ZIMBABWE BIODIVERSITY STRATEGY AND ACTION PLAN

STATUS OF BIODIVERSITY, UNMET NEEDS, STRATEGIES AND ACTIONS

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ACRONYMS

AGRITEX	Department of Agricultural, Technical and Extension Services.
AIDS	Acquired Immuno Deficiency Syndrome
ALCOM	Aquaculture for Local Community Development
BSAP	Biodiversity Strategy and Action Plan
BUN	Biomass Users Network
CabMV	Cowpea Aphid-borne Mosaic Virus
CAMCORE	Central American and Mexican Coniferous Resources Co-operative
CAMPFIRE	Communal Areas Management Programme for Indigenous Resources
CAs	Communal Areas
CIDA	Canadian International Development Agency
CIP	International Potato Centre
CITES	Convention on International Trade in Endangered Species
CLFPA	Communal Lands Forest Produce Act
COMMUTEC	Community Technology Development Association
COP	Conference of Parties
DEAP	District Environmental Action Plan
DDF	District Development Fund
DFID	Department for International Development
DNPWLM	Department of National Parks and Wildlife Management
DR&SS	Department of Research and Specialist Services
EIA	Environmental Impact Assessment
ENDA	Environment and Development Activities
ELESMAP	Elephant Survey and Mapping Project
FAO	Food and Agriculture Organisation
GATT	General Agreement on Tariffs and Trade
GEF	Global Environment Facility
GDP	Gross Domestic Product
GMOs	Genetically Modified Organisms
HNP	Hwange National Park
ICRISAT	International Crop Research Institute for the Semi-Arid Tropics
IITA	International Institute for Tropical Agriculture
IMCs	Irrigation Management Committees
IPGRI	International Plant Genetic Resources Institute
IRRI	Integrated Rice Research Institute
ITDG	Intermediate Technology Development Group
IRIS	Integrated Resource Information System
IUCN	World Conservation Union
MLARR	Ministry of Lands, Agriculture and Rural Resettlement
MTB	Mining Timber Permit Board
NGOs	Non Governmental Organisations
NRs	Natural Regions
ODA	British Overseas Development Administration
PWLA	Parks and Wildlife Act
RDCs	Rural District Councils
SAFFIRE	Southern Alliance for Indigenous Resources
SNR	Strict Natural Reserves

SPGRC	Southern African Development Community Plant Genetic Resources Centre
TRIPS	Trade Related Intellectual Property Rights Regime
SIRDC	Scientific and Industrial Research and Development Centre
UNCED	United Nations Conference on Environment and Development
UNSCO	United Nations Scientific and Cultural Organisation
UNDP	United Nations Development Programme
USA	United States of America
US$	United States Dollars
VegRIS	Vegetation Resources Information System
WTO	World Trade Organisation
WWF	World Wide Fund for Nature
WWW	World Wide Web
ZBC	Zimbabwe Broadcasting Corporation
ZERO	Regional Environment Organisation
ZIANA	Zimbabwe Inter-Africa News Agency
ZINATHA	Zimbabwe National Traditional Healers Association
ZIS	Zimbabwe Information Service
Z$	Zimbabwe Dollars

FOREWORD

Zimbabwe is a signatory to several important international and national policy frameworks for sustainable 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 Climate Change, the Convention to Combat Desertification, the Montreal Protocol and the Convention on International Trade in Endangered Species of wild flora and fauna.

In 1987, we prepared a National Conservation Strategy. This strategy became an important reference document and significant progress has been made in the area of environmental policy and planning since then. For example, a law reform process to deal with problems associated with the administration of at least 18 pieces of legislation on the environment, which are housed in nine different ministries and departments is under way. Furthermore, Zimbabwe has adopted the District Environmental Action Plan which integrates environmental conservation issues into the development planning process at the local level.

With respect to the Convention on Biological Diversity, the Government of Zimbabwe obtained funding from the Global Environment Facility (GEF) through the United Nations Development Programme, to develop a Biodiversity Strategy and Action Plan (BSAP), which is the subject of this document. The preparation of this BSAP placed a lot of emphasis on stakeholder consultation at various levels. About 400 people including environmentalists, academics, administrators, politicians, traditional healers, traditional leaders, church leaders, business leaders and journalists from government and non-governmental organisations participated in this exercise through national and provincial workshops.

This document highlights the importance of biodiversity to the social and economic development of Zimbabwe at both the local and national levels. The majority of our population directly depends on a range of biological resources for subsistence and income generation. However, the country's biodiversity is under threat from a number of factors which include conflicting economic policies, rapid population growth rates, restrictive land tenure systems, recurrent droughts, the erosion of cultural values and inadequate incentives for the rural folk who "live with" the biodiversity. Furthermore, government expenditures on biodiversity conservation have declined over time in real terms.

Finally, it is important to recognise that apart from submitting this document to the Conference of Parties as our obligation to the Convention on Biological Diversity, Zimbabwe has a responsibility to ensure that its findings are implemented in order to conserve our biological heritage for present and future generations. To this end, my ministry will keep the BSAP Secretariat Office functional for this purpose. Furthermore, given the multi-sectoral nature of the potential biodiversity projects, an inter-sectoral committee to coordinate resource mobilization and to monitor project implementation will be established.

Hon. S.K. Moyo M.P.
MINISTER FOR ENVIRONMENT AND TOURISM

1. BACKGROUND TO THE COUNTRY STUDY

1.1. Contextual framework

The Convention on Biological Diversity of which Zimbabwe is among the over 172 signatories, places the primary decision making for the conservation and sustainable use of biological resources at the national level. Thus, in response to the Government of Zimbabwe's request for support to prepare a National Biodiversity Strategy and Action Plan (BSAP), the Global Environment Facility (GEF) approved a project document ZIM/96/G31/A/1G/99 to provide funding of about US$ 300 000 through the local office of the United Nations Development Programme (UNDP). The BSAP is intended to build upon and reinforce other existing national strategies and plans such as the Communal Area Management Programme for Indigenous Resources (CAMPFIRE) which have been quite successful. The Project enables Zimbabwe to meet its obligations under the Convention on Biological Diversity by facilitating the preparation of a country study on the status of biodiversity and the development of a National Biodiversity Strategy and Action Plan.

In order to operationalise the project, a Secretariat, Steering Committee and Consulting Group were established within the Ministry of Mines, Environment and Tourism (Annex 6.1.1). The former was responsible for the day to day running of the project. The Steering Committee provided overall guidance and direction to the project and linked it to related initiatives being undertaken throughout the country. The latter included projects such as the State of the Environment Reporting, Climate Change, the National Action Plan and the District Environment Action Plan. A multidisciplinary Consulting Group was responsible for preparing the country study and for developing a national strategy and action plan. The whole process placed emphasis on stakeholder consultation at various levels. Such consultations were done 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 and national realities. About 400 people including environmentalists, academics, administrators, politicians, traditional leaders, traditional healers, church leaders, business leaders and journalists participated in the exercise. International consultants with global expertise in biodiversity planning; GEF linkages; and the preparation of biodiversity strategies and action plans were brought in to provide technical backstopping to the Secretariat at the launch of the project and during the final national workshop.

This document presents the status of biodiversity in Zimbabwe; the unmet needs in biodiversity conservation and sustainable use; and a National Biodiversity Strategy and Action Plan.

1.2 General Considerations

The climatic and edaphic conditions of Zimbabwe support a varied range of flora and fauna which play a critical role in the social, economic and ecological well being of the country. These and other related issues are presented in this section.

Zimbabwe's location

Zimbabwe is a land locked country covering some 39 million hectares. Its neighbours are South Africa in the south, Mozambique in the east and northeast, Zambia in the north and Botswana in the south west. The country lies between 15 ° 40¢and 22 ° 30¢ S and 25 ° 15¢and 33 ° 05¢E latitudes and is bounded by the Zambezi river in the north and the Limpopo river in the south.

Although, well within the tropics, Zimbabwe's climate is sub-tropical being moderated by altitude. Eighty percent of the country is above 600m, while the remainder is below this height. An outstanding feature of the country's landscape is the central plateau known as the highveld, which is about 650km long and 30km wide. On either side of this is the middleveld, which is between 600 and 1200m above sea level. The lowveld is below 600m and consists of a narrow strip in the Zambezi Valley and a broader tract between the Limpopo and the Save rivers.

Climate

Rainfall is the major climatic factor that influences the performance of sectors such as agriculture, forestry, wildlife and aquatic life in Zimbabwe. The rainy season stretches from November to March, while the dry cool season is between May and August. Frost is not uncommon during the winter season while October and November are the hottest months.

Annual rainfall varies from an average of below 400mm in the low lying areas to 900mm over the central watershed and 1 500mm in parts of the eastern highlands. The country is divided into five natural regions (NRs) largely based on annual rainfall as shown in Figure 1.1. Annual rainfall in the Natural Regions (NRs) is as follows: NR 1, over 1000mm; NR II, 800-1000mm; NR III, 650-800mm; NR IV, 450-650mm; and NR V, less 450mm (Vincent & Thomas, 1960). Recommended land use systems in the NRs are summarised below:

- NR I is suitable for afforestation, agriculture and intensive livestock production. Crops such as tea and coffee are grown in frost free areas.
- NR II is suitable for intensive crop and pasture production and accounts for about 90% of the country's annual crop output.
- NR III is recommended for livestock based production systems supplemented by short season crops.
- NR IV is suitable for livestock ranching and wildlife management and utilisation.
- NR V is suitable for extensive cattle and game ranching.

Soils and vegetation

About 70% of Zimbabwe's soils are derived from granite and are often sandy, light textured and of limited inherent agricultural potential (Grant, 1981). There is, however, a significant development of soils with a heavier clay content in various parts of the country. Such soils are derived from basic igneous intrusions and have excellent cropping potential due to their inherent fertility. The extreme west of the

country has large tracts of deep Kalahari sandy soils which have very low agricultural potential.

Zimbabwe is characterised by savanna 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.

Water resources

Zimbabwe has few perennial rivers and no natural lakes. Water storage development is therefore dependent on run-off accumulated during the rainy season (November to March). There are over 8 000 dams in the country with a storage capacity of about 4 900 million cubic metres.

Underground sources are usually the most economical and reliable for small to medium water supplies, particularly in the drier areas of the country. Such water is available at less than 40 metres and has a potential yield of 2000 million cubic metres per annum.

1.3 Human Population

According to the 1992 census, Zimbabwe's population was 10.4 million and was estimated to be 12.2 million people in 1997 at an annual growth rate of 3.2%. A decline in infant mortality rate has been largely credited for the rapid increase in the country's population over the years although the effect of the Acquired Immuno Deficiency Syndrome (AIDS) pandemic on population growth still remains to be seen.

The 1997 male to female population ratio was 1: 1.05 with 47% of the people being under 15 years of age. Such a growing population structure poses great challenges to the country's biodiversity as the demand for natural resources will continue to increase into the next millennium. This is worsened by the fact that about 66% of the country's population resides in rural areas, where, because of poverty, people tend to rely on natural resources for their survival. As is the case in other developing countries, Zimbabwe has very high poverty levels. For example, the 1995 poverty assessment study showed that 61% of the country's households are poor with 45% of them living in absolute poverty as they can hardly afford basic food requirements. Furthermore, the majority of such poor households are headed by women. There are more people per unit area in the wetter (e.g. NR I and II) than in the drier areas (NR III to V) of the country (Table 1.3.1). This has led to greater exploitation of natural resources through opening of large tracts of land for cultivation and increased demand on forest goods and services in the former natural regions. Similar negative impacts of population concentrations on biodiversity occur in areas around urban and rural service centres. The resultant land degradation is contributing to the siltation of the major water sources, such as the Save river.

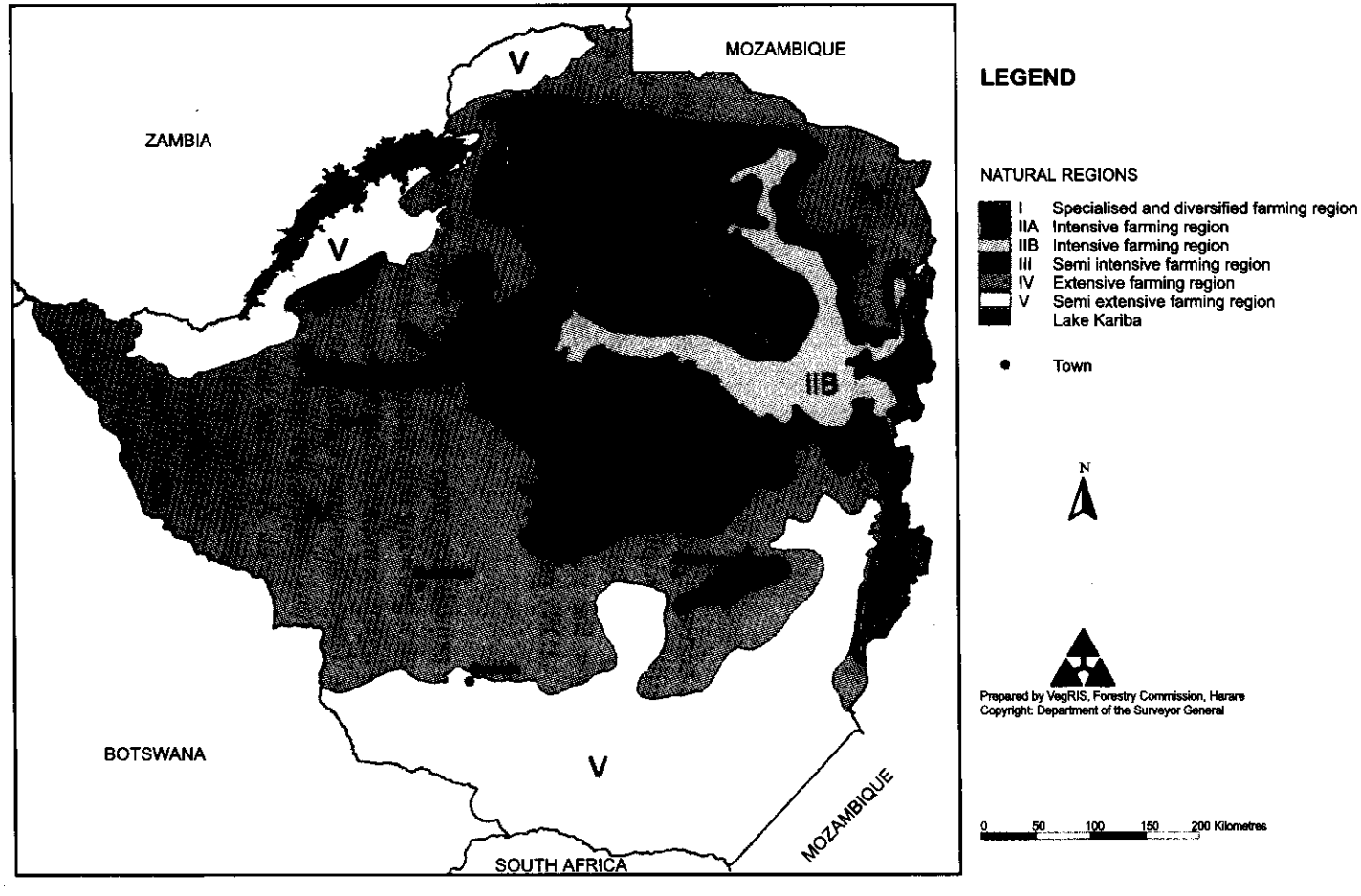


Figure 1.1 The Natural Regions of Zimbabwe

Table 1.3.1 Population density and natural resource exploitation by natural region in selected districts of Zimbabwe

District	Natural Region	Population density (people/km^2)	% of area under:	
			Cultivation	Woodland
Chipinge	I	65	47	39
Mutasa	I	65	41	26
Goromonzi	II	59	44	38
Chegutu	II	30	37	35
Tsholotsho	IV	15	25	64
Chiredzi	V	11	11	65
Gwanda	V	11	26	59

Source: Shumba et.al. (1998)

1.4 Infrastructure Development

As is the case in other developing countries, Zimbabwe continues to prioritise infrastructure development for economic growth than biodiversity conservation *per se*. Consequently, there is need to develop an appreciation of the economic value and benefits of biodiversity if a proper balance between development needs and natural resource conservation is to be realised.

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 compounded by the current drive by government to attract foreign investment with tourism, agriculture and mining being the most lucrative sectors. Such investments could result in infrastructural development which could 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. Furthermore, there is a need to put in place systems that adequately and continuously monitor the effects of nationally important developments such as the Zambezi Water Project and the Pungwe Pipeline Project on existing and potential biodiversity.

Given that Zimbabwe is generally marginal for agricultural production, there has been considerable investment in dam constructions for irrigation purposes. Apart from submerging ecosystems, dam construction introduces new ecosystems within and in the surrounding areas. For example, in addition to bringing in new aquatic life forms, dams have modified land use systems in their areas of influence such as providing sufficient water to grow cash crops, which require a higher level of chemical inputs. If improperly used, such chemicals can pollute surface and ground water and negatively impact on aquatic ecosystems.

As a way of minimising the adverse effects of infrastructural development on the environment, government has instituted an Environmental Impact Assessment policy. Under this policy, projects with potentially adverse environmental effects are prescribed, making them subject to environmental audits.

1.5. The urban environment

The urban environment has three major components namely, the built up areas; physical attributes such as soil, water and air; and biological issues of flora and fauna. Most of Zimbabwe's urban settlements are concentrated around areas of economic activity such as mining, industrial operations, manufacturing and retailing. Given the nature of these activities and the associated high human population concentrations, environmental degradation in these areas is unavoidable. Pressure is therefore being exerted on the land, water and atmosphere resulting in the accumulation of biological and chemical pollutants which have undesirable effects on people, other living organisms and the physical environment. Effects of such pollution in Zimbabwe are evident around or near fertiliser and chemical plants and other water bodies where the vegetation and aquatic life has suffered. Furthermore, the carbon dioxide produced by the various pollution sources contributes to global warming. On the positive side, urban households contribute to biodiversity conservation through the establishment of gardens and ponds that support a diversity of plant and animal life.

1.6. Land tenure, property rights and general land use systems

The land holding rights and obligations in Zimbabwe find their expression in the country's four main systems of land tenure. These are the freehold (private), state land, communal and leasehold (resettlement) tenure systems. The tenure systems impact and shape the property rights and natural resource access regimes that exist today. With the exception of the resettlement tenure system, the tenure systems are largely a part of the country's colonial heritage.

The freehold tenure system is prevalent in the commercial farming sector which consists of large scale and small scale commercial farmers and occupy about 32% of the country's land area. This sector is characterised by individual ownership of land by virtue of a title deed issued under the Deeds Registry Act. The registered land owner has exclusive property rights and full control and responsibility over the land and everything attached to it except to the extent that ownership and exclusive control over the land and some natural resources may be limited by statutory provision. Such limitations relate to changes in land use, controls over public water courses, felling of indigenous timber resources and controls in wildlife. It is often argued that freehold tenure provides land owners with incentives to conserve and improve the natural resource base.

The communal land tenure system is governed by the Communal Lands Act and is applicable to 42% of Zimbabwe's land area, where approximately 66% of the country's population resides. Furthermore, 74% of the communal sector is located in NRs III to V while the bulk of the large scale commercial sector is in high rainfall areas. According to the Communal Land Act, all communal land is vested in the State

President who has powers to permit its occupation and utilisation in accordance with the Act. Communal area inhabitants thus have usufructory rights over communal land. While Rural District Councils have a dispensation to allocate land to qualified persons on behalf of the state. Resettlement areas cover 10% of the country and are a product of the post independence period targeted at relieving population pressure in communal areas and have no title. It is often argued that the communal land tenure system is a disincentive to long term investment in agriculture and other key natural resources. To address these land tenure related problems, government set up a Land Tenure Commission in 1994 to review the current land tenure systems and make appropriate recommendations (Land Tenure Commission Report, 1995). However, some of the key recommendations related to the communal land tenure system have not yet been implemented.

The state also set aside 15% of the country as gazetted/protected forests and national parks. These offer good examples of the *in-situ* conservation and sustainable use of Zimbabwe's biological heritage.

1.7 Macroeconomic structure and policies

Zimbabwe is a developing country with a per capita income in 1996 of US$718[1] based on a total Gross Domestic Product (in nominal terms) of Z$85.5 billion and a total population of approximately 11.9 million. However, in real terms, the GDP per capita has declined from US$271 in 1980 to US$201 in 1996 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%.

Zimbabwe's economy has been undergoing some changes during the last six or so years due to the implementation of economic reform programmes. The seven major policy objectives of the reform programmes 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

[1]This figure is significantly higher than previous estimates published by the World Bank, World Resources Institute and FAO. The reason is that in recently released national statistics by the Central Statistical Office, estimates of GDP from the informal sector were included. This has increased official GDP per capita figures by almost 60 percent over previous values.

such as the AIDS pandemic. Furthermore, the current economic structural adjustment programme is putting considerable pressure on biological resources as more people turn to them in response to declining real incomes from fiscal and monetary policy changes.

1.8. Social and cultural issues

Zimbabwe's population is diverse. About ninety eight percent of the population consists of indigenous Africans, while the remainder is mostly made up of Whites and Coloureds. The indigenous inhabitants are mostly of Shona and Ndebele origin. Smaller ethnic groups of Caucasian, Hlengwe, Sena, Shangani, Sotho, Tonga, and Venda descent are also present. The country's official languages are English, Shona and Ndebele.

The rural to urban push in search of employment opportunities has led to the migration of the male population to urban centres leaving their families in the rural areas. Such an arrangement guarantees the family social security in the event of loss of a job or retirement. This "dual economy" system gives indigenous people the right to a piece of land in the communal area even if they are gainfully employed elsewhere. It is often argued that such an arrangement leads to serious competition for limited resources as more people may claim pieces of land for cultivation and grazing rights for security and not for productive purposes.

Families are patrilineal among the dominant population groups. In the event of a marriage, men pay a bride price to the family of the prospective wife. This gives the man uxorial rights to that woman for as long as the couple is married. Furthermore, the traditional land tenure system does not allow women to own land. These factors tend to adversely affect the status of women in society. Notwithstanding, the situation is changing as the crucial role of women in the various spheres of economic life including natural resource conservation and sustainable use is being recognised.

There are also a number of traditional values that have assisted in the sustainable use of natural resources in Zimbabwe. These include:

- Traditional rules and regulations that forbid the cutting of fruit trees and other "sacred" tree species for uses such as fuelwood and construction and;
- The use of one side and position of a tree to harvest roots or bark for traditional medicines. This deterred people from exploiting the same tree before it had sufficiently regenerated.

Unfortunately, some of these conservation sensitive traditional beliefs and customs are breaking down.

1.9. Environmental education/awareness

The importance of environmental education derives from the fact that communities are the custodians and users of a nation's biological heritage. Considerable effort has been put into developing conservation skills and attitudes in the youth by incorporating social and environmental science into the primary school curriculum but this is not

yet the case in secondary schools which have largely remained academic. On the other hand, although environmental education is not central in the curricula of most tertiary education institutions, it is included in primary teachers colleges. Furthermore, both public and private universities in the country have recently introduced new or amended existing teaching and research programmes to include greater focus on environmental management. These initiatives include undergraduate programmes in natural resources and agriculture at Africa University; research activities of the Centre for Applied Social Studies and the Institute of Environmental Studies; and the Masters degree programme in Tropical Resource Ecology and in Environmental Policy and Planning in the Department of Biological Sciences and Geography respectively.

However, some of the materials included in the foregoing formal environmental education programmes have tended to have limited local content and this aspect is now being addressed by involving local environment and education specialists in selecting the course content and its delivery mechanisms. The latter includes classroom lectures, drama and radio programmes. Notwithstanding, the need for a clear and definite national policy on environmental awareness, education and training cannot be over emphasised.

On the informal front, considerable progress in raising environmental awareness in both rural and urban areas has been made through the print and electronic media, and through adult education campaigns and demonstrations launched by government and non governmental organisations (NGOs). Such organisations include:

- ACTION, an NGO that produces an environment and health magazine which is sent to primary and secondary schools in the country;
- Environment 2000 which is involved in environmental education activities in schools and communities;
- A number of government and non-governmental agencies involved in the national schools Tree Growing Tree Care competition. It is interesting to note that this programme has now outgrown its competition phase and is self sustaining in some districts. Infact, a number of schools have introduced outreach programmes where they supply tree seedlings to neighbouring communities; and,
- The Mukuvisi Education Centre which has a woodland where people can experience a natural forest; view a few wild animals, birds and reptiles in their habitat; and have educational walks through the forest.

Notwithstanding the foregoing, the content and communication channels of existing environment awareness materials could be improved by stratifying the target groups to be reached, identifying their information needs and developing appropriate information dissemination strategies. Furthermore, there is need to co-ordinate the activities of the various players in order to create synergy.

1.10. Political factors

Parliament

Zimbabwe's legislature consists of the Executive President and a unicameral (single chamber) Parliament. The President heads the state and the executive and is the Commander-in-Chief of the Defence Forces. Parliament consists of 151 members including the Attorney General who is an ex-officio member. At the beginning of each Parliament session, the President delivers a speech on the government's programmes in the various sectors and reports on progress made since the previous session.

Provincial Organs

Each of the country's eight provinces has a Provincial Council responsible for co-ordinating various activities in the province. The membership of the provincial councils which are chaired by a Provincial Governor and Resident Minister consists of chairpersons from Rural Development Committees and Urban Councils, a representative each from chiefs, women, youth and experienced politicians. Parliamentarians from the province are allowed to attend provincial council meetings, but have no voting rights. Provincial Development Committees are responsible for co-ordinating the provinces' development activities and consists of civil servants and the chief executive officers of rural and urban councils.

District Organs

Rural District Councils (RDCs) are local planning authorities for community level projects in the country's 55 rural districts. RDCs consist of elected councillors, traditional chiefs and people representing interest groups such as farm and mine workers. RDCs are advised by the Rural District Development Committees which consist of Councillors elected on the voters' role and civil servants. RDCs are responsible for land allocation, a function previously performed by traditional leaders. This has considerably weakened the traditional leadership structure and the traditional systems of natural resource conservation and use in communal areas.

