainable natural resource use, the majority of which emerged from the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992. These include the Convention on Biological Diversity, the Convention on Climate Change, the Convention to Combat Desertification, the

Montreal Protocol and the Convention on International Trade in Endangered Species of wild fauna and flora (CITES).

In 1987 the country prepared a National Conservation Strategy based on the World Conservation Strategy. The objective of this strategy was to ensure that natural resources are utilised on a sustained yield basis. Unfortunately, the strategy failed to be an official document as it was not presented to Parliament; was not integrated into the First Five Year National Development Plan of Zimbabwe (1986-1990); and did not identify accountable agencies and their respective responsibilities. Consequently, the strategy became a reference document instead of a guidebook for sustainable development in Zimbabwe.

Notwithstanding, the foregoing, significant progress has been made in the area of environmental policy and planning since 1987. In late 1992, the Ministry of Environment and Tourism held a national conference to merge national and global (post -Rio) environmental and development priorities. The conference report contained a matrix of issues, objectives and responsible agencies, which upon reflection indicates that many of the objectives have been addressed. For example, the Ministry of Environment and Tourism has developed a national Environment Impact Assessment Policy. The Ministry is also leading a law reform process to deal with the problems associated with the administration of at least 18 pieces of legislation on the environment which are housed in nine different ministries and departments. Furthermore, the country has adopted the District Environmental Action Plan in order to integrate environmental conservation issues in the development planning process at the local level.

The foregoing initiatives highlight the importance that government places on sustainable natural resource use (including forest biodiversity) in the country. This is because the Zimbabwean economy heavily depends on natural resources (i.e. forests, wildlife and agriculture) for generating employment, income and foreign exchange. With respect to forests, they provide and shape habitats for the various forms of life. However, agriculture and other economic activities are gradually replacing pristine forests with other forms of biodiversity.

With respect to institutional arrangements, forest biodiversity, like all other environment oriented initiatives, falls under the Ministry of Environment and Tourism. However, given the intersectoral nature of biodiversity, an intersectoral committee has been put in place to co-ordinate biodiversity related initiatives. This committee is chaired by the Ministry of Environment and Tourism and consists of representatives from government and non governmental organisations involved in various aspects of biodiversity conservation and sustainable use.

3.2 Zimbabwe and the Convention of Biological Diversity

3.2.1 Zimbabwe's participation

Zimbabwe is one of the over 172 countries that have signed and ratified the Convention on Biological Diversity (CBD). The thrust of this Convention is biodiversity conservation, its sustainable use and the equitable sharing of the resultant benefits. The country's accession to the CBD is in recognition of the importance of

natural resources to the national economy and the fact that about 70% of its 12.5 million people still depend on these resources for survival. It was against this background that Zimbabwe found it necessary to sign and ratify the CBD. This enables the country to access financial resources from the Global Environment Facility (GEF) for the conservation and sustainable use of biodiversity components that have global significance. Furthermore, the country has a long established commitment to biodiversity conservation and sustainable use as shown by the following examples:

- About 15% of the country is under reserved forests and national parks. These offer good examples of the *in-situ* conservation of key vegetation and animal types in the country.
- The Parks and Wildlife Act gives privileges to owners of private land and Rural District Councils in communal areas to utilise and exploit animals on their land. Such an arrangement has given these communities incentives to sustainably manage wildlife resources through the formation of conservancies/game ranches on private land and participation in the internationally acclaimed Communal Area Management Programme for Indigenous Resources (CAMPFIRE) programme in communal areas. This has led to an increase in wildlife species diversity and an improvement in the ecosystems of the affected areas. However, the CAMPFIRE approach has yet to be extended to the full range of wildlife species and to other natural resources such as forests and aquatic life.