1.11. Government position on the Biodiversity Convention

International agreements and national environmental policy frameworks

Zimbabwe is a signatory to several important international and national policy frameworks for sustainable 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 Biodiversity, 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 main objective of this strategy was to ensure that natural resources are used on a sustained yield basis. Unfortunately, the Strategy failed to be an official document as it was not presented in 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. As such, the strategy became a reference document instead of a guidebook for sustainable development in Zimbabwe.

However, significant progress has been made in the area of environmental policy and planning since 1987. In late 1992, the then 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 Mines, 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 (DEAP), in order to integrate environmental conservation issues into the development planning process at the local level.

The Convention on Biological Diversity

The Convention on Biological Diversity was signed by over 150 governments at the close of the United Nations Conference on Environment and Development in June 1992. As of November 1994, the Convention had been signed by 172 countries and ratified and/or acceded by 102 countries plus the European Community. Zimbabwe has been an active member of the Convention since 1994.

The Convention's stated objectives are the conservation of biodiversity and the sustainable use of its components, coupled with the equitable sharing of benefits from the use of the genetic resources. The Convention stresses the need to promote international, regional and global cooperation on these issues. In addition, it requires parties to co-operate on matters of "mutual interest" related to biodiversity conservation and sustainable use. It also establishes an international structure for continued co-operative research, technology transfer, information exchange assistance as well as monitoring and assessing the implementation of the Convention. The Convention further requires developed countries to provide financial support for the implementation of the Convention by developing countries. A funding mechanism, the Global Environment Facility (GEF) has been established and is administered by the World Bank and UNDP on behalf of donor countries.

The Convention requires parties to:

- Inventory national biodiversity;
- Develop national strategies, plans and programmes for biodiversity conservation;
- Integrate biodiversity protection into relevant policies and programmes; and

- Identify and monitor activities that harm biodiversity, and protect biodiversity through a range of measures such as the creation of protected areas, and the implementation of regulations and incentives aimed at ensuring its sustainable use.

The first stage in the development of a National Biodiversity Strategy and Action Plan is the preparation of a Country Study document which presents the status of biodiversity in a country. It also evaluates the importance of biodiversity to the national economy and highlights the various threats to biodiversity and their significance. This is followed by extensive stakeholder consultations during which the strategy and action plan is formulated.

2. CONSERVATION OF BIODIVERSITY AND SUSTAINABLE USE OF BIOLOGICAL RESOURCES.

2.1 INTRODUCTION

2.1.1. What is biodiversity?

Biodiversity refers to the life support systems and natural resources upon which mankind depends. It has been variously described as "the variation between ecosystems and habitats; the variation between different species; and the genetic variation existing within individual species" (Convention on Biological Diversity, 1992). Stuart *et al.* (1990) looks at genetic diversity as a measure of the heritable variation within and between populations; species diversity as a measure of the total number of species within a given area; and, ecosystem diversity as a measure of the component species and how they interact to form an ecosystem.

The foregoing definitions highlight the fact that biodiversity is a complex concept that cuts across biological species, ecosystems and economic sectors.

2.1.2. Biodiversity conservation strategies

Biodiversity is either conserved *in-situ* or *ex-situ*. *In-situ* conservation involves the conservation of plant and animal species in their natural habitats or adaptive environments. These include gazetted forest areas, national parks, safari areas, sanctuaries, botanical reserves, recreational parks and non- protected areas (e.g. cattle ranches, communal grazing lands and areas which are unattractive for human settlement). On the other hand, *ex-situ* conservation involves the conservation of plants and animals outside their place of origin to ensure the perpetuation of threatened or endangered species that would otherwise be non-existent as a result of exploitation or natural loss in their natural habitats. Germplasm of such species is often conserved in genebanks, botanical gardens and resource conservation stands.

2.1.3. Why worry about biodiversity in Zimbabwe?

A major motivation for worrying about biodiversity in Zimbabwe is its centrality in the national economy and to human survival against the background of a declining biodiversity base as shown by the following examples:

- Zimbabwe's economy is heavily dependent on natural resources (i.e. forests, wildlife, aquatic life and agriculture) for generating employment, income and foreign exchange. The dominant sectors and their contribution to the Gross Domestic Product (GDP) in 1996 are presented in Section 1.7.

- Although forests provide a wide range of timber and non timber forest products and services to the majority of Zimbabwe's population, they are being lost at an alarming rate. It is estimated that about 70 000ha of Zimbabwe's forests are lost to agriculture each year. Furthermore, although about 66% of the country is still covered by woody vegetation, the cover in some districts such as Chivi now stand at only 30%.

- Wildlife is an important source of meat especially in rural areas. Consequently, the increasing human population numbers are imposing tremendous pressure on this important natural resource. For example, it is now extremely difficult to "sight" wildlife species such as the "rabbit" in most communal areas! Furthermore, the international commodification of wildlife threatens the survival of species such as the rhino.

- Fish, a nutritionally and economically important aquatic species is being threatened by over fishing in Lake Kariba (e.g. Kapenta) and by water pollution in Lake Chivero.

- The commercialisation of agriculture has contributed to the disappearance of certain traditionally important food crops (e.g. cereals, legumes and vegetables) and farming systems such as agroforestry. Despite its unquestionable contribution to the national economy, "modern" agriculture tends to be vulnerable to the vulgaries of the smallholder farming environment.

Areas under some of the above land uses in Zimbabwe are presented in Table 2.1.1. Sixty six percent 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 large scale commercial farms. Exotic plantations occupy about 156 000ha of which over 90% is in the eastern districts. Also found in the latter are the unique tropical rain forests occupying some 11 500ha.

Table 2.1.1Areas under various land use systems in Zimbabwe

Land use	Area (000ha)	% of total
Natural forests[1]	11.5	0.03
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[2]	139.1	0.36
Other[3]	379.4	0.97
Total	39 089.2	100

[1] *Tropical rain forest*
[2] *Cities*
[3] *Rock outcrops and water bodies*

Source: Forestry Commission, 1996

2.1.4. Organisation and thrust of the biodiversity report.

For purposes of breaking biodiversity into manageable units, the sector and ecosystem options were considered. Notwithstanding its inability to capture synergies and contradictions that occur across sectors, the sector approach was adopted because of the following reasons:

- The government is structured along sectoral lines and the formulation and implementation of policies that affect biodiversity is done within a sector context; and,
- International conventions are generally formulated and implemented along sectoral lines.

The four sectors considered are forestry; wildlife; aquatic flora and fauna; and agriculture. Elements considered for each sector were:

- the status and trends of biodiversity at the genetic, species and ecosystem levels;
- the causes of biodiversity changes;
- biodiversity conservation and sustainable use measures
- pertinent legislative, policy and institutional issues; and,
- the economics of biodiversity conservation.

Given their beneficial as well as harmful effects on biodiversity, micro-organisms (e.g. fungi, bacteria and viruses) which are found in association with plants and animals; or free living in the soil, water and air; are covered under the appropriate sectors.

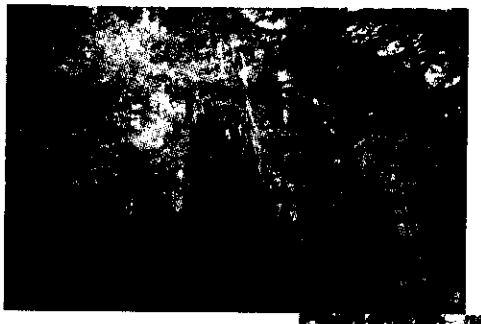
More specifically, this report covers:

- the status of biodiversity conservation and utilisation in Zimbabwe, and the associated weaknesses or gaps with emphasis on biological, institutional and economic aspects;
- opportunities for biodiversity enhancement, conservation, management and utilisation based on the identified weaknesses. These opportunities formed the basis for a national biodiversity strategic plan framework which was discussed with the stakeholders (at both national and provincial levels) during the development of the National Biodiversity Strategy and Action Plan; and,
- a national biodiversity strategy and action plan based on the high priority unmet needs that cut across the biodiversity sectors.

With respect to the format of the report, forestry is discussed first followed by wildlife, aquatic life and agriculture. This is in recognition of the fact that forests provide and shape habitats for the various forms of life while agriculture and other economic activities are gradually replacing pristine forests with other forms of biodiversity. For example, Zimbabwe's agricultural development during the last 80 years has resulted in major losses of habitats for wild flora, fauna, insects and micro-organisms including the wild relatives of domesticated plants and animals. The increasing emphasis on a few crop varieties, monocropping, continuous cropping and use of external inputs such as fertilisers and pesticides is reducing the resilience of agricultural systems to changing environmental conditions and new pest and disease challenges. Furthermore, the loss of soil organic matter, the drainage of wetlands and the

elimination of trees from agricultural systems diminishes carbon sequestration and contributes to global warming. The foregoing eco-system wide impacts of agriculture on biodiversity can be mitigated by the adoption of sustainable production practices and land use patterns hence the central role of agriculture in the biodiversity debate. Cross cutting issues such as the benefits and costs of biodiversity conservation are pulled together at the end of Chapter 2, while the unmet needs in biodiversity conservation and sustainable use are presented as Chapter 3. Zimbabwe's National Biodiversity Strategy and Action Plan is presented in Chapter 4.

FORESTRY



2.2. FORESTRY

2.2.1. Status and trends in forest biodiversity

2.2.1.1. Forest ecosystems

The Southern Africa region is dominated by six phyto-regions called the Flora Zambeziaca, Karoo-Namib, Cape Floristic, Afromontane, Indian Ocean Coastal Belt and the Kalahari-Highveld transitional zone (Beentje, 1996). The Flora Zambeziaca region is the richest in terms of species and dominates most of Zimbabwe. The eastern highlands of the country form part of the Afromontane region and has the largest level of endemism notably in the Chimanimani mountains, Nyanga and Chirinda Forest. Vegetation characteristics of the Cape Floristic region such as fynbos (fire bush) occur in the Nyanga mountains. Although the other three phyto-regions do not extend into Zimbabwe, remnant species are not uncommon.

Flora Zambeziaca phyto-region

The Flora Zambeziaca is a complex phytogeographic region situated in South Central Africa between latitudes 8 °E 10 °N and longitudes 20 °E 50 °N. The phyto-region is the centre of diversity for most woodland types found in the Southern African region. In Zimbabwe, the phyto-region has five woodland types namely Miombo, Mopane, Teak, Acacia and Terminalia/Combretum. The phyto-region has about 8 500 plant species of which 4 600 are endemic (White, 1983). The latter taxa include *Bolusanthus*, *Cleistochlamys*, *Colophospermum*, *Diphorhynchus*, *Pseudolachnostylis* and *Viridivia*. Most tree species in the 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.

Afromontane phyto-region

The Afromontane phyto-region is localised in the eastern highlands of Zimbabwe, mainly on the windward side of the mountains along the border with Mozambique, where about 740 vascular plant species are found. This phyto-region has four distinct vegetation types. The main factors controlling species distribution and composition in this phyto-region are altitude, moisture availability, human disturbance, soil type and topography. Some of the forests have remained fairly intact due to inaccessible location, legal protection (through the Forest Act and the National Parks and Wildlife Act) and presence of botanical gardens. However, a number of these forests are being threatened by plantation forest development, agricultural expansion and invasion by alien species such as jacaranda and wattle.

Exotic plantations

Zimbabwe has a well established plantation forest resource base covering some 155 853ha. About 90% of the plantations are located in the eastern districts. This area is characterised by high altitudes (700 to 2 200 metres above sea level) and high rainfall (average of 1 000mm/annum). About 71% of the planted area is under

softwoods (pines), 13% under hardwoods (eucalyptus) and 16% under wattle. With respect to plantation ownership pattern, about 42% belong to the State, 54% to private companies and the remainder to small private growers who include cooperatives.

2.2.1.2. Species diversity

Species diversity in Zimbabwe is described within the context of the five woodland types of the Zambeziaca phyto-region; the four vegetation types of the Afromontane phyto-region; and the exotic plantations (Figure 2.1).

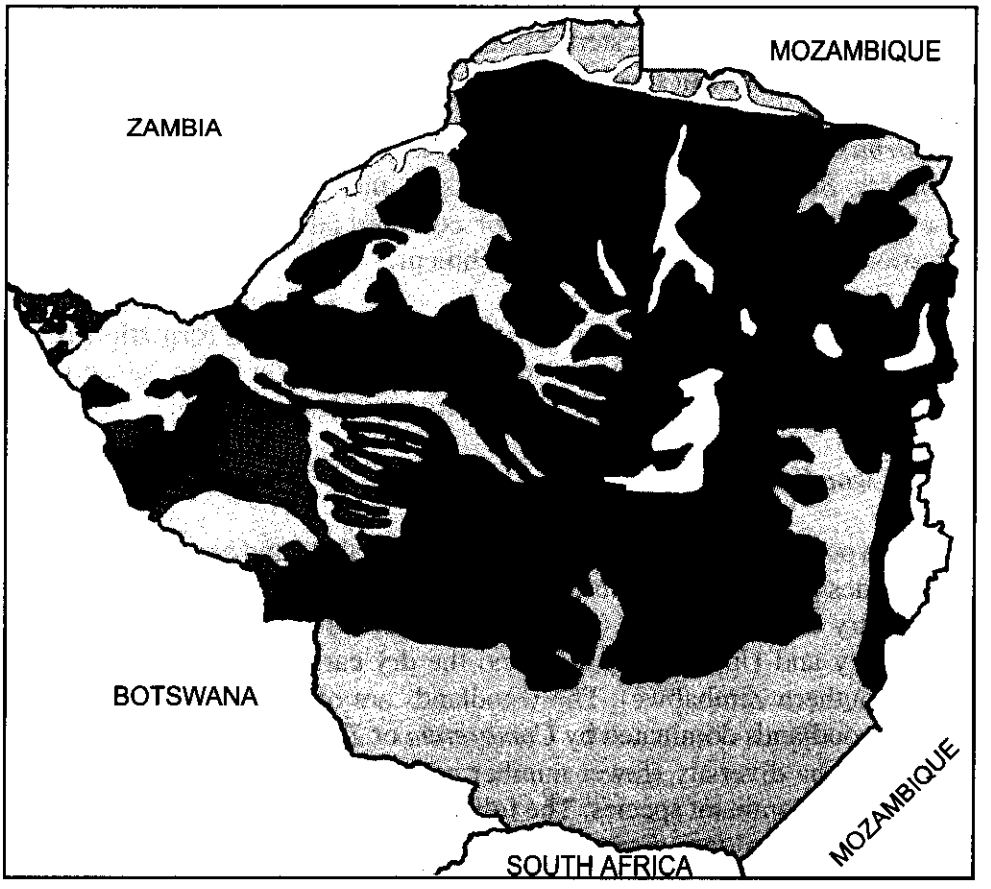
1. Zambeziaca phyto-region species

The five woodland types under the Zambeziaca phyto-region are Miombo, Mopane, Teak, Acacia and Terminalia/Combretum.

Miombo woodlands

The Miombo woodlands, locally known as the "musasa or munondo" 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 *Julbernardia globiflora* and *B. boehmii*. Other tree species found in association are *Faurea saligna, Combretum molle, Uapaca kirkiana, Pterocarpus angolensis, Albizia antunesiana, Strychnos spinosa, S. pungens, Monotes glaber* and *Gardenia spatulifolia.* On the Kalahari sands, *B. spiciformis* is often associated with *Baikiaea plurijuga* and *P. angolensis.* The second type is *B. boehmii* which commonly occurs on escarpments at higher altitudes. Common tree associates under warm and drier conditions include, *Pilostigma thonningii, Combretum spp., Afzelia quanzensis, Diospyros mespiliformis, Peltophorum africanum, Kirkia acuminata* and *Acacia* spp. The sub-type often merges with mopane woodlands at lower altitudes. The third type is *J. globiflora* which is adapted to wide altitudinal ranges. It is often found as pure stands, but occurs in association with *C. 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. Rattray (1962), postulated that the whole central plateau was once covered with *P. curatellifolia* and was invaded by *Brachystegia* spp. in the east and *B. plurijuga* in the west. This woodland type is now very limited in extent and has generally been degraded to grasslands and savanna as a result of clearing and burning. The fifth type is *Uapaca kirkiana* which occurs as pure stands limited in extend and 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 Mafungabusi Forest Reserve. Furthermore, most of the forests have been converted into intensive agricultural areas, hence it is difficult to locate pristine woodlands.



Legend

- Mopane woodland and savanna
- Miombo woodland and savanna
- Teak forest and woodland
- Acacia
- Terminalia-Combretum
- Other

Scale 1:5 000 000

Source: After Rattray and Wild 1961

N
W E
S

Figure 1.1 Common vegetation types of Zimbabwe

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. *B. plurijuga* is the dominant species and is usually found in association with *Pterocarpus angolensis* and *Guibourtia coleosperma*. Other common tree associates are *B. spiciformis, B. boehmii, Julbernardia globiflora, Afzelia quanzensis, Kirkia acuminata, Burkea africana, Combretum spp.* and *Commiphora spp.* The woodland has a long history of management for commercial timber exploitation, wildlife utilisation, cattle grazing and water catchment.

Degradation of the *Baikiaea* woodlands results in the formation of different vegetation types and the common recruitment vegetation is the savanna grassland and low height *Baikiaea-Burkea-Terminalia* woodlands.

Mopane woodlands

Mopane woodlands are quite widespread in Zimbabwe and are often associated with low altitudes and hot areas with sodic or alluvial soils. The woodlands can be divided into; the dry early deciduous (in north and west Zimbabwe); the dry deciduous (in Save Valley and Upper Limpopo); and the dry early deciduous shrubs (on basalt soils in southern Zimbabwe). 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). *Colophospermum mopane* is the dominant species. The following sub-types of mopane are recognised; *Colophospermum* alone - *Eragrostis* grass (Kalahari, Permian); *Colophospermum - Brachystegia boehmii - Aristida* (Kalahari); *Colophospermum – Acacia – Combretum - Cenchrus* (Basalt); *Colophospermum - Commiphora – Adansonia - Aristida* (several soil types). The associated tree species typical across the mopane woodland range include *Acacia nigrescens, A. nilotica, Adansonia digitata, Albizia harveyii, Balinites* spp., *Combretum* spp., *Commiphora* spp., *Dalbergia melanoxylon, Sclerocarya birrea, Terminalia prunoides, T. stuhlmanii, Ziziphus mucronata* and other shrub species such as *Combretum elaeagnoides, Dichrostachys cinerea, Grewia* spp. and *Ximenia africana.*

Where C. *mopane* is dominant, it assumes economic importance especially as a source of browse for both domestic and wild animals. It is also a source of timber for craft work, very good firewood, small household items, fence posts, hut poles, mine-props, railway sleepers, and sometimes parquet floors.

Acacia woodlands

In Zimbabwe, Acacia woodlands occupy sizeable tracts of land especially in the dry areas and grow on eutrophic soils. Available woodland sub-types include: *Acacia erioloba* on the Kalahari sands; *A. nilotica* on black clays; *A. gerradii* on the basement schists in association with *A. karroo* and *A. tortilis* on the colluvial 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. The common associated species found on the basement schist include, *Combretum apiculatum, C. hereroense, Sclerocarya birrea* and *Peltophorum africanum.* Because of their soil enriching properties, Acacia woodlands are often associated with a rich grass understorey. Common grass species include *Heteropogon contortus, Cymbopogon plurinodis, Eragrostis* spp., and *Panicum maximum.* Such woodlands 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 (mainly *Burkea africana* on granite or gneossic soils) but tends to be dominant when it colonises burnt sites. However, this woodland type has been severely cut and most of the existing vegetation is secondary. *Terminalia* also tends to be the recruitment species in areas affected by elephant damage (Boughey, 1963). It provides firewood, poles for construction and tool making, and disselbooms. *Combretum* is an important component of this woodland type and provides similar products to *Terminalia.* Associated tree species include; *Acacia* spp., *Sclerocarya birrea, Kirkia acuminata, C. mopane, Piliostigma thonningii, Peltophorum africanum, Strychnos innocua, Diospyros mespiliformis, Pseudolachnostylis maprouneifloia* and *Kigelia pinnata.* Under *Terminalia,* the predominant grass species are; *Heteropogon contortus, Eragrostis rigidior* and *Digitaria* spp. Grass species under *Combretum* include; *H. contortus, Themeda triandra, Panicum maximum* and *Eragrostis* spp.

2. Afromontane phyto-region species

Four distinct vegetation types have been described for the Afromontane phyto-region based on the following altitude zones: high to medium (1 400 to 1 800m); medium to high (1 350 to 1 650m); medium to low (1 000m); and low (<1 000m).

High to medium altitude zone (1400 to 1800)

Six sub-zones are readily recognised mainly in the Nyanga and Chimanimani mountains and the fringing rain forests and streams in the rain shadow areas.

- Sub- zone I forest is dominated by *Syzigium masukuense* accounting for almost two thirds of the canopy cover. It is found on the Nyangani massive. The canopy is usually 10 to 12 m in height with a few emergents, increasing the height to 15 m. Because of the high altitude, there is little activity and the forest is still intact.

- Sub-zone II is a distinct forest type with a limited distribution in the Nyanga mountains but is more extensively distributed in the south western areas of Chimanimani. A few patches are found in the Banti Forest area on the highest

ground. The dominant species is *Afrocania volkensii* or co-dominant with *Illex mitis* and are relatively undisturbed. Canopy height is up to 30 m.

- Sub-zone III is dominated by *Widdringtonia nodiflora* and is limited in extent and distribution. It is found in the Nyanga and Chimanimani mountains mainly between 1700 and 2100 m above sea level and is often confined to fringing streams and rain shadow areas where it is often affected by fires (Muller, 1994). The canopy rarely exceeds 10 m.

- Sub-zone IV is confined to drier sites mainly occurring on small concave patches or on ridges. The shrub layer is similar to that of Sub-zone I. Canopy height is variable, normally between 12 and 15 m. The dominant species are *Illex mitis, Schefflera umbellifera* and *Maesa lanceolata.* The forest is very variable and could be an aggregate of sub-types.

- Sub-zone V is dominated by *Syzigium guineense* and is found mainly on the Nyanga massive in association with other species such as *Aphloia theiformis, Cassipourea malosana, Cryptocarya transvaalensis, Olea hochstetteri, Pterocelastrus echinatus* and *Rapanea melanophloeos.*

- Sub-zone VI is a regenerating forest and is particularly common in the Nyanga and Vumba mountains where large areas are in different stages of recovery from clearance for agricultural and forestry activities. Near pristine *Syzigium* spp. dominated patches can be found together with *Macaranga mellifera, Aphloia theiformis, Maesa lanceolata,* and *Schefflera umbellifera.* The regenerating forests are characterised by the presence of *Cassinopsis tinifolia, Hypericum revolutum* and *Myrica pilulifera.*

Medium to high altitude zone (1350 to 1650m)

The medium to high altitude forests can be considered as an eco-tonal zone consisting of a mixture of montane and medium altitude tree species. The following four forest types can be distinguished.

- Type I forest is the mesic type found mainly in the Chimanimani and Vumba Mountains. *Syzigium* spp. dominate the canopy in association with other species such as *C. malosana, Nuxia congesta, Oricia buchmannii, Podocarpus latilifolius, R. melanophloeos, Chrysopyllum gorungosanum* and *Croton sylvaticus.*

- Type II forest is called *Craiba brevicaudata* forest which is fairly rare and found between 1400 and 1600 m confined to granite boulder screes. The canopy consists of *C. brevicaudata* in association with *C. malosana, Cassipourea gummiflua* and pioneer species such as *Albiza schimperiana, Macaranga mellifera* and *Polycias fulva*

- Type III forest is that dominated by *Albiza schimperiana* and *A. gummifera* - species indicative of a regenerating forest. The canopy height is about 40 m with emergent Albizias reaching up to 50 m.

- The fourth type is found on the driest part of the rainforest and borders with the miombo woodlands. The commonest species is *A. schimperiana* which occupies the driest parts and as moisture increases *A. gummifera* tends to dominate.

Medium to low altitude zone (1000 m)

Chirinda Forest, a gazetted forest situated 30 km south east of Chipinge town is the best example of a medium to low altitude rain forest remaining in Zimbabwe. The forest is about 905 ha in extent, of which 606 ha is the true rainforest and the rest is woodland (Timberlake and Shaw, 1994). The forest is still in the near pristine state and contains the full array of species typical of medium altitude forests. Dominant species include *Chrysophyllum gorungosanum, Craiba brevicaudata* and *Trichilia dregeana.* Other common species include *Newtonia buchananii, Maranthes goetziana, Khaya anthotheca, Ficus chirindensis* and *Lovoa swynnertonii.* Two species only found in Chirinda are *Celtis mildbraedii* and *Strychnos mellodora.* Canopy height can reach 60 m.

Limited harvesting of *K. anthotheca, C. brevicaudata, Tabernamontan ventricosa, Tannodia swynertonii* and *Strychnos mellodora* was carried out in Chirinda until 1956 when all timber harvesting rights were terminated. The forest, which hosts a unique and rare faunal species, is now being conserved for its aesthetic value, watershed protection function, scientific, educational and historical values.

Low altitude zone (< 1000 m)

The remaining lowland rain forest is found in the Risitu valley covering about two square kilometres. The dominant species are *N. buchananii, M. goetzeniana, Xylopia aethopica, K. anthotheca, Erythrophleum suaveolens, Futumia africana, Aporrhiza nitida, Blighia unijugata* and *Uapaca guineensis.* Small outliers of rain forests 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 of *Bivinia jalbertii* in Zimbabwe), Wedza, Bikita and Buchwa Mountains.

3. Exotic plantation species

The Tree Breeding Programme in Zimbabwe 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. Conservation of exotic forest biodiversity in Zimbabwe therefore provides genes for infusion in the breeding populations and contributes to global forest diversity conservation.

The genetic diversity of exotic tree species in Zimbabwe has been extensively studied by the Research and Development Division of the Forestry Commission. Exotic species were and are still being systematically introduced for evaluation for growth potential and use for production of wood. The original introductions of most commercial species came as bulk seed for plantation establishments. Plus trees were then selected in the commercial stands forming the progenitors of the sub-populations now available in the tree improvement programme. For pines and eucalypts, the sub-populations are created on the basis of adaptability to specific sites, resistance to drought and pests, and end use (timber, pulp, poles, firewood etc.). Some sub-populations were created for breeding purposes such as mating experiments, flowering studies and for maintaining resource banks.

Pinus species

The introduction of *Pinus* species into Zimbabwe may have started around 1903 when seed requirements were met by imports from South Africa. By 1937, *P. elliottii* and *P. taeda* were the major species at Stapleford. *P. patula* was first introduced in 1919 when 909g of seed was obtained from Mexico through the United States. Subsequent seedlots were introduced in 1928/29 from South Africa. Local seed collection started in 1930 and seed requirements were met from plantations established from the original consignment of 1919.

The major commercial species is *P. patula.* It is well adapted to most afforestation areas of eastern Zimbabwe that are above 1500 m above sea level and receive not less than 1000mm annual rainfall with mean annual temperatures below 18°C. Species diversity is presented 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 American and Mexican Coniferous Resources Co-operative (CAMCORE) of which the Zimbabwe Forestry Commission is a member.

The second commercially important pine species is *P. elliottii* with ten sub-populations (4 from Zimbabwean selections, 1 from South Africa, 1 from Malawi, 3 from the USA and 1 from Queensland in Australia). The species is adapted to lower altitudes of the eastern highlands. The third species is *P. teada* which is adapted to the better sites over a wide range of altitudes in the eastern highlands. The breeding status of the species consist 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. maximinoi.* For the latter species a comprehensive provenance trial has been established and all the best performing families will be grouped into one sub-

population. 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 in the highveld. The second important species is *E. camaldulensis* which is regarded as the most reliable species for the drier parts of the country. The diversity of the species in Zimbabwe is very broad and includes material 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. Research programmes with the lesser known Australian acacia species began in 1985 with seed being procured from Australia through the Australian Council for International Agricultural Research (ACIAR). The species being tested are *A. holosericia, A. auriculiformis, A. cowleana* and *A. tumida.*

Other exotic species

A whole range of other exotic species were introduced for various uses ranging from ornamental to medicinal and have changed the tree landscape of the country. Most of the original vegetation in urban centres has been removed and replaced by exotic species. For example, *Jacaranda mimosifolia*, which came from Brazil, now dominates the streets of Harare.

2.2.1.3. Genetic diversity in indigenous tree species

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 *Pterocarpus angolensis* and *Colophospermum mopane.* This section presents results from two case studies, in order to illustrate the potential genetic diversity in the natural woodlands.

Genetic diversity in indigenous fruit trees

The miombo woodlands have the greatest diversity in terms of indigenous fruit trees and a list of some of the fruit trees commonly found in this woodland is given in

Table 2.2.1. 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 or processed forms and a ready source of cash when sold on the road side or in urban markets. Such fruits include *Uapaca kirkiana, Ziziphus mauritiana* and *Adansonia digitata.* 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.

Table 2.2.1. Common indigenous fruit trees found in natural woodlands in Zimbabwe

Name of tree	Vernacular fruit name
Annona senegalensis	Maroro/Ububese
Azanza garckeana	Matohwe/Uxakuxaku
Flacourtia india	Nhunguru, Matudza/Umthunduluka
Mimusops zeyheri	Chechete/Umbumbulu
Parinari curatellifolia	Hacha/Umkhuna
Strychnos spp.	Matamba/Umtamba
Syzigium guineense	Hute
Tamarindus indica	Musika
Uapaca kirkiana	Mazhanje, mashuku/Umhobohobo
Vangueria infausta	Matufu, Nzviru/Umthofu, Umviyo
Vitex payos	Tsubvu/Umtshwankela
Ximenia caffra	Nhengeni/Umthunduluka

In order to enhance fruit production, it is important to sample the genetic diversity of the desired species throughout its distribution range. This is of major 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, this has been done using simple comparative morphological studies of fruits and seedling characteristics. Based on the level and significance of the variation observed, complex isozyme analysis can then be done to confirm variation at the gene level. Initial results of the variation in fruit characteristics of *Uapaca kirkiana* are presented in Table 2.2.2.

The Murewa provenance had the biggest fruit and a high pulp to rind weight ratio whilst the Mutarazi provenance had the lowest. Generally fruits from the eastern highlands were smaller compared to those from highveld areas. Murewa also had the sweetest fruit. There was however, little variation in fruit colour and number of seeds per fruit. 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.

Table 2.2.2. *Uapaca kirkiana* fruit characteristics

Provenance	Colour	Taste	Diameter (cm)	No.seeds/ fruit	wt. of seed .g	wt.of pulp .g	wt.of rind .g	Pulp to rind ratio
Nyamukwarara	1.99	2.20	3.19	3.96	3.20	11.81	4.96	2.4:1
Murewa	1.00	2.96	3.58	3.88	4.55	21.26	6.29	3.4:1
Domboshava	1.80	2.44	3.03	3.96	3.70	11.49	4.92	2.3:1
Musana	1.93	2.30	3.31	3.83	3.54	12.66	4.95	2.6:1
Mapanzure	2.00	2.76	3.29	3.76	4.27	16.55	5.11	3.2:1
Chatsworth	2.00	2.76	3.07	3.88	2.94	10.45	4.95	2.1:1
Ndanga	1.78	2.64	3.17	3.86	3.42	11.95	4.94	2.4:1
Wedza	2.00	2.60	2.73	4.04	2.68	8.99	3.44	2.6:1
Mandeya	1.6	2.76	3.31	4.00	4.53	13.13	5.86	2.2:1
Mutarazi	1.8	2.56	3.04	4.12	3.38	11.31	4.38	2.3:1
Zimunya	1.8	1.96	2.82	4.34	2.85	6.86	3.81	1.8:1

Source: Forestry Commission, 1996

Genetic diversity in indigenous commercial timber species

The Teak woodlands found on the Kalahari sand formations have a number of commercially important timber species which include *Baikiaea plurijuga*, *Pterocarpus angolensis* and *Guibourtia coleosperma.* Since specimens of good form are targeted during harvesting leaving poor trees, logging leads to general genetic impoverishment with the removal of the best phenotypes. In order to protect the gene pool, a number of Strict Natural Reserves (SNR) were established in areas where commercial harvesting takes place (Table 2.2.3.). The 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 need to be conserved *in-situ*, and if the variation is big then a large number of SNRs will have to be established.

Work on genetic variation has concentrated on *C. mopane* and *P. angolensis* where information on variation is being collected from glass house experiments through the measurement of seedling traits. Initial genetic study results for *P. angolensis* are given in Table 2.2.4. They indicate that seed of provenances from north western Zimbabwe (Fuller, Mzola and Gokwe forests) have bigger seeds than those from other parts of the country. Germination rates were consistently high for all provenances. Similar variation studies on *C. mopane* indicated considerable variation in seed characteristics with provenances from the northern part of the country (Zambezi valley and Mana Pools) having larger seeds than those from the south.

Table 2.2.3. Information on Strict Natural Reserves established between 1992 and 1995.

Species	Location	Area (ha)	Year
Pterocarpus angolensis	Umzibane Forest	91.6	1992
Baikiaea plurijuga	Gwayi Forest	101.6	1992
Baikiaea plurijuga	Kazuma Forest	100	1992
Pterocarpus angolensis	Ngamo Forest	94.9	1992
Guibourtia coleosperma	Ngamo Forest	99.4	1992
Colophospermum mopane	Sijarira Forest	100	1994
Pterocarpus angolensis	Fuller Forest	100	1993
Entandrophragma caudatum	Ungwe Forest	532	1993
Entandrophragma caudatum	Mudzongwe Forest	1420	1993
Baikiaea plurijuga	Gwampa Forest	80.7	1993
Colophospermum mopane	Mzola Forest	100	1995

Source : Forestry Commission, 1996

Table 2.2.4. Weight and germination % for *P. angolensis* seeds

Seed source	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	154.4	95
Nyamandlovhu	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

2.2.1.4 Relevant micro-organisms (fungi and bacteria)

Mycorrhizal fungi are associated with a wide range of exotic and indigenous tree species found in Zimbabwe. These fungi improve tree growth by increasing the absorbing surface of the root system; by selectively absorbing and accumulating nutrients such as phosphorus; and, by making feeder roots more resistant to infection by fungi such as *Phytophthora, Pythium* and *Fusarium.* Ectomycorrhizae (mostly produced by mushrooms) and endomycorrhizae (mostly produced by phycomycetes of the genera *Endogone* and *Glomus*) are often associated with miombo and kalahari tree species respectively. Unfortunately, very little work has been done on these fungi. With respect to *Pinus* plantations, mycorrhizal fungi (mushrooms) that have been

identified include: *Thelephora terrestris, Amanita muscaria, Suillus granulatus* and *Boletus edulis*. With increasing deforestation, most of the mycorrhizal fungi are lost. This has adverse effects on tree planting efforts targeted at reafforesting degraded areas.

Trees also associate with certain species of bacteria in a symbiotic fashion. For example, the bacterial genus *Rhizobium*, infects roots of leguminous tree species such as *Leucaena leucocephala* and several species of Acacias. In such relationships, the bacteria obtains nutrients in the form of sugars from the tree and fixes and avails atmospheric nitrogen in organic form to the tree. However, the taxonomic position of nitrogen fixing bacteria in Zimbabwe's forests is not well known and no efforts have been made to collect, characterise and conserve beneficial strains.

2.2.2. Causes of forest biodiversity decline, increase or maintenance

2.2.2.1. Abiotic factors

Population pressure and land tenure systems

About 70% of the country's 12.2 million people live in communal areas and depend directly on forests for firewood, construction timber, food and fodder. However, the open access to forests in these areas results in their over exploitation due to lack of accountability. This is worsened by poverty; lack of alternatives; poor enforcement of the Communal Lands Forest Produce Act and the appropriate Rural District Council by-laws; and the breaking down of traditional social structures and local customs which facilitated the control of access to forest resources. On the contrary, there is better biodiversity conservation in the large scale commercial farms which are privately owned. With respect to gazetted forests, biodiversity conservation is being threatened by neighbouring communities who illegally obtain timber and non timber forest products from them. Plans are now under way to replace the colonial protectionist approach to conserving these forests to one which considers communities living on the "forest edge" as partners in the conservation, management and utilisation of the forests through Resource Sharing Committee schemes.

Expansion of agricultural land

The opening up of forest land for agricultural expansion is the major reason for the loss of forest biodiversity. It is estimated that 70 000ha of forest land is lost to agriculture each year. In fact it is now difficult to find pristine miombo woodlands on the central watershed of Zimbabwe as most have disappeared to give way to cropping and grazing land. The growth of the tobacco industry has also increased the demand for fuelwood for tobacco curing.

Effect of fires

Controlled burning is a prescribed management tool in gazetted teak woodlands. "Cool" burning was introduced in order to reduce fuel loads and thus the intensity of late dry season fires. 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 species; and from single to multi-stemmed root-stocks (Calvert and Timberlake, 1992). Farquhar (1970) identified two shrubs namely *Bauhinia petersiana* subsp. *macrantha* and *Commiphora mossambicensis* as indicative of the adverse effect of fires. Other species which tend to dominate after repeated fires are *Terminalia sericea, Ochna pulcra* and *Combretum* species. The complete protection of teak woodlands from fires favours the regeneration of fire-tolerant species such as *Pterocarpus angolensis, Erythrophleum africanun* and *Burkea africana* (Farquhar, 1970; Geldenhuys, 1977; Calvert, 1986).

The effect of fires on other woodland types has not been extensively studied since fires are uncommon and are not used as management tools. However, the fires that occur in the wattle jungles of the eastern highlands promote seed germination and regeneration of the species and have significantly contributed to its spread.

2.2.2.2. Biotic factors

Scale insects in miombo woodlands

Miombo woodlands are considered the richest and most productive in terms of biodiversity. However, some of the key species are threatened by die-back and deaths due to a scale insect called *Aspidoproctus glaber* Linderger (*Homptera: Margarodidae*) recorded since 1985 (Mazodze, 1995; Mushongahande, 1997). The scale insects are actually sedentary females that attach themselves to tree stems and camouflage themselves by mimicking bark colour and form. In some cases they have been seen mimicking spine form on *Acacia* species. The occurrence of scale insects is widespread in the Hurungwe district and has also been reported in Makonde East, Mutare, Kwekwe and Sanyati with a total area of 115 000ha having been affected. The sap-sucking insect attacks twigs, branches and the main stems of a number of miombo trees with the preferred ones being *Brachystegia, Julbernardia* and *Acacia* species, (Table 2.2.5). Affected trees show defoliation followed by tip die - back, bark splitting, die-back of branches and stems and eventual death of the whole tree. The recommended control measures include avoiding transfer of affected logs to other areas and general "sanitary" silviculture.

Mukwa die-back

Pterocarpus angolensis (mukwa) suffers from die-back which is commonly known as mukwa die-back or mukwa blight. This phenomenon occurs in the Kalahari Sand forests notably Fuller Forest Reserve. The disease has been attributed to a wilt disease caused by *Fusarium oxysporum* and the pre-disposing conditions include droughts, fires, frosts and heavy browsing by wildlife (Pierce, 1979 and Calvert *et al*, 1992). It is projected that the disease will lead to a substantial decline in mukwa tree populations in the next fifty years (Wyk *et. al*, 1993).

Table 2.2.5. Hosts of *Aspidoproctus glaber* in Zimbabwe

Botanical name	Local name(s)
Brachystegia allenii Burrt Davy & Hutch	Muturu, Mupfuti
Brachystegia boehmii Taub.	Mupfuti, Itshabela
Brachystegia glaucescens Burrt Davy & Hutch	Muunze, Mutsotso, Umbuze
Brachystegia spiciformis Benth.	Msasa, Igonde
Julbernardia globiflora (Benth.) Troupin	Munhondo, Mutondo, Umshonkwe
Burkea africana Hook.	Mukarati, Umnondo
Pilostigma thonningii (Schumach) Mil-Rd	Musekesa, Mutukutu, Ihabahaba
Pterocarpus angolensis DC.	Mubvamaropa, Mukwa, Umvagazi
Pericopsis angolensis (Bak) van Meeuw.	Muvanga, Muwanga, Umbanga
Afzelia quanzensis Welw.	Mukamba (Mahogany), Umkamba
Albizia antunesiana Harms	Muriranyenze, Umnonjwana
Acacia tortilis (Forsk.) Hayne	Muunga, Isanqawe
Acacia nigrescens Oliv.	Chinanga, Mupumbu, Umkhayaomhlope
Bridelia cathartica Bertol.f.	Mupambare, Mutsitsvirondo
Bauhinia petersiana Bolle	Mupondo, Mun'ando, Imondo
Diplorhynchus condylocarpon (Muell). Rag) P.	Mutowa, Musikanyimo, Inkamamasane
Monotes glaber Sprague	Muvara, Munyunya, Mushava, Inyunya
Erythrophleum africanum (Benth.) Harms	Mushati, Umbako
Xerodendris stullimanaii (Taub) Mendonca	Muriravanhu, Mumwambizi, Umthundulu

Source: Mushongahande (1997)

Baobab Sooty mould

Magnificent baobab (*Adansonia digitata*) trees especially in the Chipinge and Victoria Falls areas are attacked by brown cork warts which are later colonised by sooty mould. The attacks start off on the twigs and trunks and the pre-disposing factors include drought, extensive bark stripping for basket and mat making and road construction activities. Affected trees usually turn black and later crumble into a pulpy heap. A number of fungi associated with this "condition" have been isolated and include *Antenulariella, Hyphomylete, Aureobasidium* and *Botryodiplodia* (Pierce *et. al*, 1994; Mushongahande, 1996).

Pest and diseases of commercial exotic species

The diversity of exotic plantation species in Zimbabwe is constantly under threat from a number of pest and diseases. Since the species are grown under different environmental conditions from their original habitat, they tend to easily succumb to diseases and pests due to absence of the natural predators. In some cases local diseases and pests attack the introduced tree species. For example the *Dothistroma* needle blight attacked *Pinus radiata* leading to the abandonment of the species for commercial purposes in the country.

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

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* (muranga), 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 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.

Effect of browsing by elephants

The impact of elephant browsing on forest biodiversity is a function of their population density. In general terms, 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 teak and mopane woodlands. For example, elephant damage can cause suppression of tree growth resulting in shrub and grass savanna 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. Notwithstanding, elephants are useful in spreading tree species through seed dispersal. A more detailed account of the effects of elephants on forest biodiversity is given in Section 2.3.2.2.

2.2.2.3. Cultural and ethnic value factors

Most cultural and ethnic values of local communities had the effect of maintaining or increasing forest biodiversity. These are largely related to selective harvesting of trees and non use of certain species. Traditionally, there was selective tree harvesting through 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, Julbernardia 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 the 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 agriculture, local people practised 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.

2.2.2.4. Effect of technology on biodiversity

A number of organisations are involved in forest and forest related research in Zimbabwe. For example, the Forestry Commission initiated an exotic plantation tree improvement programme in 1958. This programme reduced the rotation age of pines from 33 to 25 years and significantly increased stem form. These achievements have increased the productivity of industrial pine plantations both locally and internationally. Similar work is being extended to indigenous trees especially fruit trees that have considerable commercial value (e.g. *Uapaca* and *Zizyphus*). Other tree related research being conducted by various local institutions includes the ecology and management of indigenous trees, regeneration studies, tree planting studies, agroforestry, resource evaluations and forest resource sharing initiatives between state authorities and communities living "on the edge" of gazetted forests.

Although there have been considerable attempts to encourage the planting of trees in communal areas for purposes such as fuelwood and fruit supply, such efforts have had a biodiversity enhancement effect. For example, the Forestry Commission has been implementing the rural afforestation programme since 1983. Seedling production was identified as a key activity during the first phase of the programme and resulted in the establishment of 78 centralised nurseries of eucalypts seedlings which were then distributed and sold to interested farmers, communities, schools and local authorities. However, the concept of "centralised nurseries" proved expensive and the nurseries were thus handed over to interested local groups and individuals in the second phase of the programme. Local communities were encouraged to establish their own "satellite nurseries" in which they would raise seedlings of their own choice.

This resulted in the diversification of the seedling mix from eucalypts alone to include fruit and indigenous tree species. Such efforts by the Forestry Commission and other organisations have contributed to increasing forest biodiversity in most deforested communal areas.

There is considerable potential of using biotechnology in forestry development. For example, micro-propagation techniques which facilitate the rapid multiplication of planting material can alleviate the problem of limited availability of tree seedlings for agroforestry. Micropropagation of orchids and other woodland products such as mushrooms is being carried out at Africa University in response to a survey that showed a decline in the diversity of traditional mushrooms in line with decreases in symbiotic indigenous forest tree species. The remaining local mushroom varieties are being collected and propagated using water hyacinth, maize cobs and other local compounds as substrates.

2.2.3. Conservation and sustainable use measures

2.2.3.1. Status of monitoring approaches

Although there are no biodiversity specific monitoring programmes in the forestry sector, a number of projects incorporating vegetation inventories have been carried out by a number of institutions and are highlighted in this section.

The Department of Natural Resources

The Department of Natural Resources has been running an Integrated Resource Information System (IRIS) programme since 1992. IRIS is an information management tool used to describe and assess Zimbabwe's natural resources using remote sensing, geographical information systems 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 using 1992 as the base year. The inventories are based on a floristic framework in which vegetation is divided into eight classes (according to the dominant tree species) and subdivided into 37 vegetation types. These are depicted in Annex 6.2.1. This programme will be implemented nationally once the current pilot project is concluded. Plans are also under way to set up a national ecological land classification in order to provide a geographical context for monitoring and assessing environmental conditions and managing natural resources.

Forestry Commission

The Forestry Commission has put in place the Strict Natural Reserves (SNRs) concept in gazetted forests as discussed in Section 2.2.1.3. Eleven SNRs have been established so far and the species being conserved are *P. angolensis, B. plurijuga, G. coleospermum, C. mopane* and *E. caudatum*. Growth dynamics and genetic variation studies are being carried out in the SNRs. The Commission has also been implementing

a Vegetation Resources Information System (VegRIS) project since 1993. The project, which utilises remote sensing and geographical information systems technology, has produced national woody cover maps at 1:250 000 and 1:1 000 000. Work on the development of methodologies for monitoring vegetation changes and woody biomass estimation activities are currently under way.

Department of National Parks and Wildlife Management

The Department of National Parks and Wildlife Management conducts periodic surveys to monitor vegetation changes in National Parks. Some of the work recently completed include:

- 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.

National Herbarium and Botanical Gardens

The National Herbarium and Botanical Garden has carried out a number of vegetation inventories which include:

- A vegetation survey covering communal areas of the Zambezi and part of the Mazowe 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.

It is important to note that the foregoing surveys form valuable benchmarks for monitoring forest biodiversity changes in the country.

Timber Producers' Federation

The Timber Producers' Federation, an association of plantation growers and sawmillers in the country, has developed and adopted self-regulatory environmental management guidelines. The 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 areas. Using these guidelines, the Timber Producers' 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.

2.2.3.2. *In-situ* conservation

In-situ conservation of forest biodiversity occurs in the gazetted areas, national parks and other protected areas. These areas are shown in Figure 2.2.

Gazetted forest areas

The Forest Act gazetted the establishment of forest areas for the sustainable extraction of timber; to act as reservoirs of wildlife and water catchment areas; and, for the conservation of biological diversity. These forest areas total about 800 000ha (about 2% of the country's land area) and are located on Kalahari Sands in the north western part of the country (Table 2.2.6 and Figure 2.2.). 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 trees of bigger diameters (30cm dbh), good stem form and with at least 3 metres of utilisable timber. As a way of reducing this genetic erosion Strict Natural Reserves (SNRs) have been established in some forest areas. These are like "witness stands" and are not "touched" during a timber harvesting concession.

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 form a strong basis for the conservation of flora and fauna in Zimbabwe.

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 like Hwange, the forests are under pressure from browsing by large animals such as elephants and the vegetation is also changing from forest to shrubland. A number of Botanical reserves were also set up to conserve unusual areas of special interest.

Areas under botanical reserves, sanctuaries, national parks, recreational parks, safari areas and world heritage sites are summarised in Table 2.3.6 (see Section 2.3.3) and cover about 13% of the country.

Table 2.2.6. List of gazetted forest areas in Zimbabwe

Name of Forest	Area (ha)
Chesa	14 250
Inseze	8 400
Umgusa	32 200
Gwaai	144 230
Ngamo	102 900
Nyamandlovhu	7 420
Mbembesi	55 100
Lake Alice	39 000
Gwampa	47 000
Mzola	67 200
Sukumi	54 400
Kazuma	24 000
Fuller	23 300
Panda-Masui	35 500
Kavira	28 200
Sijarira	25 600
Molo	2 900
Umzibane	2 471
Mvutu	2 100
Mafungautsi	82 100
Ungwe	567
Mudzongwe	1 420
Total (22)	800 258

2.2.3.3. Ex-situ conservation

The *ex-situ* conservation of forest biodiversity in Zimbabwe is achieved through seed banks, resource conservation stands and botanical gardens.

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 Forestry Commission currently holds over 23 000 accessions mainly consisting of seeds of species collected from natural stands, research trials and other seed centres world wide. The material is kept in cold rooms to ensure long term seed viability. Information kept on the seed lots include; 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.

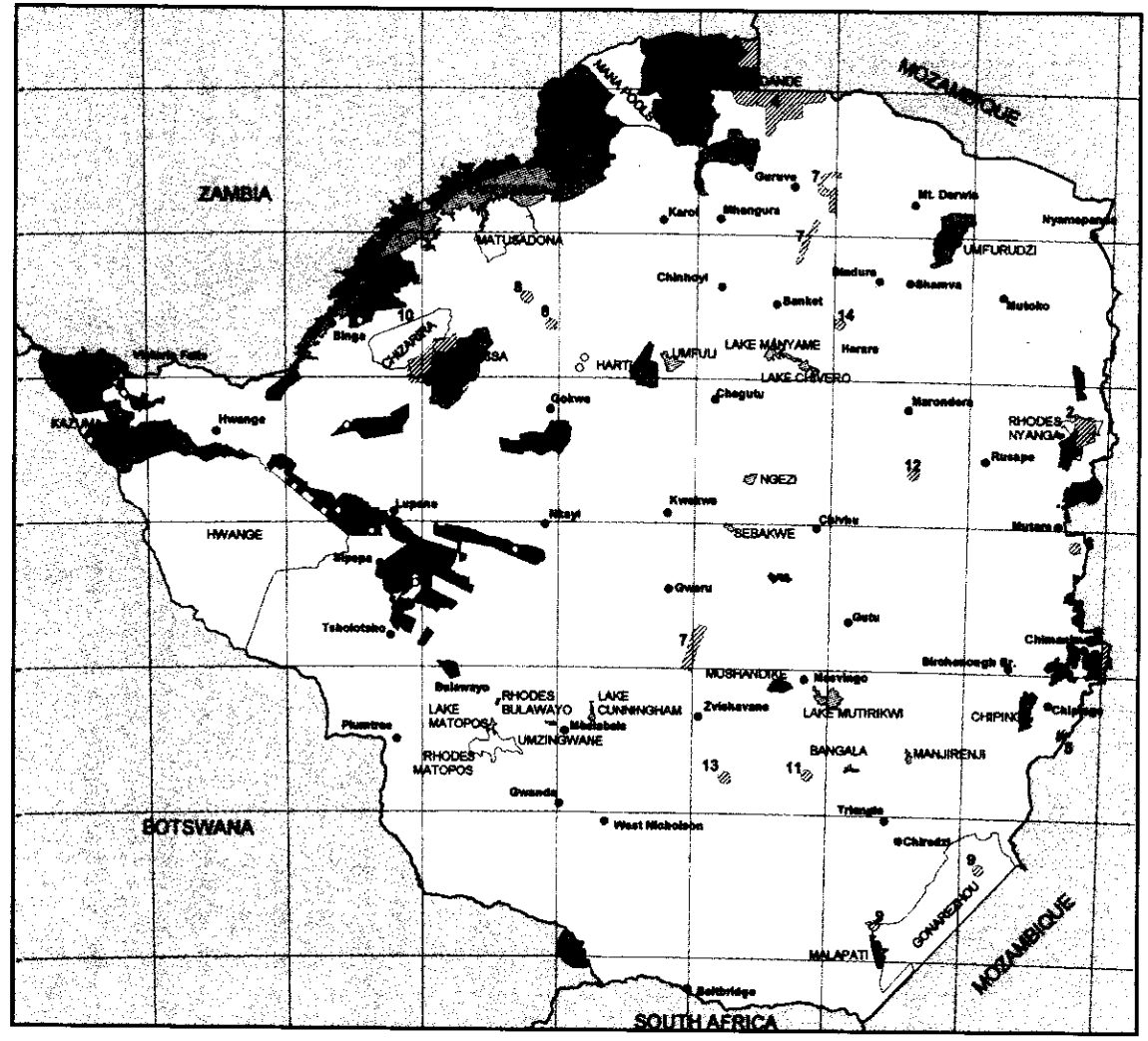


Fig 2.2 BIODIVERSITY CONSERVATION AREAS IN ZIMBABWE

LEGEND

- SAFARI AREA
- NATIONAL PARK
- SANCTUARY
- RECREATIONAL PARK
- INDIGENOUS FOREST LAND
- PLANTATION FOREST LAND
- STRICT NATURAL RESERVE
- Town
- Lake
- Proposed For Vegetation Conservation

1 Chimanimani Mountains
2 Nyanga Mountains
3 Busi-Sengwa
4 Chewore-Angwa
5 Chirinda Forest
6 Bunga Forest
7 Great Dyke
8 Gokwe Thicket
9 Gonarezhou Thicket
10 Binga Dry Forest
11 Nyoni Hills
12 Mt Hwedza
13 Mt Buhwa
14 Mazoe Botanical Reserves

N

50 0 50 100 Kilometers

November 1997

Zimbabwe Forestry Commission
Research & Development Division
Mapping & Inventory Unit

VEGETATION RESOURCES INFORMATION SYSTEM (VEGRIS)

Resource conservation stands

Resource conservation stands are established for species that are threatened by over exploitation and those 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 in order to ensure the continuation of the species. To this end, 27 sites have been gazetted under the Natural Resources Act as special areas of endermism or representatives of certain vegetation/species types on privately owned land (see Figure 2.2.).