3.2.2 The National Biodiversity Strategy and Action Plan process and follow up steps

Zimbabwe, through its Ministry of Environment and Tourism obtained funds from GEF to prepare its National Biodiversity Strategy and Action Plan (NBSAP). The NBSAP preparation process placed emphasis on stakeholder consultation at various levels. Such consultations were carried out during national and provincial workshops where relevant information was obtained; and the emerging unmet needs, strategies and action plans reviewed, prioritised and improved upon based on local level realities. About 400 people including environmentalists, academics, administrators, politicians, traditional leaders, church leaders, business leaders and journalists participated in the exercise. International experts with global expertise in biodiversity planning, GEF linkages and the preparation of NBSAPs were brought in to provide technical backstopping at the launch of the project and during the final national workshop. In order to raise awareness on the NBSAP preparation process, a communication strategy was designed and implemented. Among the activities carried out under the strategy were: a quarterly newsletter highlighting progress on the NBSAP preparation process; a media workshop attended by 20 representatives of the print and electronic media; and a parliamentarian's workshop attended by 25 legislatures.

Based on consultations elaborated above, a number of unmet needs in the conservation and sustainable use of Zimbabwe's biodiversity (which included forestry, wildlife, aquatic life and agriculture) were identified and prioritised as follows:

a) The absence of comprehensive and elaborate biodiversity inventory and monitoring programmes.

b) Inadequate incentives for some local communities and individuals to undertake biodiversity conservation and sustainable use initiatives in both protected and unprotected areas.
c) Inadequate environment awareness, education and training at various stakeholder levels.
d) Limited appreciation of the importance and contribution of biodiversity to the national economy and to local communities by policy makers.
e) Inadequate, conflicting and poorly enforced pieces of legislation that tend to adversely affect biodiversity conservation and sustainable use.
f) A limited financial base and institutional capacity to facilitate the monitoring of biodiversity projects at the local level.
g) Inadequate affordable alternatives to reduce the reliance on natural resources.
h) Inappropriate research and extension approaches in biodiversity conservation and sustainable use.

Specific strategies and plans were then formulated to address the foregoing unmet needs (the NBSAP). It must be pointed out that the NBSAP provides a framework rather than a detailed map of immediate action. Such an approach gives flexibility to various national institutions in proposing their role and participation in the implementation of the action plan.

It can be noted that most of the identified unmet needs and the resultant action plans from the NBSAP process are not new. However, what is new is the impetus which the process brought to bear on all key stakeholders and the realisation of the need for a coordinated approach given that most of the issues cut across sectors. As a direct spin off from the process, a number of project proposals addressing specific unmet needs have been developed under the overall coordination of the Ministry of Environment and Tourism. One such project is on the "Conservation and sustainable use of traditional medicinal plants in Zimbabwe" whose funding was approved by GEF in December 2000. A number of NGOs are also independently developing project proposals that relate to specific issues in the NBSAP.

3.3 Status of forest biodiversity conservation and enhancement

Forest biodiversity conservation in Zimbabwe is done both in-situ and ex-situ. In-situ conservation occurs in the gazetted areas, national parks and other protected areas while ex-situ conservation is achieved through seed banks, resource conservation stands and botanical gardens. About 15% of the country's land area was set aside for the in-situ and ex-situ conservation of forest biodiversity including wildlife. Efforts are also under way to enhance forest biodiversity in areas where widespread deforestation has take place through afforestation programmes.

3.3.1 In-situ conservation

1. Gazetted forest areas

The Forest Act of 1947 gazetted the establishment of forest areas for the sustainable exploitation of commercial timber; to act as reservoirs of wildlife and water catchment areas; and for the conservation of biological diversity. The gazetted indigenous forest areas total about 880 000 ha (about 2% of the country's total land

area) and are located on Kalahari sands in the western part of the country. Major commercial timber species found in these forests include *B. plurijuga*, *P. angolensis*, *G. coleosperma* and *Afzelia quanzensis*. Timber harvesting, repeated forest fires, intensive grazing and deforestation for agriculture and settlement purposes are unfortunately converting parts of these forests into low shrubs and grasslands.

During commercial timber harvesting, there is a tendency to leave trees of inferior quality by targeting those of bigger diameters, good stem form and with at least 3 metres of utilisable timber. This leads to general genetic impoverishment due to the removal of the best phenotypes. As a way of reducing genetic erosion, Strict Natural Reserves have been established in some gazetted forest areas. These are like "witness stands" and are not "touched" during a timber harvesting concession.

2. National parks and other protected areas

A network of national parks, safari areas, sanctuaries, botanical reserves and protected areas gazetted under the National Parks and Wildlife Act and the Natural Resources Act, forms a strong basis for the conservation of flora and fauna in Zimbabwe. Such areas cover about 13% of the country's land area.