Botanical gardens

A 68 hectare 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. Such 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.

2.2.3.4 Access to biological and genetic resources

Property rights over and access to forest resources are closely linked to the land tenure category on which the forest resource is found. It is important to note however, that land and tree tenure are not always synonymous and hence overlapping tenurial niches in forestry can be expected (Nhira and Fortman, 1993). The Forest Act and the Communal Lands Forest Produce Act (CLFPA) bring to bear two main property rights regimes, namely state and private property regimes. The large forest estate is vested in the State. The Forest Estate clearly constitutes state property to which access is gained through a system of permits, licences, agreements and concessions or in terms of a right granted to inhabitants of communal land. Communal land strictly speaking, is state land which has been designated as such. The land and resources thereon are vested in the state. Inhabitants have usufructuary rights over the resources. Forest and woodland resources are communal property. The legislation in place gives the State wide and sweeping regulatory powers as well as a broad discretion in terms of the type, location and amount of forest produce that may be harvested by any person to whom an authority has been granted. An authority to exploit forest resources guarantees a fairly secure resource tenure system, provided that the conditions of the authority are complied with for the duration of the permit. The Forestry commission may further regulate the taking of indigenous timber resources outside the forest estate and has overriding power to issue concessions for the exploitation of these. Further, the legislation gives Rural District Councils control over forest resources in

communal areas and thereby empowers them to alienate any produce occurring in the forest through a system of concessions.

Forest resources in the communal areas are accessible to communal land dwellers only for the purpose of "own use" and any commercial exploitation of these resources is prohibited by the CLFPA. This failure to allow inhabitants to benefit economically does not take into account current realities whereby commercial exploitation of forest resources, particularly wild fruits and honey, is a widely practised additional income generating activity for many rural households. The State retains the right to grant authority to exploit communal forest produce to any person and does not enjoin the State functionary to consult the residents of communal areas for whom the resources have historically constituted common property resources.

Forest resources on alienated (private) land is held under a private property regime with owners or occupiers of such land having exclusive property rights save to the extent to which the Forest Act and Natural Resources Act may place limitations on the exploitation or destruction of the forest resource, particularly indigenous timber.

Access to exotic forest genetic resources in the country is through the Forestry Commission's Tree Seed Centre, which is responsible for distributing genetic material at cost or on a free issue basis in the case of experimental material. However, access to improved genetic experimental material might become an issue once forestry companies opt for clonal propagation and thus require elite cloning material. This would require a change in the policy on access to forest genetic resources for research purposes. Such changes could include the introduction of access charges that incorporate intrinsic value; and the introduction of agreements or contracts for profit sharing offering rights to access on tender.

2.2.4. Legislative and policy frameworks

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. This is achieved through the establishment of conditions for and regulation of the magnitude to which forest produce may be utilised. Despite post independence amendments, the two Acts largely retain the colonial approach to natural resources management based on racially determined principles. As is evident from its short title, the CLFPA finds its application in the communal areas, which were assigned for African occupation. Typically, this Act imposes a rather strict regulatory framework which is highly state interventionist. On the other hand, the Forest Act, whilst seeking to be broad in its coverage of forest resources throughout the country, finds its primary focus on state forests and on forest resources occurring on private lands, most of which comprise the former European areas. The controls over private forests under the Act are less strict and provide a somewhat self regulatory control mechanism for the management of private forest resources by their owners.

The Forest Act provides for the establishment of demarcated forest areas and establishes a Commission to serve as the state authority mandated with the dual responsibility of providing policy advice to the Minister responsible for the administration of the Act and of performing regulatory functions. The regulatory functions deal with the control, management and exploitation of state forests, plantations and forest nurseries belonging to the state and any other land as may be acquired by the state for forestry purposes. With regard to forests occurring on private lands, the Act provides for their protection where the owner or occupier applies to the Minister for such protection. An application may only be made where the owner or occupier of the private land in question places all or part of the land under a system of forest management approved by the Commission. The Minister has a discretion to declare the private forest a protected forest if such a declaration is in public interest. The Minister may in the same manner revoke the declaration of protection, where the private land no longer falls under an approved system of forest.

The Minister is empowered to declare any species of tree or any forest produce occurring in a state forest and on any other state land which has been declared a demarcated forest to be specially reserved. The Minister's powers do not include trees or produce occurring in the Parks and Wildlife Estate, plantations and communal land. This power vests in the State President. The protection, control and management of state and private forests is sought to be achieved through the establishment of a range of prohibited activities and offences. It is an offence to harvest or damage any forest produce on state and private protected forests without the written authorisation of the Minister. Harvesting of and damage to any protected tree or any tree in any forest or plantation which the President has declared to be protected is further prohibited, except where this is carried out in accordance with regulations or the permission or direction of the Commission.

The forest act is directed primarily at exploitation of the forest resource rather than one of sustainable management. It has not been suitably modified to reflect the forest policy and current trends in forest management. The Act came into force in 1948 initially to control and regulate the mining industry which had hitherto conducted unregulated timber extraction for some 50 years. The supremacy of the Mines and Minerals Act over all other resource use legislation meant that most of the indigenous forests of the country had been heavily logged by miners and their contracts at the time the Forest Act was passed (Scoones and Matose, 1993). The Act however remains partial to the mining industry as is the case with all other natural resources legislation in the country. It maintains the tacit assumption prevalent in all the Zimbabwean natural resource legislation that mine development is the pre-eminent land use and that minerals may be mined wherever they occur (Henly, 1990). However, the Act provides for the formation of a Mining Timber Permit Board (MTB) which considers applications for permits for the extraction of timber for mining purposes.

The Forest Act *prima facie* prohibits the harvesting, injury or destruction of any indigenous trees or timber from private forests and forest produce from any state land except in terms of a valid mining timber permit issued with the consent of the

appropriate authority for the land. A miner does not however require a permit for the clearance of forest land where an access road to the mining claim is sought to be established or, where boundary roads are marked, and in instances where a part of the forest interferes with his mining activities. This general assumption may however be withdrawn by the MTB where it is satisfied that the miner is cutting, felling or removing forest produce, trees or timber in such a manner resulting in undue damage to the locality concerned. Other criteria for the refusal to issue a mining timber permit include the situation where the taking of timber would adversely affect the timber supplies in that locality or Zimbabwe as a whole or where suitable alternative supplies of timber are available to the applicant for the timber permit.

The Communal Land Forest Product Act (CLFPA) vests the administration of exploitation of all communal area forest produce with the Minister. However, a range of authorities are provided for, and these cover licences, agreements and permits. 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. Furthermore, an inhabitant may not exploit forest produce in a protected forest, a reserved tree, or any produce over which an authority to exploit has been granted to any person and where a plantation has been established by any person other than the inhabitant. However, these may be exploited in the course of clearing land for residential and cropping purposes, where rights of occupation and use under the Communal Land Act have been granted.

The Act empowers the Minister to set aside areas of natural forests occurring in the CAs as protected forests. The Minister may further declare any tree to be a reserved tree and such a tree may not be exploited except in terms of a special licence or permit. Some sixty trees fall into this category and are depicted in Annex 6.2.2.

Special permits and licences authorise a holder to exploit reserved trees outside a protected forest and in the case of an inhabitant, authorise him to exploit reserved trees in a protected forest area in which he is resident. Thus the CLFPA effectively removes the management of natural forest resources from the inhabitants of its area of application. Firstly, the Minster is vested with authority to exploit the forest resource on behalf of the state. In cases where a forest falls within the jurisdiction of a local authority, control over the resources therein lies with the appropriate Rural District Council, which has the right to grant concessions to outsiders to utilise forest products for commercial purposes.

In exercising his powers under the Act, the Minister is required to consult the local authority that may be affected by the exercise of his power. However, no consultation mechanism exists for the inhabitants, as the law assumes the local authority is a representative of all interests of affected persons under its jurisdiction. The Minister is however required to have due regard to the interests of present and future inhabitants of communal lands that may be affected by the exercise of his powers. The concept is however not well supported by the Act, as it does not require the Minister to prepare inventories of forest produce existing and exploited for his guidance in issuing permits. The limitation of the right for inhabitants to exploit forest produce for "own use"

prevents local level initiatives for resource sharing or exchange of resources and fails to acknowledge the centrality of woodland resources within the rural economy (Mohamed-Katerere, 1996).

2.2.5. Institutional framework, cross sectoral linkages and the human resource base.

2.2.5.1. Institutional framework.

The Ministry of Mines, Environment and Tourism, through its line departments (the Forestry Commission, the Department of Natural Resources, and the Department of National Parks and Wildlife Management) is the major player in forest biodiversity management. Other sectors such as agriculture, construction and water have both direct and indirect impacts on forest resources

The Forestry Commission, in its capacity as the state forest authority, is responsible for *in-situ* and *ex-situ* conservation of forest biodiversity and the Department of National Parks and Wildlife Management is in charge of the wildlife component. The Department of Natural Resources is responsible for regulating and enforcing broader environmental issues, while the Department of Rural and Urban Planning formulates local by-laws for resource conservation with the involvement of Rural District Councils, who are closer to the natural resources. Other important government institutions are:

- The Ministry of Transport and Energy which is responsible for developing the national biomass energy strategy and for road construction;
- The Ministry of Lands and Agriculture, formulates agricultural policies and strategies and reviews land tenure legislation;
- The Ministry of Rural Resources and Water Development, whose activities directly impact on forest biodiversity;
- The Mines component of the Ministry of Mines, Environment and Tourism whose Mines and Minerals Act overrides all other Acts in natural resource exploitation;
- The National Herbarium which has a comprehensive collection of botanical specimens and carries out taxonomic identifications and field explorations;
- The National Museums and Monuments, gazettes areas of cultural significance. Such sites often contain considerable tree diversity; and,
- The Department of the Surveyor General, provides a full range of surveying and mapping services critical for forest inventories and biodiversity monitoring.

The University of Zimbabwe generates information on resource use patterns and forest biodiversity through the Institute of Environment Studies, the Centre for Applied Sciences, and the Department of Biological Sciences.

The Woodland Management Group which consists of four local environmental Non Governmental Organisations (NGOs) *viz* ENDA-Zimbabwe, ZERO, SAFFIRE and BUN, is very active in forest matters and plays key advocacy and lobbying roles in

forest biodiversity conservation, while NGOs such as IUCN, The Zambezi Society and WWF perform important financing and lobbying roles.

2.2.5.2. Cross sectoral linkages.

Given the complementary roles played by various institutions in the maintenance of forest biodiversity, the need for cross sectoral linkages cannot be over emphasised.

The Forestry Commission's operations are guided by the Forest Act of 1948 which gives it the authority to protect forests and woodlands and to govern the exploitation of forest resources. The Commission interacts with other government departments and a plethora of NGOs, in the performance of its tasks. However, despite the complementarity of its work with that of NGOs, there is considerable mistrust among these players.

The Natural Resource Act of 1942 governs the functions of the Department of Natural Resources and covers all natural resources including forests, water, soil, air and minerals. The department's functions generally involve monitoring, regulation and enforcement of rules on environmental conservation. However, the distinction between its regulatory functions and those of the Forestry Commission in forestry matters is not clear.

The Department of National Parks and Wildlife Management is responsible for managing the country's parks which contain a large part of the country's forest biodiversity. However, vegetation resources in National Parks are largely viewed as "food" for the animals, with their conservation being accorded a subordinate role. This is worsened by the lack of joint planning between the Department and the Forestry Commission on forest conservation matters.

Although forests provide crop nutrients through leaf litter and regulate water flow and infiltration, the role of trees and woodlands in agriculture is not clearly articulated in Zimbabwe's agricultural policy. This has contributed to rather poor positive linkages between agriculture and forestry. The Draft National Energy Policy of the Ministry of Transport and Energy focuses on the utilisation of wood for fuel with emphasis on localised fuelwood deficits in many districts of the country. It also highlights the need for alternative and affordable sources of energy in rural areas in order to reduce deforestation.

Most demarcated forests in Zimbabwe were gazetted for the purpose of protecting the water catchment areas. It is however disappointing to note that there is very little linkage between the forestry and water sectors. The Save catchment area provides a paradigm where a multi-sectoral approach to resolving land degradation could successfully be adopted.

2.2.5.3. Human resources

The foregoing analysis of institutions involved in forest biodiversity management shows that there is considerable human capacity in this area. However, there are apparent inadequacies in professions such as biosystematics, botany and ecology which are critical in biodiversity conservation. Furthermore, weak cross sectoral linkages do not facilitate the judicious utilisation of available skills. Consequently, there is need for a detailed human resources and skills audit.

2.2.6. Economic factors

2.2.6.1. Valuation of forest biodiversity

Forest biodiversity (both indigenous and exotic) plays an integral role in the social and economic development of Zimbabwe through the provision of various goods and services.

Economic values and wood supply in commercial forestry

Commercial forestry in Zimbabwe is highly vertically integrated into timber production, processing, packaging and marketing. It employs about 16 000 people and contributes some 3% to the Gross Domestic Product. The structure of roundwood consumption in the industry is shown in Table 2.2.7.

The wood supply and demand picture in exotic plantations is mixed (Arnold, *et, al*, 1993). Average annual timber consumption in the sector was 656 000m^3 between 1987 and 1990 and 541 333m^3 between 1989 and 1991. However, the actual volume of roundwood harvested compared to that consumed is somewhat clouded by fibre imports as 51% of the fibre requirements for pulp and paper products and reconstituted panel products are imported. Furthermore, chips from sawlog production are used to manufacture pulp and paper and reconstituted panel products. 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 the 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.

With respect to indigenous forests, commercial production is mainly based on *Pterocarpus angolensis* and *Baikiaea plurijuga.* The total demand for roundwood in 1989/90 was approximately 50 000m^3, while the 1991/92 supply of high value hardwoods from concessions in western Zimbabwe was less than 22 000m^3. This means that the current demand for commercial hardwood timber cannot be met from the local resource alone.

Table 2.2.7 Roundwood consumption by industry (plant) type in 1995/96

Plant type	No.of plants	Roundwood m^3	% increase over 1994/95
Sawmills	54	882 971	0.1
Veneers & Ply mills	2	33 530	4.8
Particle & Fibreboard	2	133 650	38.6
Pulp & Paper Mills[1]	2	125 900	7.8
Match factory	1	12 000	96.7
Pole production	5	88 278	31.6
Mining timber	-	3 807	5.8
Wattle factory[2]	1	69 833	(13.8)
Charcoal production	1	50 125	2.3
Total		1 400 094	6.3

[1] includes 39 658 m^3 exported

[2] The wattle factory used bark stripped from this volume

Source: Timber Producers Federation, 1997.

Economic values and wood supply in non-commercial forestry.

Although a significant proportion of the country (66%) contains indigenous forests, there is no corresponding information on timber volumes by species and age class. Furthermore, the available inventory data does not classify these forests by dominant species, which could help identify the various timber and non-timber products and services flowing from them. Although no accurate figures on deforestation exist due to inadequate forestry change data, it is estimated that about 0.6% of Zimbabwe's forests are lost each year (FAO, 1997) largely due to agricultural expansion which accounts for about 70 000ha.

Zimbabwe's natural forests generate a wide range of timber and non-timber products and services. The products include: fuelwood for charcoal making, sawn timber and pulpwood, building materials, wood for small artisinal crafts, fodder, fruits, honey, mushrooms, insects, bark for rope, medicines, leaf litter and gum. The services include watershed conservation; carbon fixation; and the provision of windbreaks, shade, soil stability and wildlife habitat. No accurate 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 indirect 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 (21 million ha) can be estimated at Z$4.2 billion per year.

2.2.6.2. Economic incentives and disincentives for the conservation of forest biodiversity

Economic disincentives to conservation

At the macro-economic level, Zimbabwe's disincentives to forest conservation, include:

- macro-economic policies that encourage exports. Such policies promote land clearing for agricultural cash crops, and increased harvesting of valuable indigenous export timber species such as teak and mukwa;
- tight fiscal control over government expenditures which leads to reduced budgets for monitoring and controlling forest utilisation by the appropriate authorities;
- government policies and implementation programmes for the resettlement of communal people, which may result in increased forest degradation;
- insecure land tenure policies over communal forests and woodlots resulting in poor management and control of harvesting; and,
- unclear lines of authority within government over forest management in state forests, communal lands and national parks.

At the micro-level, economic disincentives such as low stumpage price may contribute to poor conservation practices especially for indigenous woodlands. For example, stumpage rates for mukwa and teak in government forests in 1992 were Z$155 and Z$115 per cubic metre of standing timber respectively. However, it is difficult to assess the appropriateness of these rates due to lack of data on final product revenue and the associated costs of replanting and maintaining a new forest of teak or mukwa.

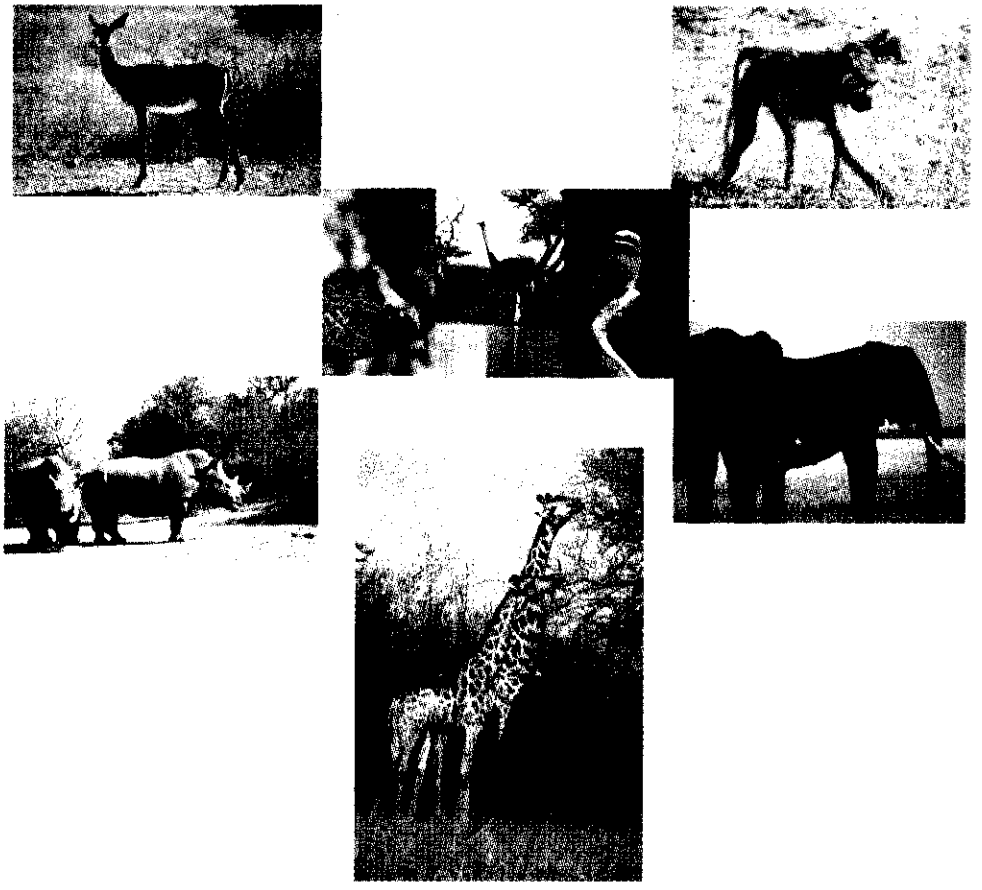
Economic incentives for forest conservation

Direct incentives include cash incentives, such as fines to deter timber poaching or improper harvesting methods; compensation for damage to community forests from wildlife or development projects; compensation to people living adjacent to state forests who are excluded from using the woodlands; and subsidies for forest management such as free seedlings.

With respect to communal forests, the Communal Land 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 imposed for improper conservation under the Natural Resources Act is Z$1,000. However, such provisions are fairly broad and do not appear to neither deter poor conservation practices, nor encourage sound resource management in communal areas.

Direct subsidies in the form of free or low-cost seedlings is a common practice in Zimbabwe. In 1983, the Forestry Commission initiated the Rural Afforestation Programme to boost the production of seedlings (through central nurseries) for distribution at little or no cost to schools, communities, farmers and local authorities (Remme, 1995). However, in 1989, seedling production was decentralised to satellite nurseries under the management of local authorities, communities, interested NGOs, schools and farmers. These efforts and those of non governmental organisations, have contributed to tree planting initiatives in communal areas. Indirect incentives include subsidies to shift rural people from woodfuel to alternative fuel sources such as the solar technology for cooking purposes; and promoting community development programmes which are tied to improved conservation practices.

WILDLIFE



2.3. WILDLIFE

2.3.1. Status and trends of wildlife biodiversity.

The presence of warm temperatures associated with tropical locations and of woodlands and open savanna grasslands as well as the availability of water from rivers, pans, swamps and man made lakes provide an ideal environment for a wide variety of wildlife species in Zimbabwe. In addition, the country has one of the most sophisticated policy, legislative, management and administrative systems for wildlife in Africa. For example, the principle of sustainable use of wildlife resources forms the basis of the widely acclaimed Communal Area Management Programme for Indigenous Resources (CAMPFIRE) programme. The presence of an adaptive, decentralised and participatory management system allows government to run the parks and wildlife estate; local communities to manage the CAMPFIRE programme; and commercial farmers to run conservancies/game ranches which are mostly located in the south eastern part of the country.

In this chapter, wildlife refers to terrestial vertebrates (mammals, birds and reptiles) and terrestial invertebrates (insects and arachnids)

2.3.1.1. Relevant ecosystems

Zimbabwe has three major forest ecosystems that are described in detail in Section 2.2.1.1. These are the Zambeziaca phyto-region (consisting of miombo, teak, mopane, acacia and terminalia/combretum woodlands), the Afromontane phyto-region and Exotic plantations. These diverse forest ecosystems provide a wide range of habitats for wildlife.

2.3.1.2. Vertebrates

Mammals

About 337 species of mammals are found in Southern Africa and 175 of these occur in Zimbabwe and belong to 12 orders (Table 2.3.1). The orders with large numbers of species in the country are the Chiroptera (51 species), the Rodentia (40 species), the Carnivora (31 species), the Artiodactyla (26 species) and the Insectivora (16 species). Most species belonging to the Bovidea (e.g. buffalo, kudu, bushbuck, sable, antelope, water buck, reedbuck and impala); Insectivora; Chiroptera; Lagomorpha; and Rodentia have very wide geographical distributions. The population status of some of the common species of mammals found in Zimbabwe is presented in Annex 6.3.1. and is well above minimum viable levels.

Birds

Southern Africa has a very high bird diversity, consisting of about 900 species of which 133 are endemic. Over 600 of these species occur in Zimbabwe. The families with the largest numbers of species are: the Sylvidae (warblers) with 53 species; the Charadridae (plovers, turnstones) with 34 species; the Ploceidae (queleas) with 27

species; the Estrildidae (finches) with 22 species; the Hirundidae (swallows, martins) with 20 species; the Turdidae (thrushes, chats, robins) with 20 species; and the Lonnidae (stikes) with 20 species; and the Ardeidae (herons, egrets) with 17 species.

The large number of bird species found in Zimbabwe are due to the high habitat diversity. The richest bird habitats are the bushveld (various types of deciduous, small tree woodland and mixed bush varieties) and the woodland (Newman, 1983). However, there is a general decline in the population status of birds due to habitat loss.

Table 2.3.1. The diversity of mammal species in Zimbabwe

Order	No. of families	No. of species in Southern Africa	No. of species in Zimbabwe
Insectivora	4	40	16
Chiroptera	10	73	51
Primates	2	7	5
Pholidota	1	1	1
Lagomorpha	1	6	2
Rodentia	8	74	40
Carnivora	6	36	31
Tubulidentata	1	1	1
Proboscidae	1	1	1
Hyracoidea	1	4	1
Artiodactyla	6	40	26
Perissodactyla	2	5	4

Reptiles

Southern Africa has about 400 species of reptiles of which a considerable number occurs in this country (Table 2.3.2.). The families with large numbers of species are the Boaedontinae (with 12 species), the Gekkonidae (with 10 species), the Corylinae sub family (with 9 species), the Calubrinae sub family (with 9 species), the Atractaspidinae (with 9 species) and the Najinae (with 10 species). However, with the exception of the crocodile, the population of reptiles has not been monitored regularly.

Table 2.3.2. The diversity of reptiles in Southern Africa and in Zimbabwe

Order	No. of families	No. of species in Southern Africa	No. of species in Zimbabwe
Chelonii	6	20	6
Squamata	11	68	64
Amphisbeania (sub order)	1	12	7
Sauria (sub-order)	7	229	186
Crocodilians	1	1	1

2.3.1.3 Invertebrates

Insects

Within the invertebrate group, insects are numerically the most abundant. Estimates of insect species richness (largely based on extrapolations from ratios of temperate to tropical species numbers) vary from 5 million to 80 million world wide (Gullan and Cranston, 1994). Of the 29 insect orders, beetles, true flies, bees and wasps have the most species. However, this could be a reflection of collector preferences, as there are no comprehensive inventories of all insect orders in most countries.

Zimbabwe still lacks a systematic inventory and monitoring system for insect species. However, indications from the Natural History Museum (Bulawayo) and the insect collection at the Plant Protection Research Institute (Harare) are that the country has a rich diversity of insects and all the 29 insect orders have been reported. Most collections are of beetles, where 128 genera have been recorded in the carabid family alone. The scarab beetles are also widely distributed and have been well documented (Gardiner, 1995).

Nine families of butterflies have been recorded with well over 400 species mostly collected from the eastern highlands (Cooper, 1973). The abundance of butterflies is generally seasonal, with greater numbers occurring during the rainy season, when there is ample vegetation. Dry season forms of butterflies are duller than the wet-season ones. Of the butterflies indigenous to Zimbabwe, most are found in the Vumba Mountains and Chirinda forests. For example, the flame bordered charaxes is very scarce and has been only recorded in Chirinda and Burma Valley. While the extremely local Vumba fritillary has a restricted flight period, being limited to the rainy season. The largest butterfly, the Emperor Swallowtail (128 mm), is found exclusively in the rain forests of the eastern highlands.

Moths have some of the most studied species, mainly because their larval stages are economic pests. Most of the defoliators, borers and bollworms belong to the noctuid moths and over 300 genera have been recorded. Most species are widely distributed and may have several generations a year. The more specialised feeders such as the pink and red bollworms and the maize stalkborer over winter in crop stover as they do not have alternate hosts in the dry season.

Grasshoppers and locusts constitute an important widely distributed economic invertebrate order with nearly 300 species. Most of the species are defoliators with seasonal abundance. Four families of termites have been recorded. Termites are important both as a food source and in nutrient recycling and at least 45 species have been documented in the country. Species such as the harvester termite, are widely distributed, while others like the dry wood termites are limited to areas such as the south-eastern part of the country.

True bugs have been well-documented largely because of their pest status. Twelve genera of these sound-producing insects have about 21 species recorded mostly from the eastern districts and other tourist areas and more occur in other parts of the country.

Scale insects have been mainly collected from fruit trees and the Plant Protection Research Institute Museum has a collection believed to be the largest in Southern Africa.

Of the other insect orders that have been collected, the most important ones are the mosquitoes and tsetse flies. Of the 22 species of tsetse fly recorded in Africa, only three are found in Zimbabwe and are known to transmit the sleeping sickness parasites, especially to livestock. The distribution of the fly is limited to altitudes below 1 000m in northern and south-eastern Zimbabwe. The highest densities of the pest occur below the Zambezi escarpment in the Dande-Kanyemba communal areas, Chewore and Mana Pools. Medium densities occur South of Lake Kariba in Matusadonha National Park, Gache-Gache and Charara. Omay, Kanyati and Hurungwe have low densities of the fly. One particular species of tsetse fly has been recorded in the Honde Valley only and re-invasions are believed to come from Mozambique.

More that 1 600 species of mosquitoes have been recorded world-wide and Zimbabwe has only one genus (*Anopheles*) which is important for being the intermediary host of the malarial parasite. The other (*Culex*) is a carrier of a parasite causing elephantiasis, although in Zimbabwe it only tends to be a nuisance pest rather than a health hazard. The malarial vector mosquito occurs throughout the year in the lowveld, especially in the Zambezi Valley, Chiredzi and Beit Bridge. Elsewhere in the middleveld and highveld, this mosquito tends to be seasonal.

The foregoing discussion has shown that insects are very diverse and because of their small size, they can occupy more niches than the larger organisms. Furthermore, unlike other arthropods, most insects are winged hence are able to disperse rapidly. In the case of mites, which are wingless their associations with other living organisms increase their chance of survival. Other factors that encourage insect diversity are the sophistication of their sensory and neuro-motor systems as well as their ability to exist in different life forms such as the egg, larval, pupal and the adult stages. All these stages have different requirements and niches.

Arachnids

This group consists of scorpions and spiders. Scorpions are characterised by a poisonous sting used in defence, but not for capturing food. Food is torn by small jaw-like structures and the juices are sucked through a narrow mouth. There are nine genera and nearly 30 species recorded in the Natural History Museum. Two of the species are poisonous and have been collected from Gwanda, Plumtree and Beitbridge areas. Forty families of spiders from various parts of the country are in the Museum collection, but most of them have not yet been identified.

Other invertebrates include centipedes and millipedes from various parts of the country which are in the Museum, but most have not been identified. This also applies to pseudoscorpions, crustaceans and molluscs.

2.3.1.4. Identification of trends in wildlife diversity.

Mammals

The most widely monitored mammals are those of some economic importance. Population status data of 19 species exists with the elephant being the most surveyed species especially in the Hwange National Park. Other large mammals counted during elephant surveys include buffalo, eland, giraffe, kudu, waterbuck, zebra, roan, antelope and sable. The population of the elephant currently stands at twice the ecological requirement and threatens habitats of many species and biodiversity in general. White and black rhino numbers are also increasing following the establishment of four Intensive Protection Zones in response to heavy poaching of these mammals in the 1980s. The population of cats, sable and antelope is on the increase, while that of buffalo has been decreasing in the Hwange National Park. However, it is not clear whether buffalo populations in other parts of the country are also on the decline.

Table 2.3.3. shows animal species that have had to be specifically protected through international protocols such as the Convention on International Trade in Endangered Species (CITES) and through local legislation in order to arrest their decline in numbers. The wild dog (*Lycaona pictus)* should be placed in this category of specially protected animals because of rapidly declining numbers resulting from conflicts with people.

Birds

Total bird numbers fluctuate within and across years due to intra-Africa, Palaearctic and local migrations. On a local scale such migrations are due to variations in temperature, rainfall, drought etc. Notwithstanding, there is a general decline in bird populations with the disappearance of their specialised habitats. This has given impetus to the need to protect a number of bird species which are depicted in Table 2.3.4. Information on bird species found in the country is presented in Annex 6.3.2.

Table 2.3.3 Specially protected mammal species in Zimbabwe

Local name	Scientific name
Aardwolf	*Proteles cristatus*
Bat-eared fox	*Octocyon megalotis*
Cheetah	*Acinonyx jubatus*
Gemsbok	*Oryx gazella*
Lichteinstein's hartebeest	*Alcelaphus lichsteini*
Pangolin	*Manis temmincki*
Black rhinoceros	*Diceros bicornis*
White rhinoceros	*Ceratotherium simun*
Roan antelope	*Hippotragus simum*

Table 2.3.4. Specially protected birds in Zimbabwe

Common name	Scientific name
African hawk eagle	*Hieraatus spilogaster*
Bustards and Korhaans	Family: *Otidae* (4 species)
Cranes	Family: *Gruidae* (3 species)
Flamingos	Family: *Phoenicopteridae* (2 species)
Pelicans	Family: *Pelecanidae*
Storks	Family: *Ciconiidae* (8 species)
Vultures	Family: *Aegypiidae*
Ayres' Hawk Eagle	*Hieraaetus dubius*
Bateleur	*Terathopius acaudatus*
Black eagle	*Aquila verreauxi*
Black-breasted snake eagle	*Circaetus pectoralis*
Black sparrowhawk	*Accipiter melanoleucus*
Brown snake-eagle	*Circaetus cinerus*
Crowned eagle	*Stephanoaetus coronatus*
Fish eagle	*Haliaeetus vocifer*
Hammerkop	*Scopus umbretter*
Lanner falcon	*Falco biarmicus*
Long-crested eagle	*Lophaetus occipitalis*
Martial eagle	*Polemaetus bellicosus*
Osprey	*Pandion haliaetus*
Peregrine	*Falco peregrinus*
Secretary bird	*Sagittarius serpentarius*
Teita falcon	*Falco fasciinucha*
Tawny eagle	*Aquila rapax*

Reptiles

The population of reptiles has not been monitored on a regular basis hence it is difficult to discern population trends. The crocodile (*Crocodylus niloticus*) is the only reptile that has been extensively studied due to its economic importance, while the python (*Python sebae*) is the only protected reptile in the country. Snakes have the highest number of species (61) while there is only one species of crocodile in Zimbabwe.

Invertebrates

Data available on invertebrates are very scanty and do not allow for any meaningful trend analysis. However, the general trend is that the population of many invertebrates is declining due to human activities such as agriculture which have led to the destruction of many habitats.

2.3.2. Causes of wildlife biodiversity decline, increase or maintenance

2.3.2.1. Abiotic factors

The physical environment, particularly soils, slope and climatic factors such as rainfall and temperature influence wildlife richness and abundance through their effect on the quality, quantity, structure and productivity of the vegetation. Changes in the status of the physical environment may either increase the rate of stochastic extinctions or may facilitate coexistence of species and in the process promote conservation of biodiversity. Some of these issues are discussed in this section

Drought and frost

The severe and prolonged drought of the early 1990s in Zimbabwe led to reduced capacity of the savanna vegetation to support wildlife and domestic animals resulting in widespread animal deaths. Species which had relatively low populations such as the hippopotamus, buffalo, warthog and red hartebeest had their populations further reduced. Severe frost, which is common in the sand ecosystems, can alter plant species composition which in turn affect habitat diversity. For example the frost of 1980 in Hwange killed more trees than the elephants.

Fire

The effect of fire on the structure and composition of vegetation was partly described in Section 2.2.2.1. Mismanaged and heavy fires negatively impact on habitats as they kill individual organisms, damage unprotected living tissues, modify growth and reproductive rates, change the availability and use of resources and alter the competitive balance between organisms. In the long term such changes may alter the productivity and population structure of a species and the composition of communities. Fire can reduce habitat diversity by promoting grasslands in better watered areas with fertile soils or by destroying the perennial grasses to promote thicket formation and accelerated erosion in situations of low rainfall and infertile soils.

In the African savanna, high densities of elephants (*Loxodonta africana*) act synergistically with fire in reducing woodlands and thickets to grasslands. By opening the wood canopy, elephants enable more grass to grow and this provides fuel for fires (Norton-Griffiths, 1979). Furthermore, fire inhibits tree recruitment by killing seedlings and stunting the growth of young trees and also keeps woody plants at a height and in a state that is highly acceptable to browsers. Where herbivore numbers are low, repeated fires may maintain a relatively open vegetation physiognomy that promotes a diverse assemblage of herbivores.

2.3.2.2. Biotic factors

Negative impact of elephants at high density

At high density, elephants can radically modify habitats by reducing both faunal and floral species diversity as has been the case in Zimbabwe's major national parks. For example, the decline in the population of buffalo, roan and bushbuck in the Hwange National Park could partly be due to a reduction in tree density caused by elephant destruction (Wilson, 1997). During the 1974 to 1978 period, they caused a 4% per year reduction in woodland cover in the Sengwe area. While in Chizarira National Park, elephants reduced a well developed *Julbernardia globiflora* savanna woodland to virtual grassland within a decade (Thompson, 1975). A comparison of floral and faunal species diversity in an elephant impacted woodland on a parks estate along the Zambezi escarpment and on a non impacted woodland in an adjacent communal area showed lower species diversity in the former woodland where elephant density was higher (Table 2.3.5).

Table 2.3.5 Comparison of species richness of woody plants, birds, ants and mantises in intact and elephant impacted woodland sites

Group or Taxon	Intact woodland	Impacted woodland
Trees	25.5	11.2
Shrubs	35.6	5.5
Total woody plants	61.1	16.7
Woodland birds	16.0	10.2
Other birds	5.7	8.7
Total birds	2.3	18.8
Bats	3.5	3.3
Ants	9.2	7.3
Mantises	3.0	1.8

Source: Cumming et. al, 1997

There is also a threat from elephants to *Colophospermum mopane* woodlands in the protected areas of Southern Africa. Such mopane woodlands are habitats of key endangered species such as the black rhinoceros (*Diceros bicornis)* and the wild dog. This has led to a research project, to evaluate the effects of elephant browsing and patch dynamics in the *C. mopane* habitats of the Zambezi region by the University of Alaska-Fairbanks (USA).

The positive impact of elephants at medium and low density.

Grazing and trampling by mega-herbivores, in combination with frequent fires, may increase patch diversity by increasing vegetation heterogeneity, which facilitates the continuity of evolutionary processes and maintenance of biodiversity. In wooded and forest areas, elephants open up thickets and closed-canopy woodlands and create pathways for other species. The resultant gaps become enriched islands as light dependent grasses, herbs and seedlings germinate and provide readily available food to a diverse assemblage of herbivores, such as duikers, small mammals, birds and insects. Furthermore, the resultant elevation of soil temperatures accelerates the growth of soil biota and organic matter decomposition.

At low densities, elephants may help in the establishment of savanna woodlands. Studies have shown that elephants play a role in distributing, fertilising and facilitating the germination of savanna seeds as seedling germination and growth is greatly accelerated in elephant dung. For example, having co-evolved with the diverse assemblage of both large and small vertebrates and invertebrates, Acacia seeds are a vital source of food for both large and small mammals and the trees and their seedlings provide homes to birds, reptiles and insects.

2.3.2.3. Effect of technology on biodiversity

Technology has tended to have an adverse effect on wildlife biodiversity through habitat fragmentation. For example, the elimination of tsetse flies in the Zambezi Valley has opened up the area which is marginal for agriculture to cattle. Furthermore, the eradication of the buffalo in some parts of Zimbabwe to create foot and mouth free zones or the European Economic Community beef catchment areas has marginalised this wildlife species.

Mining activities involving the digging up of earth, creating roads, piling of mine dumps, noise and gas pollution and the discharge of chemicals during the purification of ores have either direct or indirect effects on wildlife biodiversity. At present there are conflicts between mining and conservation of biodiversity in most national parks areas despite the environmental impact assessments (EIAs) carried out before mining. Similarly, tourist related activities such as the development of accommodation facilities and roads, the movement of cars and people and the disposal of waste, if not properly controlled and monitored, can have adverse effects on biodiversity. On the other hand, dam construction disrupts habitats and corridors for the traditional movement of wildlife. For example, the environmental impact assessment on the construction of the Batoka dam on the Zambezi river identified problems of flooding *Acacia albida* communities and key habitats of some birds.

2.3.3. Conservation and sustainable use measures

2.3.3.1. Status of monitoring approaches

The monitoring of population trends in wildlife has tended to concentrate on species of economic importance such as the elephant. The elephant contributes enormously to the incomes realised in the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) programme areas through trophy hunting. Furthermore, habitat destruction is closely associated with large elephant numbers. The USAID, a major financier of the CAMPFIRE programme, is facilitating elephant population studies in the country, while the European Union funded ELESMAP project is supporting regional elephant population surveys in order to avoid double counting. Elephant habitat interactions are also being closely monitored in the Sengwa area and the Hwange National Park.

Other species of economic importance being monitored include the buffalo, sable, antelope, kudu, lion, leopard and the white and black rhino. Monitoring approaches used in gazetted indigenous forests, safari areas, recreational parks, botanical reserves and botanical gardens, as they relate to forest biodiversity are presented in Section 2.2.3.1.

2.3.3.2. *In-situ* conservation measures

The crucial issue in wildlife conservation today is the uncontrolled human population growth leading to the shrinkage of habitats at the cost of the environment and wildlife. In response to this threat, protected areas have been set up to protect habitats and wildlife. However, these areas are often not the ideal habitat, having been selected because they are marginal for agriculture. Furthermore, they restrict wildlife to small areas in comparison to the original situation when habitats were large and wildlife performed extensive migrations. In addition, although the preservation of fauna and flora has been the main justification for setting up protected areas, the need to: protect specific geological formations (e.g. the Victoria Falls): promote tourism; and preserve areas of particular natural excellence and human appeal (e.g. recreational parks) have also been factored into the selection of such areas (Child and Heath, 1992).

Thirteen percent of the country's land area has been set aside as the parks and wild life estate under the Department of National Parks and Wildlife Management (DNPWLM). About 7% of this area consists of National Parks, while the remainder comprise of Safari Areas, Recreational Parks, Botanical Gardens and Botanical Reserves (Table 2.3.6 and Figure 2.2.). In addition to the 13% under the parks and wildlife estate, another 2% of the country is set aside as gazetted indigenous forests under the Forestry Commission (see Table 2.2.7). The latter harbours considerable wildlife biodiversity.

Table 2.3.6. National Parks and other protected areas.

Protected area	Land area (000ha)
National Parks Areas	
Chimanimani	17.1
Chizarira	191.0
Gonarezhou	505.3
Hwange	1 465.1
Kazuma Pan	31.3
Mana Pools	219.6
Matopos	42.4
Matusadona	140.7
Nyanga	33.0
Victoria Falls	2.3
Zambezi	56.0
Sub Total 1	2 703.8
Safari Areas	2 367.0
Recreational Parks	308.6
Botanical Reserves	7.0
Botanical Gardens	0.5
Sanctuaries	18.6
Sub Total 2	2701.7
Grand Total	5405.5

2.3.3.3. Access to biological and genetic resources and property rights issues

The Government of Zimbabwe regards wildlife utilisation as a valuable, legitimate and sustainable land use system; which may be most appropriate in agriculturally marginal areas. This is partly because wildlife makes better use of available vegetation compared to livestock and has many marketable uses apart from the provision of game meat. Furthermore, the local wildlife industry has a comparative advantage in world markets due to the presence of unique large mammals and high biological diversity. Thus, in 1975 the Government took a bold positive step in the area of wildlife conservation by putting provisions in the Parks and Wildlife Act which allowed the "custodial ownership" of wildlife to private landholders. The fact that landowners could benefit from the use of wildlife on their land encouraged them to invest in wildlife management by establishing game ranches. In addition, the Parks and Wildlife Act was further amended to give appropriate authority status to Rural District Councils (RDCs) so that they could manage and benefit from wildlife within the communal areas. This saw the inception of the CAMPFIRE programme and 33 of the country's 55 RDCs are currently participating in this programme. Such policy developments in which local people benefit from the "wild" biodiversity in their areas, are consistent with world conservation trends as espoused in international

initiatives such as the Convention on Biological Diversity, the World Conservation Strategy and the United Nations Conference on Environment and Development.

2.3.3.4. Local participation

The Parks and Wildlife Act gives privileges to owners or occupiers of private land and Rural District Councils in the case of communal areas to utilise and exploit plants and animals on their land. Such an arrangement has given these communities incentives to sustainably manage these natural resources through the formation of conservancies/game parks on private land and participation in the CAMPFIRE programme in communal areas.

With respect to conservancies on private land, the domestic stock predators such as lion, cheetah and leopard which were being eradicated to safeguard domestic stock before the legislation and policy changes were put in place, have now started to increase in numbers. For example, surveys on 206 game and game/cattle ranches carried out in 1985 and 1996 showed that the leopard population had increased from 1 050 to 1 550, while cheetah monitored on 37 ranches increased from 220 to 700 over the ten year period (Heath, 1990). Conservancies are mostly located in areas of low agricultural potential where wildlife is the only viable and sustainable form of land use.

Regarding CAMPFIRE, experience has shown fundamental changes in the attitudes of communities who live with wildlife. They now perceive wildlife as an asset with value and not merely as posing a threat to life, property, crops and domestic stock. Some communities are now willing to share land with and to bear the costs of living with wildlife since the associated benefits outweigh the costs. On average, CAMPFIRE projects in Zimbabwe generate over Z$ 25 million annually. Ninety percent of this income is from hunting of elephants, buffalo, sable, antelope etc. More income could, however, be realised if ivory and other elephant products were marketed commercially, hence the excitement generated by the acceptance of Zimbabwe's proposal on the downlisting of the elephant and the partial lifting of trade in elephant and elephant products by the CITES Conference of Parties (COP) 10.

In addition to income directly accruing to participating households from the CAMPFIRE programme, local authorities have put up schools, grinding mills, electric fences and sales depots using revenue from the programme. Another critical factor that has influenced the success of the CAMPFIRE programme is the effective and broad technical support received from the government, NGOs and the University of Zimbabwe. These organisations meet regularly to co-ordinate their support services as the CAMPFIRE Collaborative Group and have the following responsibilities:

- The DNPWLM provides all basic information on wildlife matters. It also trains game guards and approves quotas for safari hunting;
- The World Wide Fund (WWF) conducts economic and ecological research on the consequences of cattle and wildlife production and advises accordingly;

- The Centre for Applied Sciences at the University of Zimbabwe conducts socio-economic, institutional and policy research on CAMPFIRE;
- The Zimbabwe Trust focuses on capacity building;
- Africa Resources Trust sources appropriate information on issues that affect CAMPFIRE's capacity to market natural resources; and
- The CAMPFIRE Association (a national body consisting of all district councils under the CAMPFIRE programme) organises relevant educational visits for its members within and outside the country.

2.3.4. Legislative and policy framework

The Parks and Wildlife Act (PWLA), is the principal piece of legislation regulating the conservation and utilisation of the wildlife resources of the country. The Minister of Mines, Environment and Tourism is mandated with the administration of the Act through the DNPWLM which is the management and scientific authority for wildlife.

The conservation and preservation of wildlife, fish and plants is achieved through the establishment of a system of protected areas, which constitute the Parks and Wildlife Estate. The Act sets out six types of protected areas which may be established, namely national parks, safari areas, sanctuaries, botanical gardens, botanical reserves and recreational parks; each with a specific objective. The Parks and Wildlife Estate constitutes 13% of the total land mass of the country. Although the President may subtract or add to the estate, he may not reduce it by more than 1% of its total land area as of February, 1979.

The first Schedule to the Parks and Wildlife Act constitutes eleven national parks totalling some 2 718 010 hectares (see Table 2.3.6) of state and trust land. The purposes for which national parks are constituted are the preservation and protection of the natural landscape, scenery of wildlife and plants and the natural ecological stability of wildlife and plant communities found in the parks with the ultimate objective being public enjoyment, education and inspiration. The Minister is enjoined to control, manage and maintain national parks in accordance with the purposes for which they were established. All human activities in national parks are prohibited except as provided in a permit, licence or other authorisation issued by the responsible authority. The Minister may introduce any specimen of wildlife, fish or plant, but may not introduce any exotic species of plant or wildlife. Measures necessary or desirable for preventing or controlling human and animal diseases, controlling and limiting quelea birds and locusts or eradicating weeds within a national park may further be authorised.

National parks are site specific areas of *in- situ* conservation of both biological resources and natural physical features. A general prohibition exists against picking plants, hunting or destroying wildlife. Trade restrictions are placed on the sale of any animal, plant or fish or their derivatives where these are obtained from a national park without the written authorisation of the Minister. Recreational hunting or commercial harvesting of wildlife or fish is strictly prohibited.

Botanical reserves are established for the purpose of preserving and protecting endangered indigenous plants and/or representative plant communities growing naturally. Botanical gardens are established for propagating and cultivating both exotic and indigenous plants for public enjoyment and educational benefits. The Minister is empowered to cede his powers, functions and duties in relation to a botanical garden or botanical reserve to another Minister who may then exercise the full powers, duties and functions outlined in the Act in respect of these areas. Consequently, botanical gardens are administered by the Minister of Lands and Agriculture who hosts the National Herbarium and the Botanical Garden. A general prohibition exists against the introduction into or picking of any plant from a botanical garden or a botanical reserve except in terms of a permit. The Minister has a discretion to issue a permit for the introduction of any plant into a botanical reserve. The permit issued may not authorise a holder to introduce any plant of a non-native species to the botanical reserve.

Sanctuaries are constituted for the purpose of affording special protection to all animals or particular species of animals for the enjoyment and benefit of the public. The hunting, removal and sale of an animal or part of an animal from a sanctuary is prohibited except in terms of a permit. Again, sanctuaries are treated as strict habitat/ species management areas where active intervention is necessary to meet the requirements of particular species. The permit, which the Minister may issue for the exploitation of animals within a sanctuary may not authorise its holder to hunt or remove a designated animal from such a sanctuary except where this is intended for scientific purposes or the protection of human life or property.

Safari areas are constituted for the purpose of preserving and protecting the natural habitat and the wildlife within the safari area in order to afford the public with facilities and opportunities for hunting and fishing and otherwise engage in various tourism and recreational activities as may be permitted in the Act. Wildlife in safari areas may be exploited in terms of a permit. In terms of the recognised classification of protected areas, safari areas in Zimbabwe would constitute managed resource areas which are maintained mainly for the sustainable use of natural ecosystems.

Recreational parks are constituted for the purposes of protecting and preserving the natural features contained in the park. Recreational parks almost always invariably surround the major water reservoirs of the country, the most notable of which is Lake Kariba. No provisions for the exploitation of wildlife or indigenous plants are contained in the Act. Accordingly, it would appear that consumptive utilisation of the biological resources within recreational parks is prohibited and the Minister has no powers to issue permits for any consumptive activity. Recreational parks are principally intended to be tourist facilities for the enjoyment of the public.