National Parks offer the best example of *in situ* conservation of some vegetation types in the country. Although large national park areas such as Hwange and Gonarezhou are located in the dry parts of the country, the available vegetation protects the soil and provides browse and fodder to wildlife. In fact, in areas such as Hwange, the forests are under pressure from browsing by elephants and the vegetation is now changing from forest to shrubland. A number of botanical reserves were also set up to conserve unusual areas of special interest.

3.3.2 Ex-situ conservation

1. Tree seed banks

The establishment of Tree Seed Banks involves the collection of genetic resources in the field and their subsequent storage. Scientific principles are applied during seed collection expeditions to ensure that a population is adequately sampled and conserved. Such seed banks also provide operational planting material. The Seed Centre of the Zimbabwe Forestry Commission currently holds over 23,000 accessions mainly consisting of seeds of species collected from natural stands, research trials and other seed centres worldwide. The material is kept in cold rooms to ensure long term seed viability. Information kept on the seed lots includes: species name; date of collection; and origin details such as location, latitude, soil type and climatic information. Growth performance data is also gathered and stored.

2. Resource conservation stands

Resource conservation stands are established for tree species that are threatened by over exploitation and whose population structure is heavily fragmented. Such species include *Chlorophora excelsa* which has a few trees left in Gonarezhou National Park, *Bivinia jalbertii with a relic population left in the Ngundu Hills and Warburgia salutaris* in the Chipinge area. However, for species that do not survive if planted

outside their natural range, enrichment planting is being encouraged. In some cases such sites are gazetted as special conservation areas to ensure the continuation of the species. As a result of this, some 27 sites have been gazetted under the Natural Resources Act as special areas of endemism or representatives of certain vegetation/species types on privately owned land.

3. *Botanical gardens*

A 68 ha Botanical Garden was established in Harare in 1962 with the objective of building a comprehensive collection of plants found in Zimbabwe and the Southern African region. To date, 1,060 plants representing 82% of the 1,230 woody plants found in Zimbabwe have been established in the garden. Dome collections contribute towards conservation through authentic plant identification; and education and awareness campaigns. However, because of space constraints, botanical gardens do not contribute much to the physical conservation of forest genetic resources because only one or two plants can be grown to represent a species.

3.3.3 Forest biodiversity enhancement

Deforestation is a major cause of forest biodiversity loss in communal and resettlement areas largely due to lack of individual tenure on the land. It is against this background that the Zimbabwe Forestry Commission, in collaboration with various donors, government departments and NGOs has been spearheading the rural afforestation programme since 1983.

The first phase of the rural afforestation programme (RAP I) ran from 1983 – 1989 and was based on a perceived fuelwood crisis in the communal areas. It was targeted at afforesting these areas using fast growing exotic eucalypts in order to relieve pressure on indigenous woodlands through the establishment of individual and communal woodlots by communities. The programme which was supported by 73 central nurseries sae an increase in eucalypt seedling production and planting from 0.2 million in 1982/83 to 4.2 million in 1989/90. However, post establishment survival of the seedlings was low due to livestock and termite damage; water stress; and poor post establishment management and protection. The second phase of the rural afforestation programme (RAO II) ran from 1990-1998. This phase broadened its content from eucalypt woodlots alone to include agroforestry and indigenous woodland management with emphasis on poverty alleviation and food security. The programme thrust also moved from "centralised nurseries to individual nurseries with the Forestry Commission providing training in nursery management to interested communities. RAP II saw the diversification of nursery product mix from 100% eucalypts to about 85% with the remainder consisting of exotic fruit tree ad indigenous tree species. Seedling production increased to 9 million in 1998 with a post establishment survival of 67%. Some 1470 agroforestry sites were established during the period. With respect to woodland management, 803 sites measuring a total of 64 000 ha were set aside for deliberate management through local level Resource Management Committees.

Since 1999, the rural afforestation programme is being implemented within the context of an Agricultural Services Support Programme (ASSP). The ASSP

recognises the link between forestry and agriculture in communal area land use systems and rural livelihoods. The specific objectives of the programme are to:

- Increase the quantity and quality of tree and forest resources through tree planting and woodland management.
- Increase rural incomes from timber and non timber forest products through the promotion of forest based enterprises such as beekeeping, craft production and the processing of indigenous fruits.
- Build local level capacity for the sustainable management and utilisation of tree and forest resources through the establishment and training of Resource User Groups in leadership, by-law formulation and in technical aspects of forestry management.

Since the launch of the ASSP in 1999, some 12 million seedlings are being produced annually; 501 woodland management sites have been identified and deliberately managed; and 1134 agroforestry sites have been established. All these activities are contributing towards the enhancement of forest biodiversity in the country.

3.3.4 Costs and incentives for forest biodiversity conservation and enhancement

1. Cost of biodiversity conservation

The cost of current biodiversity conservation and enhancement measures are important for determining future strategic directions on the subject. In a limited sense, current expenditures are a measure of the value placed on biodiversity conservation by decision makers. However, such expenditures are limited by the available financial resources. Consequently, current expenditures alone can significantly under estimate the value of biodiversity conservation to a country. Notwithstanding, current expenditures can be useful for determining costs and resource requirements of future strategies and actions to improve biodiversity conservation. Where resources are limited, trade-offs can be better appraised between biodiversity conservation and other options for public expenditures.

Long term biodiversity conservation and enhancement in Zimbabwe is undertaken by government through its technical departments. Table 1.2 shows that the government's budget allocation to key departments involved in some aspects of forest biodiversity conservation and management increased from Z$171 million in 1987/88 to Z$801 million in 1997/98. This represents a 36% budget increase over the eleven-year period in nominal terms. However, when inflation is accounted for, it becomes apparent that government expenditure levels on biodiversity conservation fell by 49% from Z$276 million in 1996/97. Given the thrust of the national economic reform programme (i.e. reduction in public expenditure this trend is likely to continue into the future. This will effectively reduce the state machinery's capacity to implement forest biodiversity conservation and enhancement programmes.

Apart from central government, a number of local and international non-governmental organisations (NGOs) and private landowners are actively involved in financing biodiversity conservation and enhancement in Zimbabwe. However, no comprehensive data exists on their expenditure levels. In addition, it is generally difficult to identify the budget line items that go directly into biodiversity

conservation. Notwithstanding, NGOs, the private sector and local communities are expected to play an increasing role in this area in future.

2. Economic incentives for forest biodiversity conservation and enhancement

Given the declining government budget allocations to biodiversity conservation and enhancement, the need to consider various economic incentives cannot be over emphasised. Direct incentives include cash incentives such as fines to deter timber poaching or improper harvesting methods; compensation for damage to communally owned forests from wildlife or development projects; compensation to people living adjacent to gazetted forest areas who are excluded from utilising the forests; and subsidies that shift rural people from woodfuel to alternative fuel sources such as solar energy for cooking purposes; and the promotion of community programmes that are tied to improved conservation practices.

With respect to communal forests, the Communal Lands Forest Produce Act allows communal area inhabitants to exploit timber for personal use within certain limits free of charge, while licences are issued for commercial exploitation of the forest resource. Where forest damage occurs, costs of ameliorating the damage may be imposed by the State. For example, the maximum fine for improper conservation under the Natural Resources Act is Z$1,000.00. However, such provisions are fairly broad and do not appear to deter poor conservation practices nor encourage sound natural resource management in communal areas.

Table 3.1 Zimbabwe government's expenditure on issues related to forest biodiversity conservation: 1987/88 – 1997/98

Gvt Dpt	Budget allocation (Z$ million)										
	87/88	**88/89**	**89/90**	**90/91**	**91/92**	**92/93**	**93/94**	**94/95**	**95/96**	**96/97**	**97/98**
Forestry Com	12.4	14.5	18.0	19.3	19.0	21.2	19.7	18.5	16.3	23.2	36.3
Natural Resource	4.5	5.0	6.5	8.3	9.4	9.6	12.3	14.0	12.8	21.5	40.2
National Parks	21.9	19.2	25.7	31.1	35.1	37.5	40.2	47.3	51.8	48.4	20.0
Agriculture Extension	35.5	39.4	42.4	53.1	63.9	185.1	111.5	152.8	216.2	169.5	399.6
Agricultural Research	16.9	19.2	19.6	24.9	26.7	29.5	37.6	43.2	53.1	73.2	135.4
Water Resource	80.3	103.9	51.4	100.3	92.2	169.0	185.3	148.4	124.7	145.9	169.8
Total (nominal)	**171.4**	**201.2**	**163.6**	**237.0**	**246.3**	**451.9**	**406.6**	**424.2**	**474.9**	**481.7**	**801.3**
Total (real)	**276**	**274**	**187**	**237**	**187**	**272**	**202**	**169**	**162**	**137**	**-**