The Act provides for the declaration of specially protected plants and animals. Eight species of mammals, eighteen species of birds and one reptile species are listed as specially protected. Where an animal is declared to be specially protected, it may not be hunted, possessed or sold except under a permit. The permit to exploit a specially protected animal may only be issued for public interest purposes ranging from research and education to the protection of human life and property. The trophy or other

derivative of a specially protected animal is considered state property except in a few exceptional cases. Only plants which are indigenous to Zimbabwe may be granted special protection. Natural hybrids of plants between specially protected plants are not included in the list of specially protected plants. It is an offence to pick a specially protected indigenous plant in Zimbabwe except in terms of a permit. There are limited exceptions to this rule, for example, where the plant occurs in an area where the Minister has declared that such a plant may be picked. Currently, no such areas are provided for in the Act or in subsidiary legislation. The Act empowers the Minister to issue a permit authorising the holder to pick a specially protected plant for export, cultivation and propagation for scientific purposes; for providing specimens to a museum, herbarium, botanical garden or similar institutions; and for any matters the Minister may deem fit. Trade in specially protected plants is generally prohibited except as otherwise provided by a permit. It is an offence to purchase specially protected indigenous plants from a person not qualified to sell these plants.

The shortcoming of the provisions for specially protected animals and indigenous plants in the PWLA is the fact that it does not provide for the underlying reasons for according this status to certain species or the criteria to be used in deciding which species qualify for listing (DNPWLM, 1990). Only criteria for the protection of animals or plants occurring in communal areas and on private land is provided for and this relates to scarcity, over utilisation, utility or where the value deserves to be protected. The protection afforded here is against over-utilisation by individuals and communities as have been granted appropriate authority status for wildlife in these areas. Appropriate authority status for wildlife in communal areas is granted to Rural District Councils to exploit wild animals and plants on behalf of the communities they serve.

2.3.5. Institutional framework, cross sectoral linkages and the human resource base.

2.3.5.1. Institutional framework and cross sectoral linkages.

The Department of National Parks and Wildlife Management (DNPWLM) is the management and scientific authority for wildlife as enshrined under the Parks and Wildlife Act. It manages wild fauna and wild flora within the protected areas. As the state forest authority, the Forestry Commission is responsible for all wild flora outside the parks and wildlife estate. The Department of Veterinary Services is involved in wildlife issues in a number of ways particularly in the control of tsetse flies and the foot and mouth disease. While the Department of Research and Specialist Services works on some wildlife issues through its Plant Protection Research Institute. The latter tests, registers and controls chemicals such as quelox which controls quelea birds.

Communities which include both the large scale commercial farmers running conservancies/game ranches and smallholder farmers involved in the CAMPFIRE programme are key players in sustainable wildlife management. The former have also been providing space for relocated animals such as the rhino from the Zambezi valley and offer the DNPWLM opportunities to carry out research on their farms.

Non-governmental organisations such as the Zimbabwe Trust, the Africa Resources Trust and the World Wide Fund play central roles in wildlife management through their support to the CAMPFIRE programme.

It is clear from the foregoing that the various stakeholder institutions involved in wildlife are linked through the services and facilities they offer. For example, the DNPWLM sets out the overall policies and controls on wildlife utilisation; offers opportunities to other stakeholders for research within the protected areas and negotiates on the international fora (e.g. CITES) for wildlife product markets. The Universities offer trained manpower to organisations involved in wildlife. For example, the two year MSc. Programme run by the University of Zimbabwe in Tropical Resources Ecology was specifically designed to train specialised staff for the DNPWLM. NGOs undertake local human capacity building and research initiatives within CAMPFIRE programmes. However, collaboration between the DNPWLM and the Forestry Commission in the management of wild flora in protected areas is rather weak.

2.3.5.2. Human resources

It is obvious from the previous section that organisations involved in various aspects of wildlife management are highly specialised. They have ecologists, veterinarians, glossinoecologists, botanists, rangers and planners. There is therefore need to strengthen inter-institutional linkages to ensure the most efficient utilisation of specialised human resource capability.

2.3.6. Economic factors

2.3.6.1 Valuation of wildlife biodiversity

Wildlife is one of the major tourist attractions to Zimbabwe, hence the financial gains from tourism are, partly a reflection of the value of wildlife resources to the country's economy. To a certain degree, the economic and social benefits accruing from tourism in Zimbabwe are based on the existence of a healthy stock of wildlife biodiversity and supporting habitats. Various measures of the wildlife value can be estimated through different types of economic studies. On the other hand, while other wildlife resources like most insect species are an important and integral part of different ecosystems their values are difficult but not impossible to estimate. Research studies should therefore be commissioned for a wide range of wildlife resources at both the macro and community levels in order to estimate their use and non-use values.

An accurate economic valuation of the country's wildlife resources requires a detailed inventory of the specific numbers (quantities) of the individual species. However the value of some smaller species is difficult to quantify. This would require separate studies and extrapolations based on the roles played by the species within the ecological system. Furthermore, with the exception of elephants and other endangered species, specific inventories, in terms of numbers or quantities, for the larger wildlife species are not readily available. The valuation of the larger wildlife species is, however,

relatively easier largely because of the prevalence of safari hunting as a sport and also because of the CAMPFIRE programme (see Annex 6.3.4). It must however, be pointed out that developing accurate measures of all components of total economic value would be prohibitive in terms of cost, time and efficiency. A better approach might be focused on a sample of key indicator species.

2.3.6.2. Economic incentives and perverse incentives

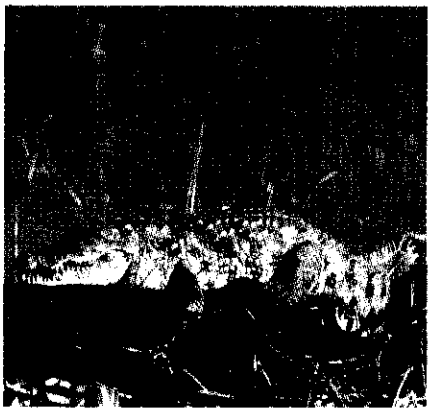
Zimbabwe has direct and indirect incentives for wildlife biodiversity conservation. The former can be in cash or in kind and includes tax concessions, subsidies, grants and compensation for animal damage to crops. Other direct incentives are low interest rates or interest free loans, sales of wildlife below market prices to stock private or communal conservation areas, reduced lease fees, and the sharing of conservation proceeds and/or park entry fees with communities. Indirect incentives include developing community level conservation institutions such as local parks boards; building capacities for community involvement in both management and decision making for resource use; conserving and promoting traditional knowledge, and providing appropriate education to the local people.

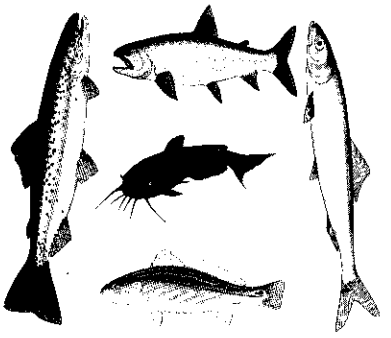
The most notable, and internationally renowned incentives to sustainable wildlife management in Zimbabwe is the CAMPFIRE programme. It provides direct cash injections to a co-ordination unit and in some cases to local communities to manage resources. Furthermore, it creates awareness among local communities on the economic benefits of wildlife conservation through sharing of benefits accruing from wildlife resources and capacity building for effective local communities' involvement in wildlife management and conservation. Nature Tourism (eco-tourism) is gaining momentum as a key and complementary incentive to the CAMPFIRE programme to most local authorities and communities. Skills acquired through involvement in nature tourism further empower communities to take advantage of future opportunities and to increasingly become capable of assuming greater control of their livelihoods.

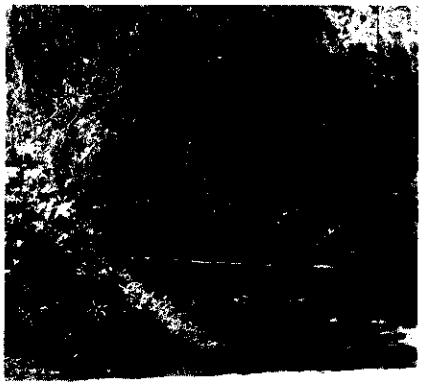
Drought relief programmes are an indirect form of incentive and compensation for crop damage by wildlife, though the programmes are not specific for this purpose. However, such programmes are generally targeted at drought stricken or food shortage areas, which encompass those communities whose crops will have been damaged by wildlife. Plans are also under way to stock some communal and resettlement (model D) areas with wildlife through government grants.

The current land tenure system in Zimbabwe results in lack of security and accountability among communal farmers and in most cases leads to excessive exploitation of the natural wildlife habitat. The natural resources, more specifically wildlife, belong to the state, and not to the communities who live with them. This leads to the use of enforcement rather than participatory approaches to protect wildlife.

AQUATIC FLORA AND FAUNA







2.4 AQUATIC FAUNA AND FLORA

2.4.1. Status and trends in aquatic biodiversity

2.4.1.1. Relevant ecosystems

The diversity of Zimbabwe's aquatic flora and fauna is directly related to the type and distribution of its wetlands (areas that are permanently or temporarily covered with flowing or stagnant water). These wetlands, whose general distribution is shown in Figure 2.3, include floodplains, riparian wetlands, dambos, pans, swamps and artificial impoundments which are described below.

Floodplains

Floodplains are confined to the mid Zambezi Valley around Mana Pools and the Save-Runde river confluence in the south eastern part of the country. These wetlands are an important centre of aquatic biodiversity as they provide a range of unique habitats. For example, their sand banks are an important crocodile breeding area and they provide shelter to water birds such as White fronted Plover and the African Skimmer. Fish species recorded in these areas include Tilapines and Hydrocyon. However, the extent of the floodplain below the Kariba dam has been decreasing due to changes in discharge patterns.

Riparian wetlands

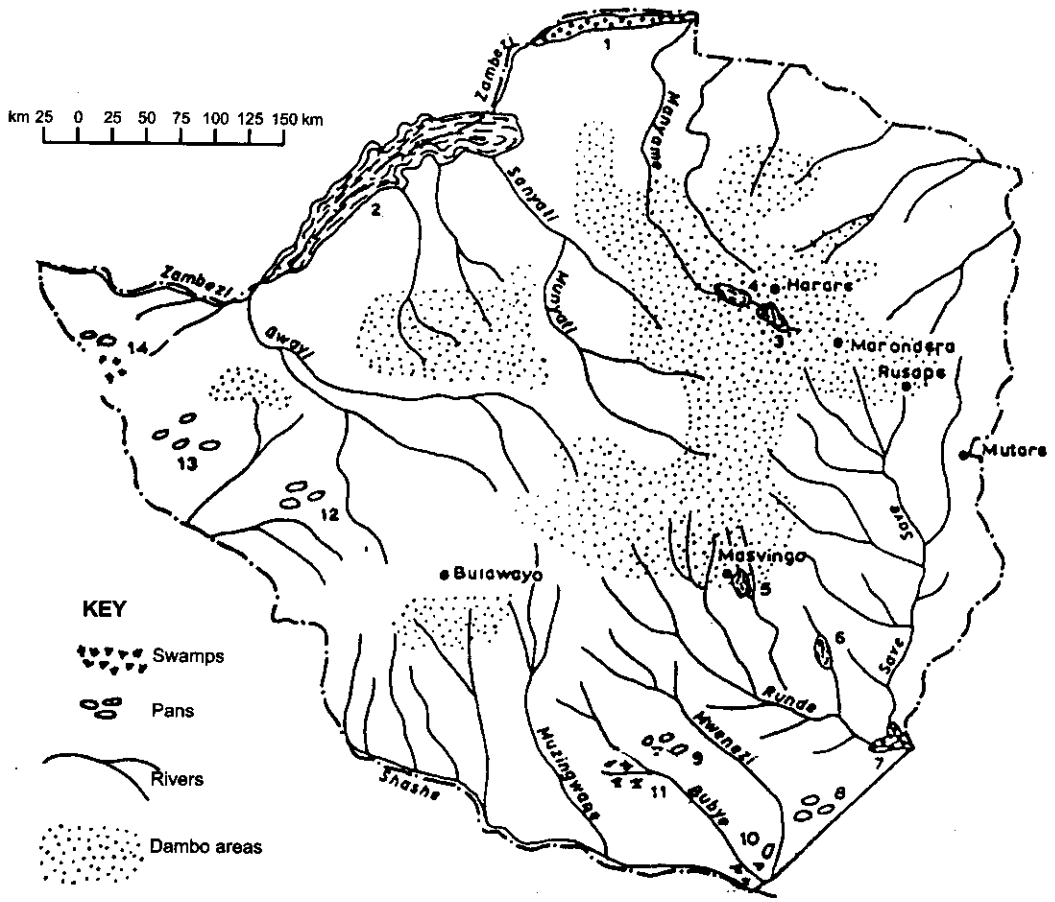
Notable river wetlands of national importance in Zimbabwe are the Zambezi, Save-Runde, Manyame, Gwayi-Shangani, Mazoe and Sanyati systems. Such riverline wetlands are usually characterised by riparian vegetation such as *Faidherbia albida.* Save is the country's main inland river which drains the central watershed. However, as is the case with most of the country's rivers, Save is heavily silted due to physical destruction caused by gold panning, stream bank cultivation and other forms of human interference.

Dambos

Dambos are grass covered and generally tree-less wetlands that cover about 1.28 million hectares of land in Zimbabwe. They are a source of water, grazing and cultivation and present an irrigation potential of about 200 000 ha. (Bell *et al.*, 1987). Before the arrival of the white settlers, the indigenous communities used dambos for flood recession irrigation and Selous (1920) and Brooke (1965) confirmed that dambo cultivation was a well established and highly productive form of traditional agriculture. However, most dambos have been badly eroded and have lost some of their unique habitats through human interference over time.

Pans

Although not widespread in the country, sizeable pans occur in Tsholotsho communal lands and Hwange National Park in the west; in Gonarezhou National Park and some



1 Mid Zambezi Valley – Mana Pools
2 Lake Kariba
3 Lake Chivero
4 Darwendale Dam/Manyami Lake
5 L. Kyle/Mutirikwi
6 McDougal Dam
7 Save – Runde Confluence flood plain (Chipinda Pools, etc.)
8 Gorhwana pans
9 Budye pans
10 Majinji pans
11 Kwaluzi Swamp
12 Mabomo – Joweni pan complex
13 Lememba – Shabashaba complex
14 Tsamtsa

Figure 2.3. General distribution of wetlands of Zimbabwe.

parts of Mwenezi district in the south; and in the mid Zambezi Valley. Pans in communal areas are largely used for cattle grazing, while those in national parks are important habitats for waterfowl and a variety of game.

Swamps

The country has very few swamps. Notable ones include the Tsamtsa and Kwaluzi which are being threatened by overgrazing and drying.

Artificial impoundments

Although Zimbabwe has no natural lakes it has over 8 000 impoundments. The major artificial impoundments are the Kariba, Mutirikwi, Chivero, Manyame, Mazvikadei, Osborne and Manyuchi dams. With the exception of Kariba, which was dammed for hydro-electric supply, all these dams were constructed for irrigation, domestic water supply, fisheries and tourism. Kariba, the country's largest dam which is shared with Zambia, has now assumed functions of water supply, fisheries and tourism. A large part of the lake is protected by the National Parks and Wildlife Management Act, as a safari area and recreational park. Notwithstanding, the lake is threatened by over fishing; erosion of the escarpment; siltation; future mining activities at Sengora; and pressure on the shoreline by private developers.

The Manyame lakes are a group of four man-made reservoirs on the upper Manyame and Mukuvisi rivers built to provide water to the city of Harare, Chitungwiza and Norton (with a combined human population of about 1.7 million). A major factor in the ecology of these lakes is eutrophication caused by sewage effluent from the urban centres. This has led to the accelerated growth of plants such as the blue green algae and water hyacinth in Lake Chivero and the dams.

2.4.1.2. Genetic and species diversity

Zimbabwe relies on inland lakes and waterways for its aquatic fauna and flora. Of major economic importance to biodiversity conservation are the fish genetic resources and to a lesser extent reptiles and ducks.

Fish

Lake Kariba supports an important fishery, based on introduced sardine *(Limnothrissa miodon)*, which yields about 20 000 tonnes/year. The damming of the Zambezi river to form Lake Kariba in the late 1950's gave Zimbabwe its first potential fishery of significant size, though the lake's stocks were initially seen as a recreational facility rather than a major source of protein and employment. However, the rapid growth of the Kapenta industry has transformed Zimbabwe's fisheries sector. Fish (mainly kapenta) now contribute significantly to the protein consumption of the lower income groups.

Exotic fish species were introduced into Zimbabwe by angling societies for fishery stocking and aquaculture. Of the indigenous fish stocks present and the 31 introduced

species, only 9 are suitable for aquaculture. Of the latter, only Tilapia (e.g. *Oreochromis mossambicensis, O. macrochir, O. andersoni, T. rendalli* and *Clarias gariepinus*), exotic trout, prawn and crayfish are actively farmed. The Rainbow Trout *(Salmo gairdneri)* which can withstand slightly higher water temperatures, can establish itself in unfavourable environments and has excellent sporting and table qualities. Its ova are easy to handle from a fish culture point of view and the fry learn to feed early and are usually resistant to diseases.

Bream *(Tilapia/Oreochromis)* are very prolific breeders and if not controlled, they can easily overstock ponds resulting in stunted fish. Although more than 30 exotic species have been introduced into Zimbabwe, none of them are as productive as the indigenous tilapia. Because of their herbivorous habit *Tilapia*, especially *T. rendalli* and *T. zilli* are widely used in irrigation channels and dams to control aquatic weed growth. They are capable of eating submerged, semi-submerged, or floating weeds and may even consume submerged parts of emergent plants, provided they are not too tough.

The Green-Headed Bream *(O. macrochir)* is tolerant to low water temperatures with its lower limit being around 12-13°C. *T. mossambica* is more adapted to cold water than other kinds of *Tilapia*. It can also be artificially fed with any grain meal, bran etc. The male is darker in colour than the female, and can turn to black during the spawning act. Colourations and morphometrics are commonly used to identify different *Tilapia* fish species.

T. macrochir is a warm water fish. It was introduced into the country because of its special feeding habits; which are intermediate between *T. mossambica* and *T. melanopleura*. Another fish almost identical in form and habits to the former is *T. andersonii*, which is adapted to colder water.

East Bottlenose *(Mormyrus longilostris)* is also a species highly rated by the African consumers in the Zambezi systems.

Reptiles

Reptiles in Lake Kariba are dominated by the crocodiles whose flesh (especially the crocodile tail) are a delicacy especially for tourists. Crocodile skins are used as hides in the leather manufacturing industry.

Aquatic ducks

Besides producing tasty poultry meat, aquatic ducks can also be produced or kept extremely successfully in conjunction with fish. The Pekin duck, appears to be most suited to integrated duck-fish production.

2.4.1.3. Status and trends of biodiversity in fish

Fish status in river systems.

Zimbabwe is drained by six major river systems namely the Zambezi, Save-Runde, Limpopo, Nata, Bubi and Pungwe. The presence of physical barriers in the form of waterfalls and dam walls on these rivers has resulted in partially different fauna and flora above and below each barrier. Fish biodiversity in the six river systems is described below:

- The Zambezi river system: Eighty-four and 70 species of fish occur above and below the Victoria Falls respectively, with only 46 being common to both systems. Species specific to the upper Zambezi system include *Pollimyrus castelnaui, Hepsetus odoe* and *Coptostomobarbus wittei.*

- The Save-Runde river system: The Chivirira and Selawandome Falls demarcate Save-Runde into the lower and upper systems. Thirty-nine fish species have been recorded from the upper Save-Runde system. The following are only found in the Save-Runde system: *Megalops cyprinoides, Barbus aenus, B. natalensis* (exotic), *Belonichthys fluviatilis, Carcharhinus leucas* and *Pristis microdon.*

- Limpopo river system: Forty-six species have been recorded with *Chetia flaviventris* and *Lebeo rudii* being confined to this system only.

- Nata river system: The Nata river ceases to flow after the rainy season and has a series of pools for most of the year. Only four fish species which also occur in the other river systems have been recorded.

- Bubi river system: Of the 49 species known to occur in this system, only 16 have been recorded in Zimbabwean waters. The size of the river's tributaries and several waterfalls in Mozambique inhibit the upstream migration of some fish species.

- Pungwe river system: Only 22 species occur in this system due to its small catchment. Eight of these 22 species are of the genus *Barbus.*

Fish status and trends in dams and lakes.

Of the 123 fish species occurring in Zimbabwe, only a few economically and biologically important ones have been monitored. Dams whose fish populations have been monitored are Lake Kariba, Lake Chivero, Lake Mutirikwi and Darwendale Dam. Those dams which are not regularly monitored but have limited records available, are Manjirenji, Osborne, Mazvikadei, Ngezi and Sebakwe. Monitoring is done through collections of data from fishermen on a monthly basis. Fisheries officers also carry out experimental gill and seine netting fishing to confirm the fishermen's data. The collected data are extrapolated to derive the species composition and population status. Information on trends in fish species in the four dams is presented in this sub-section.

Trends in Lake Kariba.

There are about 42 fish species in Lake Kariba and of these 18 are commercially exploited and regularly monitored in the inshore fishery. The inshore fish species of Lake Kariba have undergone several population changes. The initially dominant species namely, *Hydrocynus vittatus, Malapterurus electricus, Tilapia rendalli* and *Clarias gariepinus* have declined in importance and have been replaced by *Synodontis zambezensis, Mormyrus longilostris, Sargochromis codringtonii, Serranochromis macrocephalus, Oreochromis mortimeri* and *Labeo altivelis* (Sanyanga, 1996). Such changes are related to changes in the availability and abundance of food. The species composition of the inshore fishery in Lake Kariba is presented in Table 2.4.1.

Table: 2.4.1. Fish catch records in Lake Kariba

Species	% catch in Zimbabwe 1995	% catch in Zimbabwe 1994	% catch in Zambia 1994
Brycinus imberi	-	-	5.2
Clarias gariepinus	4.0	8.4	8.4
Distichodus schenga	-	1.0	0.7
Hydrocynus vittatus	38.0	24.2	1.2
Labeo altivelis	17.0	6.5	9.1
Mormyrus anguilloides	3.0	2.8	16.1
Mormyrus longilostris	8.0	10.6	8.9
Oreochromis mortimeri	11.0	36.2	6.0
Sargochromis condringtonii	11.0	5.1	23.8
Serranochromis macrocephalus	1.0	1.0	7.3
Synodiontis zambezensis	-	-	2.2
Others	5.0	2.2	-

Source: 1994 and 1995 Statistical Reports.

Trends in Lake Chivero, Lake Mutirikwi and Darwendale Dam

The species composition and catches in Lake Chivero, Lake Mutirikwi and Darwendale Dam are depicted in Table 2.4.2. Fish populations have been generally increasing in Lake Chivero and Darwendale Dam due to an increase in nutrient levels. The most dominant species in Lake Chivero is *O. macrochir* and *Tilapia spermanii* seems to be increasing although the numbers cannot be verified. The latter is the most abundant species in Lake Mutirikwi and Darwendale Dam.

2.4.1.4. Status and trends of biodiversity in aquatic insects

Aquatic insects are as versatile as their terrestrial counterparts in the use of a wide variety of food sources. However, very few are adapted to a completely submerged

existence with the majority having terrestrial periods due to respiratory problems associated with low oxygen concentration in water. Most of the aquatic insect biodiversity occurs in running water habitats which are more continuous than lakes that fill up and may disappear. Running water also has a higher oxygen concentration due to turbulence. Furthermore, cooler temperatures that prevail under such conditions encourage insect survival.

The biodiversity of aquatic insects, unfortunately has not been studied in Zimbabwe. However, records on very few insect species are available in the National History Museum and these have largely been a result of personal interests.

Table 2.4.2. Fish catch records for Lake Chivero, Lake Mutirikwi and Darwendale Dam.

Species	% composition Chivero	% composition Mutirikwi	% composition Darwendale
Oreochromis macrochir	73.3	1.2	9.1
Tilapia rendalli	8.6	79.6	28.0
Labeo altivelis	7.3	-	23.7
Clarias gariepinus	5.8	7.2	27.8
Serranochromis lepidotus	0.1	-	4.0
Tilapia spermanii	0.2	-	1.2
Hydrocynus vittatua	0.1	-	5.3
Oreochromis mossambicus	0.2	2.9	0.20
Alestes imberi	0.1	-	0.1
Micropterus salmonides	-	6.7	-
Serranochromis robustus	-	2.4	-
Momyrus longilostris	-	-	0.1
Pharyngochromis darlingi	0.1	-	-

Source: Fisheries Report 1996

2.4.1.5. Status and trends of biodiversity in aquatic flora

Whilst it is recognised that aquatic plants play an important role in the ecology of lakes and rivers, not much information has been collected on their population status, trends and threats. The most studied water body with regards to aquatic macrophytes is Lake Kariba whose information dates back to 40 years ago. The water hyacinth has also been well documented due to its negative impact on the ecology of Lake Chivero and its economic significance.

Lake Kariba has a low species diversity as compared to other lakes. The following seven species of submerged macrophytes have been recorded; *Lagarosiphon ilicifolius, Najas pectinata, Vallisneria aethiopica, Ceratophyllum demersum, Potamogeton octandrus, P. pisillus* and *P. schweinfurthii.*

Biodiversity trends of macrophytes on the lake are depicted in Annex 6.4.1. In terms of floral biomass, it is estimated that Lake Kariba has 101 000 tonnes (dry weight) consisting of *L. illicifolius* (52%), *N. pectinata* (33%), *V. aethiopica* (11%), *C. demersum* (3%) and *P. octandrus* (0.5%). With respect to Lakes Chivero and Manyame and the Manyame River, thousands of tonnes of the water hyacinth have infested these water bodies resulting in huge costs for weed clearing, loss of fishing and boating sites, loss of fish and an increase in the cost of purifying domestic water. Elsewhere, especially in the eastern highlands, invasion of trout dams by the water lily and the oxygen weed has reduced the quality of trout fishing.