[1] *Real expenditures are deflated by the Gross Domestic Product index, 1990 = 100 to account for inflation*

(Source: Central Statistical Office, 1997). Nominal expenditures were also deflated by the CPI index with little differences in results

4.0 LINKS BETWEEN LOGGING AND BIODIVERSITY CONSERVATION AND PLANNING

4.1 The contextual framework

Only 5% of Zimbabwe's total land area of some 39 million ha is occupied by indigenous forests which holds timber of some commercial value namely *P. angolensis*, *B. plurijuga* and *G. coleosperma*. These forests are found on private land, communal land, national parks land and gazetted forest areas which currently provide 30 000 cubic metres of commercial roundwood per year. The exploitation of commercial timber is carried out by private concessionaires and is regulated by the Forestry Commission under the Forest Act (for gazetted forests and private land); and the Communal Area Forest Produce Act (for communal areas). Details on the tender awarding processes for these logging areas are elaborated in section 1.5.

The key requirements for awarding timber concessions in communal area and gazetted forests are a timber inventory and a cutting plan. These two instruments are used to monitor the logging activities of the concessionaire by Forestry Commission employees who are based on site. However, there is considerable poaching of timber by illegal settlers or neighbouring communities in the case of gazetted forest areas; and by communal inhabitants in the case of communal areas. With respect to private land, the Forest Act only refers to activities "that can injure the environment". To address this, the Act requires that the private landowner gives the Forestry Commission notice of his/her intention to harvest timber. The forest authority is then expected to inspect the area to be logged and issue a timber movement permit within 14 days. However, this legal instrument is not explicit on the need for an inventory or a cutting plan before a permit is issued to a private landowner. Such a set up can lead to over exploitation as there is also no provision for monitoring by the forest authority. Notwithstanding, there is more forest biodiversity, forest cover and biomass on privately owned land than on communal and gazetted forest areas. This has been largely attributed to security of land tenure in the former case and the ability of the owners to internalise benefits from biodiversity conservation.

4.2 Problems and constraints to biodiversity conservation under logging conditions

Constraints to forest biodiversity conservation under logging conditions can be grouped into policy, socio-economic, technical (managerial) and human capacity. These issues are highlighted in this section.

1. Policy framework

The Forest Act and the Communal Lands Forest Produce Act (CLFPA) are the principal pieces of legislation that govern the exploitation and protection of forest and woodland resources in Zimbabwe. Despite post independence amendments, the two Acts largely retain the colonial approach to natural resource management which places more emphasis on protection and not on the human element. On the other hand, the Parks and Wildlife Act is the principal piece of legislation regulating the conservation and utilisation of wildlife resources of the country.

The Forest Act imposes a rather strict regulatory framework which is highly interventionist as it vests the administration of exploitation of all communal area forest produce with the Minister through the appropriate Rural District Councils (RDCs). According to the CLFPA exploitation of forest produce by communal area inhabitants is restricted to "own use" and the sale or supply of any forest produce to any other person is prohibited. Only the RDCs have the right to grant concessions to outsiders to utilise forest products for commercial gain. This does not give local communities incentives to sustainably manage their forest resources and gives rise to commercial timber poaching.

While the Forest Act seeks to be broad in its coverage of forest resources throughout the country, it finds its primary focus in gazetted forests and on private land (predominantly large scale commercial farms). However, controls of the Forest Act over private forests are less strict and provide a somewhat self regulatory control mechanism for the management of private forest resources by their owners. The Act, *prima facie* prohibits the harvesting, injury or destruction of any indigenous trees or timber from private forests except in terms of a valid timber permit issued with the consent of the Forestry Commission. Within the gazetted forests, the Act advocates the colonial protectionist approach to conservation which does not allow communities neighbouring or within the forests to derive any benefits from them. This has promoted widespread timber poaching by such communities.

2. Socio-economic environment

Zimbabwe's economy has been undergoing some changes during the last ten or so years due to the implementation of economic reform programmes whose major policy objectives are:

- Trade and investment liberalisation;
- Removal of trade restrictions
- Deregulation of financial and labour markets;
- Removal of price controls;
- Attainment of a 5% annual growth in GDP;
- Reduction in the national budget deficit; and
- Reform of public enterprises and the rationalisation of the civil service.

While the first four objectives have been largely met, the last three have been more difficult to achieve due to a number of constraints. These include: persistent droughts, government's assumption of parastatal debts, delayed disbursement of external financial support for reform programmes and increased social expenditures on issues such as the AIDS pandemic. The net effect of these measures has been increased economic hardships for the population and reduced government funding on activities such as natural resource conservation. According to a 1995 poverty assessment study, 62% of the country's households are poor with 46% of them living in absolute poverty as they can hardly afford basic food requirements. Some of these households are turning to commercial timber poaching for survival.

3. Technical issues

Although several projects incorporating vegetation inventories have been carried out by a number of institutions in Zimbabwe, there have been no biodiversity specific monitoring programmes in the forestry sector in general and in commercial timber harvesting in particular. Consequently, very little is known on the impact of our logging operations on forest biodiversity at various levels. In addition, no accurate economic values have been established for the various goods and services that can be derived from the existing forests other than timber. This tends to underplay the importance of forests within the natural economy.

Commercial timber logging operations target specific volumes and stem forms. This results in the "creaming off of phenotypically superior trees and the gradual genetic impoverishment of the forests. The Strict Natural Reserve concept has gone some way in addressing this issue in gazetted forest areas. However, Strict Natural Reserves are limited in terms of their geographical spread and tree species coverage. Furthermore, they do not exist in communal areas and on private land.

4. Human capacity

Most of the issues that impact of forest biodiversity fall outside the forestry sector itself. This is partly because forestry is largely considered as a medium for the development of other more economically visible sectors such as agriculture, mining and industry. However, because of lack of intersectoral co-operation, the forestry sector finds itself wanting in certain professional disciplines such as resource valuations, biosystematics, botany and ecology which are critical for biodiversity conservation.

5.0 STRATEGIES AND SOLUTIONS TO LINK BIODIVERSITY CONSERVATION AND PLANNING

This section is based on constraints highlighted in section 4.2 in the following areas: policy framework, socio-economic environment, technical issues and human capacity.

1. Policy framework

The protectionist approach of the Forest Act in the gazetted forest areas does not give neighbouring communities and those within the forest area any incentive to assist in the conservation of the commercial timber species found therein as they do not directly benefit from the income accruing to the Commission from commercial timber concessions. There is therefore need to replace the protectionist approaches to conserving gazetted forests which those that consider the affected local communities as partners in the conservation, management and sustainable use of the forests. This can be achieved by adopting the CAMPFIRE concept which has been quite successful in the wildlife sector. Under such a dispensation, part of the revenue accruing to the Forestry Commission from timber concessions would be passed on to the communities. Such an initiative would motivate the latter to ensure that the gazetted forests are conserved. With respect to private land, there is need to amend the Forest

Act so that it compels the private land owner to produce a forest inventory and a logging plan before the Forestry Commission issues a timber movement permit.

In the communal areas, there is need to relax the provisions of the Communal Lands Forest Produce Act to enable communities harvest forest produce, including commercial timber for sale. At present the Act only restricts such a provision to own use while commercial timber exploitation is done by the Rural District Councils. Under the proposed dispensation, communal area inhabitants would be organised into Resource User Groups for the management and exploitation of timber in selected areas. Currently, Resource User Groups are confined to non-timber forest products. However, they have demonstrated that once communities see direct benefits from a resource, they will be motivated to sustainably manage it.

2. Socio-economic environment

The issue of increasing poverty levels cuts across the whole economy and can therefore not be meaningfully addressed within the context of the forestry sector alone as it reflects the prevailing macro-economic fundamental within the economy. However, the sector can contribute towards poverty alleviation if communities are allowed to accrue part of the timber logging revenues through the amendment of the existing legislation as discussed in point (1) above.