2.4.2. Causes of aquatic biodiversity changes

Not much is known about the factors that influence fish biodiversity in Zimbabwe although the creation of reservoirs as a result of impounding the country's rivers has some implications on it. Fish diversity and distribution is influenced by several natural factors such as depth, temperature, oxygen and rainy season movements. Abiotic factors include artificial barriers like dam walls and weirs, siltation, introduction of exotic species, commercial fishing, poaching and pollution. Some of these factors are elaborated below.

2.4.2.1. Abiotic factors

Interbasin transfer

The mass transfer of water from one geographically distinct river basin to another is called interbasin transfer. The Upper Zambezi system is one of the richest ecosystems in terms of biodiversity south of the Sahara. Thus, should the water from the Victoria Falls eventually get into the Middle Zambezi system by way of pipes and canals (e.g. irrigation), this will be an easy route for fishes of the Upper Zambezi to be introduced into the Middle Zambezi. The Victoria Falls has been a natural barrier separating fishes of the two river systems. Consequently, the proposed Matebeleland Zambezi Water Project which will draw water from the Zambezi river, both above and below the Falls through a pipeline could increase fish biodiversity downstream. However, no detailed ecological impacts of Interbasin Transfers have been done in Zimbabwe.

Reservoir formation

The building of reservoirs has sometimes led to a decline in fish biodiversity. For example, fish species such as *Barbus* that are not adapted to lacustrine conditions have either disappeared or their numbers have been greatly reduced.

Pollution

The full impact of pollution on the diversity of fish in Zimbabwe has not been evaluated. However, both organic and inorganic pollution affect the diversity of fish in lakes and rivers. For example, the Tigerfish (*Hydrocynus vittatus)*, which used to be an important commercial fish in Lake Chivero in the 1970s has not been caught in the last 6 years. It is generally believed that the high pollution loads in rivers draining into Lake Chivero and in the Lake itself have contributed to the demise of this fish species.

2.4.2.2. Biotic factors

Hybridisation has the effect of reducing fish biodiversity. Zimbabwe has two groups of tilapine fishes namely the substrate spawners of the genus *Tilapia* and the mouthbrooders of the genus *Oreochromis*. However, the accidental introduction of *Oreochromis niloticus* into Zimbabwean waters has complicated the taxonomy of tilapias since they can easily breed with indigenous species. Furthermore, the hybridisation of closely related species resulting from such introductions compounds the taxonomic confusion that already exists.

2.4.2.3. Effect of technology on biodiversity

Technology has contributed to aquatic biodiversity by broadening site niches and species propagation techniques.

Artificial propagation and selective breeding of fish is one technology used to maintain the fish stock. Ripe fish are stripped (i.e. the eggs or ova of the female or hen-fish are extruded by hand into a slightly damped bowl) and manual pressure on a male fish releases a flow of spermatozoa in fluid medium and this milt is permitted to fall amongst the ova already secured. Ova and milt are stirred together, as water is added to the bowl and the presence of this water activates the sperms. The newly fertilised ova are taken to the hatchery, where they are laid upon trays with wire-mesh floors. Thirteen to twenty-nine days after fertilisation, the eyes of the embryo become sufficiently pigmented to be visible to the naked eye. These tolerate shipment and comparatively rough treatment and are the form of ova which is purchased by riparian owners.

Bream are prolific breeders, and if not properly harvested can result in too many stunted fish with limited food in a pond. If breeding continues under such conditions, the fish could start dying from lack of oxygen and food. To overcome this problem, commercial producers are now cross-breeding various types of bream in special breeding tanks to produce hybrids with predominantly male progeny. Producers can then stock their ponds at the correct levels using the resultant hybrid. The use of such hybrids also allows fish to be harvested at one time, since they will be of approximately similar size. Indigenous species that can be satisfactorily crossed with reasonable results are *O. macrochir* males with *O. mossambicus* females.

Polyculture, which involves the growing of more than one species or type of fish in the same pond, is the most common form of fish culture being practised in the country. The main advantage of this practice is the more efficient utilisation of feeding niches by different fish species which leads to an overall increase in productivity per unit volume of water, thus optimising pond efficiency.

Another way of maintaining aquatic fauna is by employing integrated production techniques. For example, ducks can be produced and kept successfully in conjunction with fish. The ducks benefit from an ideal environment, the pond, in which they also forage for additional food. While, the fish benefit from ducks dunging directly into water, which promotes the growth of algae. In addition, any wasted duck food can be directly fed to the fish.

Captive breeding is a technique used in crocodile farming. Registered crocodile farmers are allocated an annual quota of eggs laid in the wild that they collect in prescribed areas under the control of the Department of National Parks and Wildlife Management. Hatching and raising young crocodiles in captivity reduces the high juvenile mortality (about 95%) that characterise the wild population.

2.4.3. Conservation and sustainable use measures

2.4.3.1. Status of monitoring approaches

The Department of National Parks and Wildlife Management runs the Lake Kariba Fisheries Research Institute Kapenta fish length, weight and frequency programme; as well as the Lake Kariba Fisheries Research Institute fish biomass monitoring programme. These programmes have established systems for capturing catch and effort data and for collecting samples for analysing length frequencies. A stock assessment group on Kapenta has also been set up. This group analyses the bio-economics and predicts and monitors stock parameters using computer programmes.

Aquatic plants on Lake Kariba are monitored by scuba diving along vertical transects and observation of surface coverage. However, there is no systematic way of monitoring aquatic vegetation in the other water bodies. New occurrences and infestations are reported to fisheries officers by patrol scouts, fishermen and boaters.

2.4.3.2. Genetic and species diversity

Applications of molecular biology have been utilised in fish genetics for species identification and conservation of indigenous Tilapine genetic resources of Zimbabwe. Like most other fish, wherever two or more *Tilapia spp.* which do not occur together in nature (allopatric species) are bred together, hybridisation usually occurs. For example, it has been reported that *O. andersonii*, *O. mortimeri* and *O. mossambicus* may hybridise freely when they occur together. This makes it difficult for fisheries agencies to identify fish stocks with certainty. Most native Tilapia have not yet been evaluated in terms of their potential use in aquaculture in Zimbabwe. For this reason and also for taxonomy as well as conservation of fish biodiversity, it is important to prevent uncontrolled hybridisation among *Tilapia spp.* Pure indigenous species need

to be identified and used for development of aquaculture. The availability of simple and rapid methods for identifying the different *Tilapias spp* and their hybrids is therefore essential. Consequently, an enzyme assay for the Zimbabwean *Tilapia spp* was developed using two fish each from *O. mossambicus* and *T. rendalli* populations.

Introductions of new exotic species and the possibility of hybridisation between the indigenous fishes and newly introduced species may lead to losses of indigenous fishes and a significant decline in aquatic biodiversity in Zimbabwe. Preliminary research has also shown that indigenous male *O. macrochir* and female *O. mossambicus* produce 100% male hybrid progeny. In addition, some hybrids grow faster than the parental species and are superior in converting food or exhibit greater cold tolerance. Projects were initiated locally aimed at the use of DNA fingerprinting and isozyme gene-loci as species-specific genetic markers to:

- unambiguously identify all *Tilapine* species native to Zimbabwe and estimate and characterise the genetic variation within and among species,

- establish enzyme assays and appropriate DNA probes for large scale sampling in areas where introductions have occurred to assess the degree of hybridisation, and

- develop a conservation plan to mitigate against potential future losses.

2.4.3.3. *In-situ conservation measures*

About 13 % of Zimbabwe's surface area has been set aside as National Parks Estate or Protected areas. Some of the protected areas are termed Recreational Parks, which can be described as protected areas established around national dams. These national dams by virtue of being surrounded by a conservation zone have become protected areas for fish diversity. Dams that fall under this category are; Kariba, Chivero, Mutirikwi, Manyame, Ngezi, Manjirenji, and Sebakwe. The recently completed Osborne Dam will soon become a recreational park. While, the Chinhoyi Cave pools, which are inhabited by a unique fish species, are specially protected. Although commercial fishing is done on these dams, specially protected zones are closed from fishing in an effort to protect breeding and feeding areas.

There are no botanical reserves for aquatic plants in Zimbabwe. Several species have, however, been transplanted from their natural systems to home garden ponds and aquaria as ornamental plants. These include *Cyperus flabelliformis, Potamogeton thunbergii, Nymphea caeruela* and *Lagarosiphon major.*

2.4.3.4. *Ex-situ* conservation measures

There are four Government owned hatcheries which maintain populations of certain commercially important fish for restocking purposes in the country. These are:

- Nyanga Trout Research Centre which breeds rainbow trout;

- Henderson Research Station which breeds pure stocks of *Oreochromis* and *Tilapia* species;

- Lake Chivero Fisheries Research Station which breeds pure stocks of O. *mossambicus* and conducts growth experiments. The centre has also set up a hatchery for *Cyprinus carpio* and *C. gariepinus; and,*

- Lake Kyle Fisheries Station which breeds pure stocks of *Oreochromis* and *Tilapia* species.

In addition, Zimbabwe has two privately owned hatcheries with permits to breed pure stocks of the exotic *Orechromis niloticus.*

2.4.3.5. Access to biological and genetic resources

Access to aquatic resources may be seen in the broad context of access to wildlife resources in general. It is greatly dependant on the location of the resource. In terms of the law, access to aquatic resources is under the control of the state in terms of an authority, usually a permit or licence which attaches conditions for their exploitation. In line with the current economic development strategy and poverty alleviation policy, the rural population occupying areas adjacent to aquatic resources are allowed access, provided sustainable harvesting measures are employed. In large dams, commercial fishing by locals is allowed through co-operatives. These co-operatives compete for permits with private commercial companies. However, fishing for subsistence by rod and line is permitted, although in some dams this attracts a small fee. Sport fishermen, aquarists and researchers are allowed access with a special National Parks and Wildlife permit. Private dam owners control access to fish resources in these dams and may grant authority to any other person to fish in their waters.

2.4.4. Legislative and policy framework

Aquatic fauna and flora are regulated under the general wildlife and natural resources laws of Zimbabwe as part of the broader biological resources of the country. The Parks and Wildlife Act (PWLA) principally regulates the elements of aquatic flora and fauna by seeking to provide for the preservation, conservation, propagation or control of wildlife, fish and plants of Zimbabwe.

Fish conservation is more particularly dealt with in the PWLA. The Act empowers the Minister responsible for its administration to declare any waters to be controlled fishing waters; where such a declaration is necessary or desirable for fish conservation. The Minister is also empowered to take any necessary measures to reduce or increase fish populations and to eradicate or encourage plant growth within or around controlled fishing waters.

The PWLA prohibits the introduction of exotic species of fish or aquatic plants into any waters and the importation of live fish or ova of any fish except in terms of a permit. However, such a permit specially prohibits the introduction of any aquatic

plant which is a weed. Any fish or aquatic plant life considered injurious to fish populations may be killed in terms of an order issued by the Minister to an appropriate authority for the water.

The exploitation of fish falls under a general prohibition; which only falls away where a permit has been issued. Fishing without a permit is authorised in any waters that the Minister may specify. A permit is required for the conduct of any business of catching and selling fish. It is issued for the exploitation of kapenta from all waters controlled by the State. The permits are issued on an annual basis and are based on a number of unit catches. A permit holder is required to make annual returns on his/her catch. Fishing nets and methods of fishing are also the subject of regulation, with a requirement that all dealers and manufacturers of fishing nets be registered. A registered fishing net dealer is required to make a return of each fishing net sold on a monthly basis. The Act further regulates the type of fishing gear which may be utilised as well as the methods in terms of which fish may be harvested.

No regulations particular to aquatic plant life are available except where such plants have been declared to be specially protected plants or noxious weeds. A number of species of aquatic plants are treated as noxious weeds and are regulated and controlled through the Noxious Weeds Act. This Act prohibits the introduction of any noxious weed or its seed into any water body, road or land. Such weeds include the water lettuce (*Pistia stratiotes*) and water fern (*Salvinia molesta* Mitchell).

The Natural Resources Act bears some implication on aquatic fauna and flora as it broadly deals with natural resources and specifically regulates the use of wetlands which are important habitants for aquatic fauna and flora.

Controls over aquatic flora and fauna in terms of the PWLA are problematic as its application only covers the Parks and Wildlife Estate. With the exception of fish resources, areas outside the Parks and Wildlife Estate are regulated and controlled under other legislation.

2.4.5. Institutional framework, cross-sectoral linkages and the human resource base.

2.4.5.1. Institutional framework and cross-sectoral linkages

The main institutions involved in fisheries in Zimbabwe are the Department of National Parks and Wildlife Management (DNPWLM), Department of Agricultural, Technical and Extension Services (AGRITEX), the Department of Research and Specialist Services (DR&SS) and the University of Zimbabwe.

The DNPWLM is responsible for overall fisheries management, research and extension within and outside the Parks Estate. However, due to staff shortages the department's activities outside the Estate are limited to the management of exotic fish; licensing commercial operations and purchasing of fishing gear; and giving appropriate authority status to Rural District Councils (RDCs).

AGRITEX is responsible for fisheries extension outside the Parks Estate. Zimbabwe has many small dams largely developed for irrigation and to provide water for domestic stock. Such dams have also been developed for fisheries. Most RDCs have appropriate authority status for fisheries management and in conjunction with AGRITEX, have organised communities to communally manage this resource along CAMPFIRE lines. Assistance in this area is being provided by the FAO/ALCOM (Aquaculture for Local Community Development) Project. The University of Zimbabwe is responsible for staff training through its postgraduate degree or diploma programmes on fisheries. The university also carries out fisheries research at its Lake Kariba Research Station. DR&SS has very elaborate aquaculture research facilities at Henderson Research Station, where it works together with the DNPWLM and AGRITEX on multiple production systems and extension.

According to the foregoing, the different organisations involved in fisheries have strong functional linkages. For example, the DNPWLM has the overall responsibility for fisheries development throughout the country; the University of Zimbabwe is in charge of training although current programmes are limited in scope; while AGRITEX is involved in the promotion of aquaculture.

2.4.5.2. Human resources

The different organisations involved in fisheries are specialised. The areas of specialisation include research, management, extension, sociology and law. However, the institutions tend to be inadequately staffed in certain disciplines.

2.4.6. Economic factors

2.4.6.1. Valuation of aquatic biodiversity

Given the landlocked nature of Zimbabwe and the fact that it has no natural lakes, aquatic biodiversity is restricted to river systems and dams. Some of these reservoirs, such as Lake Kariba have developed into valuable recreational areas and commercial fishing zones. The various values associated with aquatic biodiversity include both use and non-use values. The former is created when people derive satisfaction from using the biological resource and the latter from knowing that the resource exists and is to be passed on to future generations or safeguarded for future development options.

Direct use values

Direct use values include both consumptive and non-consumptive. Consumptive use values include fish from both wild capture and commercial fish farms. In 1996, approximately 32,500 tonnes of fish, half of it consisting of kapenta was harvested from Lake Kariba. Over 1,000 tonnes of other fish species were also harvested from fish farms throughout the country. With respect to kapenta fisheries, approximately 235 rigs operate a total of 75,000 boat nights per year. Assuming an average of six crew per boat, the total primary employment could be about 1, 410. In addition, there is a large processing industry on shore that generates secondary employment

and income. Consumptive values also include recreational fishing on inland lakes and dams; and fishing for small-scale commercial trading and personal consumption.

Non consumptive values centre around tourism related to aquatic ecosystems. The main contributors are the tourism industries on Lake Kariba and Victoria Falls; and canoeing on the Zambezi river. Within Victoria Falls, aquatic tourism activities include kayaking, white-water rafting, canoeing, and boat cruises. While Kariba has a significant luxury cruise boat industry to complement several hotels and a large number of smaller private tourist lodges along the shore. Unfortunately, no accurate information is available on revenues generated from these activities. However, an economic study carried out in Victoria Falls showed that water related tourism activities of canoeing/kayaking, white-water rafting and river cruises generated a gross revenue of almost Z$70 million. Canoeing/kayaking and white-water rafting accounted for 77% of all tourism based revenue (excluding accommodation) in the area (Dube and Milne, 1995).

Indirect use values

Indirect use values are tied to the ecological benefits of aquatic biodiversity and supporting ecosystems such as wetlands. These include the regulation of water flow; maintenance of water quality; and the provision of habitat for aquatic and terrestrial fauna. Although these values are critical from an ecological perspective, they are very difficult to measure in practice.

Non-use values

Non-use values relate to values generated even when people may not have, or will never use the aquatic resources such as wetlands. The value of knowing that the resource exists (existence values), can be conserved to pass on to future generations (bequest values), or may be available in the future for other development options (option values) can be important. As an example, some Zimbabweans may place a high value on conserving the shores of Lake Kariba and associated biological resources, even if they have never visited the area. However, these values are difficult to measure in practice.

2.4.6.2. Economic incentives and perverse incentives

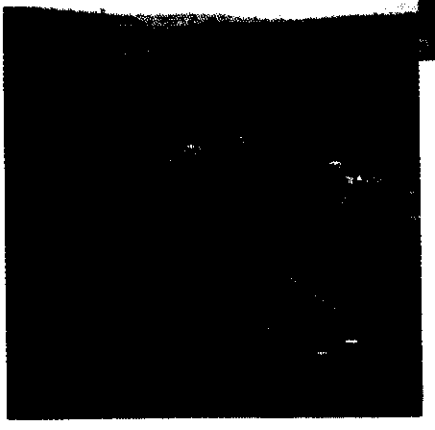
One of the more intractable problems associated with the conservation of aquatic biodiversity is the lack of clarity over property rights, especially where more than one country is involved. For example, fishing boats in Lake Kariba operate from both Zimbabwe and Zambia. Since fish are fugitive resources and migrate from one side of the lake to the other, a well-regulated fishing industry in one country, can be threatened, if the other country over-harvests. This lack of clear property rights is a disincentive to biodiversity conservation and more pronounced if one or both countries fail to put in effective monitoring programmes. As a contrast, the case of private fish and crocodile farms is a positive incentive for conservation. Such operations reduce the pressure on natural ecosystems to supply a flow of products for local and export markets. For example, the operation of private crocodile farms in the country has

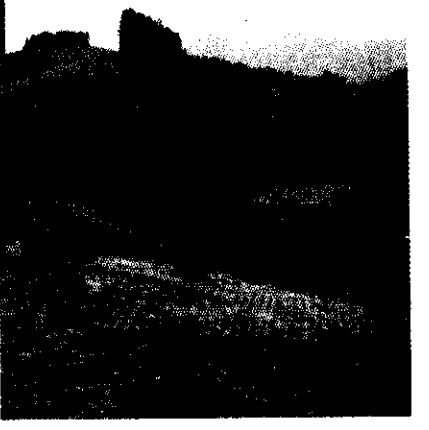
often been cited as an important factor in the conservation of that species of aquatic fauna.

Another critical economic incentive/disincentive requiring further investigation is the cost of various government permits relative to potential values generated. For example, the annual permit cost for a luxury cruise boat is Z$50 000, yet one boat can generate at least Z$500,000 per annum. With canoeing in Victoria Falls, the annual permit cost to an operator is Z$25 000 while the industry generates about Z$50 to Z$60 million per annum. Some key economic and policy questions that have to be addressed in this area of permits include the following:

- are the permit costs high enough to cover government costs of monitoring and regulating the industry;
- are permit fees high enough to discourage over-entry into the industry and the subsequent resource degradation. If the permit system is not designed to regulate entry into the industry, is there an effective quota system to limit the numbers of operators; and
- are permits supported by regulations governing the activities of the industry and are these being effective.

AGRICULTURE





2.5 AGRICULTURE

2.5.1. Status and trends in agricultural diversity

Agro-biodiversity refers to the variability among living organisms associated with cultivated crops and domesticated animals and the ecological complexes of which they are a part (Convention on Biological Diversity, 1992). A unique feature of agricultural biodiversity is the emphasis on its utility to human beings.

Because of its tropical location; and variations in altitude, rainfall and evapotranspiration, Zimbabwe can produce agricultural products found in most regions of the world. They include: tobacco, maize, mangoes, bananas, sugarcane and coffee for tropical climates; citrus fruits (e.g. oranges and lemons) and sheep for mediterranean climates; and deciduous fruit (peaches and apples) for temperate climates. In addition, a wide diversity of crops associated with subsistence farming such as small grain cereals, cowpeas, sweet potatoes, bambaranuts and indigenous vegetables are also grown.

Agro-ecosystems occur where naturally occurring plants and animals have been replaced by crops and livestock deliberately selected by human beings. The degree of disruption of the natural systems varies with the type of agriculture practised. In the case of Zimbabwe, the country has been divided into five agro-ecological zones (NRs) largely based on rainfall (see Section 2.5.1.1). Natural Regions (NRs) I and II are suitable for intensive farming based on crop production; NR III for semi-intensive farming based on both crop and livestock production; and NR IV and V for extensive farming based on livestock and wildlife management (Vincent and Thomas, 1960).

2.5.1.1. Agro-ecosystems

The distribution of agricultural land by farming sector and NR in Zimbabwe is depicted in Table 2.5.1.

Table 2.5.1. Land use classification by sector and natural region in Zimbabwe

Natural region	Farming sector			
	Communal (000ha)	Large scale commercial (000ha)	Small scale commercial (000ha)	Resettlement (000ha)
I & II	1 410	3 890	250	620
III	2 820	2 410	530	1 240
IV	7 340	2 430	500	810
V	4 780	2 490	100	620
Total	16 350	11 220	1 380	3 290

Source: Zimbabwe Agric. Sector Memorandum, 1991.

Only 9% of the communal land is in the high rainfall areas (800 to over 1 000mm/ year) of NRs I and II compared to 35% of the large scale commercial sector. Corresponding figures for the small scale commercial and resettlement areas are 18% and 16% respectively. Land distribution in NR III, a medium rainfall zone (650 - 800mm/year) is 17%, 21%, 38% and 33% for the communal, large scale commercial, small scale commercial, and resettlement areas respectively.

Overall, only 19% of Zimbabwe's farmland is in NRs I and II and almost 63% of this high potential land is in large scale commercial areas. This land distribution pattern highlights the fact that:

- overall, Zimbabwe has limited agricultural potential; and
- the large scale commercial areas have an inherently higher agricultural potential than the other three farming sectors.

2.5.1.2. Plant genetic diversity

Zimbabwe is very rich in domesticated plant genetic resources which include cereals; pulses; industrial and horticultural crops; indigenous and exotic vegetables; roots and tubers; and medicinal plants. Cultivated crops cover about 27% of the country and this area continues to increase as more forest land is opened up for cropping due to increasing human population. Wild relatives of some of these crops also exist and include cotton, rice, sorghum, pearlmillet, fingermillet, cowpeas and bambaranuts. However, very little work has been done to document the diversity and distribution of these wild relatives. The status of crop biodiversity in Zimbabwe is discussed in this section.

Cereals

The commonly grown cereals in Zimbabwe are maize, sorghum, pearlmillet, fingermillet, rice and winter wheat. Cereals were traditionally intercropped with legumes, but the practice has largely given way to monocropping with the modernisation of agriculture.

Maize (*Zea mays)* is the staple food and an important cash crop grown throughout the country. It has a lot of genetic diversity in terms of maturity, plant height, endosperm type, stress tolerance, yield potential and grain colour within the improved varieties. There are about 30 accessions of landraces collected from various parts of the country; 28 accessions being used in population improvement programmes; 34 accessions of populations from crosses of Mexican with local material; over 124 accessions of inbred lines; over 104 accessions of F1 hybrids from locally developed inbred lines; and a lot of exotic lines being used in crossing programmes.

Sorghum (*Sorghum bicolor*) is widely grown in the low rainfall communal areas of Zimbabwe (NRs III – V). Over 2 000 accessions of developed landraces have been collected and about 830 of these have been characterised and described using morphological and agronomic features. White grained varieties are preferred for making porridge, while red or brown seeded varieties are mainly used for brewing

purposes. Five basic races of sorghum (namely kafir, caudatum, guinea, duvra and bicolor) are found in the country but their frequency of occurrence is variable.

Pearlmillet (*Pennisetum glaucum*) is important in the drier parts of Zimbabwe (NRs III – V). A total of 824 accessions of local lines have been collected and 400 accessions of foreign lines were sourced from the International Crop Research Institute for Semi-Arid Tropics (ICRISAT) in India. These accessions are being used in crosses for higher yield, early maturity and superior grain quality, since local landraces are very tall and late maturing. Pearlmillet is also being developed as a fodder crop especially in combination with napier grass in an inter specific hybrid called "bana grass"

Fingermillet (*Eleusine coracana*) is usually grown in areas of relatively high rainfall and high elevation for beer brewing. Over 700 local accessions have been collected and additional germplasm has come from East and Central Africa and India. The crop is highly self-pollinated with minusculate flowers hence is difficult to emascule and create segregating populations. A mutation breeding programme to create variability in fingermillet has been initiated and male sterility has been successfully induced in the crop.

Zimbabwe has very few accessions of rice (*Oryza sativa*) which were obtained from the International Rice Research Institute (IRRI). However, the country has some wild relatives of rice which include *O. punctata, O. longista-minata* and *Lersia spp.* Wheat (*Triticum spp.*) is the most important winter cereal grown under irrigation and has over a thousand accessions of exotic lines being used in breeding programmes. These lines, which originated from different parts of the world such as Mexico, Canada, United Kingdom, South Africa and China show high genetic diversity in terms of maturity, plant height, stress tolerance, grain yield potential and grain quality.

Pulses

The major pulses grown in the country are groundnuts, cowpeas, field beans, soya beans and bambaranuts. These legumes are grown in rotation with cereals.

Most of the groundnut (*Arachis hypogea*) introductions came from the USA and their genetic background is in Latin America. There are over 2 000 exotic and 400 local lines of groundnuts but no mapping of the latter has been done.