Ways of improving forest biodiversity management in the face of declining public sector support include the following:

- Providing incentives to local communities through CAMPFIRE type programmes. This will motivate the communities to participate in forest conservation and management and lead to a reduction in the overall cost of forest protection to government.
- Undertaking a systematic quantification of the economic values of the various goods and services derived from the existing forest biodiversity. Once computed, such values can help improve the visibility of forestry within the overall national accounting system and thus, hopefully, entice government to allocate more resources to the sector.
- Forging mutually beneficial partnerships with private sector players involved in logging and other timber related industries and entice them to contribute towards forest management.
- Submitting project proposals for funding to appropriate international financing windows such as the Global Environment Facility. Despite being a signatory to a number of international conventions, Zimbabwe has not yet fully tapped into their financing windows to support its forest conservation programmes.

3. Technical issues

The following technical interventions are proposed:

- Biodiversity monitoring. There is need to undertake forest biodiversity specific monitoring programmes. Such studies are necessary for the design of effective forest biodiversity conservation and utilisation programmes and their assessment.
- Reducing genetic erosion. To reduce the genetic erosion associated with the selective extraction of commercial timber species, there is need to expand and strengthen the Strict Natural Reserves (SNRs) concept which is being

implemented in the gazetted forest areas. However, the success of this concept will largely depend on a good understanding of the genetic variability of the tree species in question. This aspect has not been well studied and deserves urgent attention. In addition, the concept of SNRs should be extended to communal areas and private lands.

4. Human resources

The best option to address the human resource constraint in the short term is to foster inter-institutional collaboration. This will help bring other important disciplinary views that might not exist within the forestry sector. In addition, emphasis should be on in service training in order to tackle the new challenges facing the forestry sector. These include local level capacity building, resource evaluations and biodiversity monitoring.

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Appendix 2.1 Floristic framework used in the Department of Natural Resources' Integrated Resources Information (IRIS) programme

Riparian Forests and Alluvial woodlands

B1 - Dense woodland on alluvium/colluvium
B2 - Mixed riparian woodland
B3 - Faidherbia riparian woodland
B4 - Syzigium riverine vegetation

Dry forests and thickets

C1 - Terminalia brachystema bushed woodland
C2 - Xylia dry forest
C3 - Combretum woodland thicket on colluvium and sandstone
C4 - Guibourtia conjugata woodland thicket
C5 - Baikiaea woodland thicket on Kalahari sand
C6 - Baikiaea woodland on Kalahari sand
C7 - Baikiaea-Acacia bushed woodland on Kalahari

Miombo woodlands

D1 - Brachystegia spiciformis-Baikiaea woodland on Kalahari sands
D2 - Brachystegia spiciformis-B.boehmii woodland on sand
D3 - Brachystegia boehmii-Julbernadia-Pterocarpus angolensis open woodland on sandstone plateaux
D4 - Brachystegia boehmii-Julbernadia woodland on shallow soils
D5 - Brachystegia-Julbernadia woodland on granite
D6 - Brachystegia glaucesens woodland on hills
D7 - Brachystegia allenii woodland
D8 - Mixed woodland on Zambezi Escarpment

Miombo-Mopane woodlands

E1 - Brachystegia boehmii-Colophospermum woodland catena
E2 - Julbernadia-Colophospermum woodland catena
E3 - Combretum-Colophospermum open woodland mosaic
E4 - Colophospermum-Diospyrous kirkii open woodland on shallow soils
E5 - Colophospermum-Brachystegia allenii woodland mosaic

Mopane woodlands

F1 - Colophospermum woodland on skeletal soils
F2 - Colophospermum-Terminalia stuhkmanii woodland
F3 - Colosphopermum woodland (Single dominace)

Combretaceae open woodlands

G1 - Combretum collinum open woodland on sand
G2 - Mixed dry woodland mosaic on granite

Acacia open woodlands

H1 - Acacia open woodland on goldbelt soils
J. Grasslands
J1 - Parinari wooded grassland
J2 - Cynodon-Eragrostis grassland on sand
J3 - Cynodon-Sporobolus grassland in granite vleis
J4 - Panicum repens lakeshore grassland
J5 - Andropogon grassland on serpentine
J6 - Grassland on basalt soils
J7 - Setaria grassland on clay