Cowpeas (*Vigna unguiculata*) is one of the most important drought tolerant pulses grown in Zimbabwe. There are 120 exotic and 30 local lines available. Most of the local lines are of the creeping type although short and erect cowpea lines are more desirable for higher grain yield. There are presently 100 local and 1 000 exotic lines of field beans (*Phaseolus vulgaris*). Given the high susceptibility of field beans to pests and diseases, lines with resistance to some major diseases such as Bean Common Mosaic Virus, anthracrose and common bacterial blight have been identified. On soyabeans, very few local lines exist while about 5 000 exotic and 1 240 locally developed lines are available. With respect to bambaranuts (*Voandzeia subterranea),* 75 exotic and 12 local lines have been assembled.

Industrial and horticultural crops

Industrial and horticultural crops commonly grown in Zimbabwe are tobacco, sunflower, cotton, castor, coffee, sugarcane and fruits. There are approximately 600 different types of tobacco (*Nicotiana spp.*) which include flue-cured, burley, air cured and fire cured. There are also 40 indigenous species and 91 oriental ones. In addition, 3 000 lines and more than 5 000 selections are available. With respect to sunflower (*Helianthus annus*), about 800 exotic germplasm lines and 1 440 locally bred ones are available. On cotton (*Gossypium herbaceum*), 2 000 accessions consisting of acquisitions and breeding lines are present.

Zimbabwe is a centre of diversity for castor bean (*Ricinus communis*) and about 85 collections are available. Some materials have also been sourced from countries such as Brazil, Israel, USA, South Africa and Malawi. With respect to coffee (*Coffea arabica*), 133 cultivars exist, five of which are resistant to coffee berry disease. About six wild species of coffee have been reported. On sugarcane there are 661 varieties kept in a germplasm collection in Chiredzi. Most of the collections originated from other sugarcane growing countries around the world and some were locally selected from seed produced in South Africa and propagated locally. Locally selected sugarcane varieties exceed 105 and this number grows annually.

With regard to fruits, there are about 3 000 cultivars of apples while many cultivars of peaches, plums, mangoes, bananas, citrus etc. are available. On the other hand, indigenous fruits are increasingly becoming an important food and cash source in the smallholder farming sector, although they have not been subjected to much research.

Vegetables

Vegetables are the cheapest source of protein, vitamins, minerals and essential amino acids in the diet of many rural communities in Zimbabwe. The most common exotic vegetables are brassicas, onion (*Allium cepa*), pea (*Pisum sativum*) carrots, tomato (*Lycopersicon esculentum*) and okra. Although the country imports seed of most brassicas, work has started on cabbage and onion seed production.

There are over 30 different indigenous vegetables found in the country and the common species are *Amaranthus hybridus, A. thumbergii, Cleome gynandra, C. monophylla, Corchorus olitorius, C. tridem, Aerva leucura, Triumfetta annua, Bidens pilosa, Solanum nigrum, Cucurbita spp.* and *Hibiscus articulatus.* Most of these vegetables grow wild and are either harvested regularly or in times of food scarcity. However, a few specialised collections have been done on *Cucurbita, Amaranthus, Solanum* and *Vigna spp.* Zimbabwe is a centre of diversity for crop relatives of curcubits which range from small spiky cucumbers (*Cucumis metuliferus*) to some indigenous gourds and pumpkins. Notwithstanding, there is an overall decline in the quantity and types of major indigenous vegetables growing in the country due to the introduction of exotic vegetables.

Roots and tubers

The most common root and tuber crops in the country are irish potatoes, sweet potatoes and cassava. Over 1 500 clones of irish potatoes from the International Potato Centre (CIP), Holland, Scotland and USA are available. With respect to sweet potatoes, about 20 different cultivars are present and their micropropagation for disease elimination and the rapid propagation of disease free planting material is being undertaken. Despite its drought tolerance, cassava is not widely grown except in certain areas in the Zambezi valley and the Eastern districts.

Medicinal plants

More than 500 species of medicinal plants have been collected, out of the 5 000 species normally used in Zimbabwe. Of these, 39 plants are used by most practitioners for the same ailment and 50 exotic plants have been identified.

Endangered medicinal plant species in Zimbabwe include: *Alepidea amatymbica,* which has been recorded in two localities and its tuber is used for a number of aliments such as abdominal pains and headaches; *Ansellia gigantea,* whose numbers in the wild have been greatly reduced and is used for a variety of illnesses; *Harpagophytum procumbens* has been located in two areas and its rhizomes are used as an anti-rheumatic treatment; and, *Warburgia salutaris,* which has been recorded in only two localities and its bark is used as a panacea.

Other vulnerable medicinal plants include *Aloe spp., Asparagus spp., Gardenia. resiniflua, G. volkensis, Trichilia emetica, Triumfetta welwitshii, Mondia whytei, Peltophorum africunum,* and *Vernonia amygdalina.* The populations of these plant species have dropped drastically in communal areas and around human settlements although they are still abundant in protected areas and on commercial farms. *Crinum macowanii* and *Hydnora solmsiana* are now regarded as rare species because of the high levels of their exploitation.

2.5.1.3. Animal genetic diversity

Population and uses of domesticated animals

Domesticated animals in Zimbabwe can be divided into the following categories: large herbivores comprising cattle and a few equines; small ruminants consisting of goats and sheep; and, non-ruminants composed of pigs, poultry and rabbits.

The populations of these animal species are depicted in Table 2.5.2. The large decline of about one million head of cattle between 1990 and 1996 was largely due to the catastrophic effects of the 1991/92 and 1994/95 droughts. It is, however, difficult to get reliable livestock statistics from the country's livestock production systems which vary from subsistence in the smallholder farming sector to intensive operations in the large scale commercial farming sector. The number of equines is even more difficult to estimate with donkeys being put at 300 000 and horses at 20 000.

Table 2.5.2. Domesticated animal population in Zimbabwe: 1980 - 1996

Species	Population (000)		
	1980	1990	1996
Cattle	5 279	6 407	5 500
Goats	982	2 557	2 690
Sheep	411	600	613
Pigs	150	190	198
Poultry	45	60	76

Source: Ministry of Agriculture, 1996.

Domesticated animals play critical roles in the economy and farming systems of Zimbabwe. Within the large scale commercial farming sector, livestock provides marketed meat, milk and eggs for both the local and export markets. While in the smallholder farming sector, livestock, especially cattle provide invaluable inputs into crop production. These include traction/draught power for land preparation, transport and manure to fertilise cultivated crop lands (Scoones et. al, 1996). In addition, cattle provide milk for the household and constitute indispensable capital assets with respect to family savings and investment. Goats, sheep, pigs, and poultry are important cash and meat sources, while donkeys provide draught power especially in the drier parts of the country.

Status of genetic diversity in domesticated livestock.

During the evolution of livestock species in Africa, capacity to adapt for survival has taken precedence over increased productivity hence most indigenous breeds cope better with harsh tropical environments than temperate breeds. Consequently, the genotype of indigenous species in countries like Zimbabwe has been overemphasised as a primary constraint to increased production and productivity resulting in huge resources being allocated to conventional breeding programmes with indigenous species involving selection, crossing with exotic breeds and multiplication schemes. However, recent studies have shown that the perceived low genetic potential of indigenous cattle is critical only in terms of their milk production for commercial purposes and not in terms of meat production under comparative management conditions (Tawonezvi *et. al*, 1988). This is also true with small ruminants. Despite this evidence, the advantages of indigenous animals are not widely exploited due to the limited availability of improved indigenous stock and the lack of properly articulated animal breeding policies in the country. Consequently, the greatest need in genetic improvement programmes is not only improvement within indigenous breeds, but also ensuring that the merits of these breeds are widely promoted. In addition, there is need for vigilance to ensure that genes of these breeds are not lost due to overuse of exotic stock in breeding programmes directed at increasing meat and milk production. Consequently, the current conservation efforts of indigenous cattle germplasm being done for Tuli and Nkone cattle at Matopos Research Station

and for Mashona cattle at Makoholi Research Station must be maintained as an integral part of the national breeding programme.

Artificial insemination is the most commonly used strategy by cattle breeders in Zimbabwe and has been successful in producing uniform crops of both beef and dairy breeds. For example, indigenous Zebu cattle have been cross-bred with the exotic Hereford, Charolais, Simmental and Sussex breeds to increase beef production. On the other hand, all the dairy stock is exotic, consisting mainly of Friesland and Jersey breeds with Ayrshire and Guernsey as minor stock.

Indigenous goats have been cross-bred to a limited extent with the Boer goat for meat production and with the Saanen goat for higher milk yields. They have also been bred with the Angora goats from Namibia and South Africa for mohair, although this industry is very small in Zimbabwe. The indigenous black pig is basically a scavenger and its meat is very fatty. Because of this and the limited focus on the indigenous pig, only exotics such as the Landrace, Large White and Duroc are bred for porkers and baconers. With respect to sheep, the Blackhead Persian and the local Sabi sheep have been cross-bred with the exotic Merino types from Germany and Australia for meat production. The commercial poultry industry relies heavily on exotic breeds from various countries, while indigenous poultry breeds are non-commercial and are kept on free range in the smallholder farming sector.

The foregoing livestock improvement initiatives have been at the expense of local breeds whose diversity has been greatly reduced.

2.5.1.4. Relevant micro-organisms (fungi and bacteria)

A number of mycorrhizal fungi are known to beneficially associate with root systems of many crop plants. For example, cassava, citrus, onion, cowpea, asparagus and *Stylosanthes* species have strong dependency; maize, sorghum and *Paspalum* species have medium dependency; and wheat, barley, potatoes and rice have weak dependency on mycorrhizal fungi. However, no detailed studies have been undertaken to determine the quantitative benefits of such associations and how they can be enhanced. With respect to livestock, fungi such as *Saccharomyces cerevisae* (a yeast) and *Armillaria heimii* (a white rot fungi) are known to increase forage and roughage utilisation in ruminants (cattle, goats and sheep).

Legume crops commonly grown in Zimbabwe (e.g. soyabeans, groundnuts, cowpeas, field beans and pastures) form associations with strains of *Rhizobia.* These nitrogen fixing bacteria have received a lot of attention with about 540 local and exotic strains of *Rhizobia* and *Bradyrhizobia* being kept by the Ministry of Agriculture at Grasslands Research Station primarily for inoculant production (Table 2.5.3).

Associations between bacteria and non-leguminous crops are also known to exist. Such associations involve nitrogen fixing bacterial species such as *Azospirillum* (e.g. *A. lipoferum, A. irakense, A. brasilense, A. amazonense* and *A. halopraeferens*) with crops like maize, wheat, rice, sugarcane and sorghum and have demonstrated

considerable nitrogen fixing potential. However, very few studies have been conducted on this type of nitrogen fixation in Zimbabwe.

Table 2.5.3. *Rhizobia* and *Bradyrhizobia* strains kept at Grasslands Research Station.

Cross inoculation group	Origin		Total
	Zimbabwe	Other areas	
Tropical cowpea	168	111	279
Temperate cowpea	4	14	18
Medicago	23	24	47
Trifolium	15	50	65
Vetch (peas)	9	16	25
Field beans	11	23	34
Soyabean	11	51	62
Lupin	1	8	9
Azorhizobium caulinodans	0	1	1
Total	242	298	540

Source: Samson et. al., 1996.

With respect to ruminant animals, a number of bacterial strains that assist in the degradation of cellulose, hemicellulose and pectic substances are found in the rumen (Table 2.5.4). Other bacteria of importance to domestic animals are the lactic acid forming bacteria which "sour" milk. The most widely used of such bacteria are *Lactobacillus bulgaricus* and *L. thermophillus* which are imported into the country as freeze dried cultures.

2.5.1.5. Dryland cropping

The range of crops grown in Zimbabwe is discussed in section 2.5.1.1. This section illustrates the status of dryland crop production in the four farming sectors using six widely grown crops namely maize, sorghum, cotton, groundnuts, sunflower and burley tobacco. Table 2.5.5 shows the areas planted and yields achieved in these crops by farming sector. The following points can be deduced from the table.

With the exception of burley tobacco, the bulk of the area planted to maize, sorghum, cotton, groundnuts and sunflower is in communal areas. This is followed by the large scale commercial, resettlement and small scale commercial areas in that order.

Although burley tobacco production is currently concentrated in large scale commercial areas, the area allocated to the crop in the other sectors is continuously increasing through the entry of new growers.

Table 2.5.4. Bacterial strains found in the rumen of cattle, sheep and goats.

Strain	Substance degraded	Host animal
Bacteroides ruminicola	Hemicellulose Pectic substances	Sheep, cattle & goats
Bacteroides succinogenes	Cellulose Hermicellulose Pectic substances	Sheep & Goats
Eubacterium cellulosolvens	Cellulose Hermicellulose Pectic substances	Sheep & cattle
Lachnospira multiparus	Pectic substances	Sheep & cattle
Ruminococous flavefaciens	Cellulose Hermicellulose Pectic substances	Sheep & cattle
Streprococcus bovis	Pectic substances	Sheep & cattle

Source: Mpofu, 1992.

Table 2.5.5. Summary of mean area planted and yield by crop and sector: 1987/88 - 1990/91.

Crop	Sector			
	Communal	Large scalel	Small scale	Resettlement
Area (000ha)				
Maize	934.0 (11)*	136.2 (8)	40.0 (4)	77.0 (4)
Sorghum	147.0 (29)	4.4 (30)	1.2 (41)	3.5 (35)
Cotton	147.0 (11)	50.1 (17)	9.6 (16)	15.0 (13)
Groundnut	197.0 (10)	4.3 (28)	8.3 (8)	1.3 (16)
Sunflower	120.9 (22)	4.6 (80)	6.7 (11)	12.2 (14)
Burley tobacco	1.0 (46)	1.7 (12)	0.3 (53)	0.4 (-)
Yield (t/ha)				
Maize	1.37 (10)	4.70 (3)	1.87 (10)	1.99 (13)
Sorghum	0.71 (24)	3.01 (5)	0.62 (18)	0.56 (25)
Cotton	0.73 (24)	2.03 (7)	0.78 (25)	1.07 (18)
Groundnut	0.46 (14)	3.10 (6)	0.59 (12)	0.51 (8)
Sunflower	0.53 (15)	0.71 (6)	0.44 (34)	0.66 (11)
Burley tobacco	1.20 (18)	2.34 (9)	0.92 (4)	0.80 (-)

** Figures in brackets show the CVs.*
Source: Price Waterhouse, 1994

Most of the area planted to crops in the communal areas and to some extent in the small scale commercial and resettlement areas is in NRs IV and V, while the bulk of the large scale commercial area crop is in the better rainfall areas (NRs I to II).

Consequently, crop production is riskier and the chances of environmental degradation are higher in the smallholder farming sectors. Notwithstanding, farmers in these sectors still concentrate on growing maize, a drought sensitive crop, at the expense of more drought tolerant crops such as sorghum. This highlights the cash orientation of smallholder producers and the absence of profitable alternatives to maize.

There is considerable seasonal variation in the area planted to the six crops across farming sectors. This can be partly attributed to the farmers' response to change in the official commodity producer prices. This variability is, however, generally larger in the large scale commercial sector. Reasons for the lower seasonal variability in the area planted to some of the crops in the other sectors, especially communal areas, include:

- the lack of alternative cropping options for marginal rainfall areas;
- the availability of more lucrative informal market outlets for crops like groundnuts; and
- the food security role played by crops such as maize, which restricts the extent to which it can be substituted.

Seasonal variability in crop performance is generally lower in the large scale commercial than the smallholder farming sectors. This is partly because crops in the former sector are mostly grown in the higher rainfall areas (NRs I-III). Furthermore, the sector usually has access to supplementary irrigation facilities and production inputs such as inorganic fertilisers.

2.5.1.6. Irrigated cropping

Overview

Irrigation development in the agricultural sector of Zimbabwe assumes greater significance given that 80% of the country's farmland receives low (<800mm/year) and erratic rainfall. Consequently, irrigation development has been a major feature of the country's agriculture for a long time and has had a negative impact on agro-biodiversity by narrowing the crop range in preference to high value crops. Large scale commercial irrigation in Zimbabwe started in 1910, while the first government sponsored smallholder scheme was established in 1932. In addition, informal irrigation in the form of small vegetable gardens from shallow wells in dry river beds, pools or vleis has been practised for a long time.

The current situation

The area developed for irrigation in the large scale commercial farming sector is estimated at 139 000 hectares on 1 500 farms and is growing at 2 000ha each year. High value crops such as tobacco, cotton, wheat, sugarcane and horticultural crops are grown. In the 1995/96 season, it was estimated that over 70% of the total agricultural production on the large scale commercial farms was grown under full or supplementary irrigation. In addition, some 26 estates of the Agricultural Development

Authority (a parastatal organisation in the Ministry of Lands and Agriculture) have an irrigation capacity of 13 500ha.

The smallholder (communal and resettlement areas) irrigation schemes have a total operational area of 9 450ha spread amongst 306 schemes that benefit some 20 600 smallholder farmers. About 89% of this area is under surface irrigation and the remainder is under sprinklers. Farmers grow a wide variety of crops ranging from maize, cotton, wheat and some high value agricultural crops. However, of concern on these schemes are the low crop yields which are one third of those achieved under large scale commercial irrigation. This is largely due to poor scheme and crop management and the limited use of inorganic fertilisers and pesticides. Scheme maintenance has been poor as evidenced by leaks, inefficient water use, unreliable water supplies and poor catchment area management. Furthermore, the schemes are heavily subsidised by the state which meets the capital and development costs and a significant proportion of costs for scheme operation, repairs and maintenance. However, this has proved to be unsustainable, and government has committed itself to a phased hand over of the schemes to farmers. In this regard, government has revised the scheme operation and maintenance charge from a flat Z$145 per ha to a charge based on the amount of water used. In addition, all schemes are now run by Irrigation Management Committees (IMCs) which are being trained for the eventual take over of the schemes. There is, however, need to give these committees and their constitutions and bye-laws a legal basis to enable them to operate as corporate bodies which are able to enter into legal contracts.

Given the importance of irrigation to food security and agro-biodiversity enhancement in the smallholder sector, government has further committed itself to building two dams per district each year, although, this target has been hampered by financial constraints. In addition, government has recently passed a decree to provide 10% of the available water from national dams to smallholder farmers.

2.5.1.7. Livestock production

Overview

The livestock species kept in Zimbabwe are described in section 2.5.1.3. This section focuses on the performance of cattle, the major livestock species in the country.

Natural pasture from grazing areas is the basis for cattle production in the four farming sectors. However, the relative contribution of grazing areas to cattle performance varies with sector. In the case of the communal farming sector, communal grazing has led to veld deterioration due to overstocking and lack of veld improvement measures. Despite being communally owned, grazing in resettlement areas is still in a relatively good condition because of the relatively low stocking rates and the limited time frame that such schemes have been operational. On the other hand, privately owned grazing areas of the large and small scale commercial sectors are still satisfactory, partly because farmers use optimal stocking rates, rotationally graze their cattle and implement strategies such as legume reinforcement into the veld.

The beef enterprise

Performance indices for beef production in the four farming sectors are presented in Table 2.5.6. Large scale commercial areas show comparatively higher cattle productivity and offtake figures than the other sectors. For example, calving rate and offtake figures in this sector are 75% and 33% respectively. Corresponding statistics for communal, small scale commercial and resettlement areas are 29% and 3%; 38% and 7% and 50% and 4% respectively.

Table 2.5.6. Productivity coefficients for beef production by farming sector

Parameter	Communal areas	Large scale	Small scale commercial	Resettlement commercial
Age at 1st calving, yrs	5	2.5 - 3	4-5	4-5
Calving rate, %	29	75	38	50
Offtake, %	3	33	7	4
Herd mortality, %	21	4	11	17

Source: Adapted from the Beef Production Manual, 1988

Reasons for the low beef performance indices in the smallholder farming sectors are:

- grazing is based on the natural veld which is generally inadequate both in quantity and quality, particularly during the dry season. Crop residues are the major food source to supplement veld grazing. Unfortunately, the low crop yields achieved in these sectors invariably limit the amount of residues produced. Furthermore, high stocking rates, coupled with the communal grazing system have led to the rapid deterioration and depletion of natural pastures and the environment in communal areas. On the other hand, large scale commercial farmers supplement veld grazing (usually reinforced with legumes or other improved pastures) with purchased stockfeeds. Furthermore, these farmers use rotational grazing and adhere to optimum stocking rates to maintain the veld and animals in good condition; and,
- cattle play a multiple role in smallholder farming systems including: provision of draught power; provision of manure (organic fertiliser); supply of milk; socio-cultural roles such as lobola (bride price) payment; and financial and economic roles such as the use of cattle as sink areas for savings and investment. Consequently, the low beef offtake in these sectors is not necessarily an indicator of low efficiency, but a reflection of the "non commercial" approach to cattle production.

Grazing schemes

Rotational grazing is widely and successfully practised by large scale commercial farmers and a number of government and donor funded grazing schemes have also been established in a number of communal areas. Such schemes are aimed at:

- improving livestock production through increased quantity and quality of herbage; and
- conserving the vegetation cover of grazing areas through rotational grazing and adherence to recommended stocking rates.

Table 2.5.7 depicts the distribution of communal area grazing schemes by natural region. Only 27% of the schemes are in NRII while the rest are in NRIII, IV and V. Such a distribution confirms the importance of livestock in marginal rainfall areas. On average, each scheme incorporates land under three kraal heads and all households in that community are eligible for membership and make equal contributions (in labour or cash) towards scheme operation.

Table 2.5.7. Distribution of communal area grazing schemes by natural region: 1992

Natural region	No. of schemes	Total area (ha)
II	15	11 357
III	10	7 911
IV	24	25 533
V	6	5 847
Total	55	50 648

Source: Chinembiri, 1992.

According to Chinembiri (1992), evaluations of communal area grazing schemes carried out by AGRITEX showed that:

- there had been zero or negligible increases in herbage yield and species composition at the schemes;
- stocking rates were much higher than those planned for the schemes; and
- only 27% of the 55 schemes are practising any of the recommended management systems.

On the basis of the foregoing analysis, it is difficult to suggest that grazing schemes have increased animal and veld productivity in communal areas. If anything, they have tended to worsen environmental degradation, through increased stocking rates. This largely reflects the problems associated with the management of common property resources and the "non commercial" status of cattle in this sector. Nevertheless, grazing schemes are popular in some communal areas and a number of communities (e.g. in Gutu) have been operating them for some years.

2.5.1.8. Game ranching

Game ranching has been on the increase since the passing of the Parks and Wildlife Act of 1975. This Act introduced flexibility in the government's control of wildlife

in Parks and Reserved areas by allowing:

- private landowners to manage and benefit directly from wildlife on their land; and
- greater participation of communal area residents in the management and utilisation of wildlife by granting Rural District Councils similar rights to those of farmers on private land.

Low beef prices and rising costs of cattle production following the 1982/83 drought accelerated the incorporation of game farming into large scale commercial farming (MLARR, 1988). While, wildlife programmes in communal areas have been encouraged through the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) which works with relevant District Councils. The major motivation for this programme has been the need to enable rural families to exploit wildlife in their environment profitably, sustainably and legally. This has occurred through a combination of game ranching and organised safari operations.

About 10% of the large scale commercial farmland in Zimbabwe is currently used for game ranching, while 33 districts participate in this activity in communal areas. The majority of game ranches in the two farming sectors are located in the drier agro-ecological zones. Some of the large scale commercial farmers have introduced game to the rough areas of their land such as rocky outcrops, steep slopes and shallow or waterlogged soils. On the other hand, communal area game ranching is concentrated in areas with no or low cattle populations and sizeable wildlife numbers.

Within the large scale commercial farming sector, returns from game ranching, hunting and photographic safaris are more attractive than those from meat production. The higher returns from game in comparison to cattle farming in this sector are evidenced by the considerable shift from beef production that has occurred on some farms. On the other hand, a theoretical comparison of wildlife and cattle performance in a typical communal area showed that wildlife produced a value of Z$0.63/kg of biomass compared to Z$0.38/kg from cattle (Martin, 1989). This analysis included the value of the other roles played by cattle in the farming system. The assessment suggests that it would be more economically efficient for communal area farmers to use their grassland resources to raise and harvest wildlife, than to increase cattle production in the appropriate areas.

2.5.2 Causes of agro-biodiversity decline, increase or maintenance.

2.5.2.1. Effect of land degradation

Because of its location in marginal agricultural environments coupled with poor agricultural practices and overgrazing, the communal area farming sector losses about 75t/ha of soil through erosion each year compared to 15t/ha in the large scale commercial sector (Whitlow, 1988). In addition, the continuous cultivation of the predominantly sandy soils has tended to encourage soil loss through sheet erosion and compaction in the sub-soil. Such land and soil disturbances reduce soil

waterholding capacity, soil fertility and the population of beneficial micro-organisms with an adverse effect on agro-biodiversity.

2.5.2.2. Cultural and socio-economic factors.

The widespread use of traditional crop varieties (landraces) by smallholder farmers tended to have a positive effect on agro-biodiversity. However, the commercialisation of agriculture has led to the adoption of intensive cropping methods such as the use of hybrid seed, inorganic fertiliser, pesticides and monocropping. On the other hand, low-input, low-output agricultural systems such as agroforestry and intercropping used to enhance biodiversity and to guarantee food security at the household level. Furthermore, the use of plant species such as blackjack (*Bidens pilosa*), marigold (*Tagetes minuta*) and chowa (*Datura stramonium*) instead of inorganic chemicals to control termites, aphids, cutworms and other insects helped reduce the adverse effect of chemicals on the environment.

2.5.2.3 Effect of technology on biodiversity

The use of modern technology such as high yielding varieties, agricultural chemicals and irrigation in Zimbabwe, has increased with the following adverse effects on agro-biodiversity:

- the homogenisation of most commercial crop and livestock species; which has reduced their gene pool and increased their susceptibility to pests and diseases;
- the erosion of landraces and breeds of traditionally important crops and livestock species; and,
- the decline in the population and species range of soil organisms such as beneficial fungi, bacteria and insects such as bees; which are important in the pollination of certain crops such as sunflowers.

On the other hand, if properly used, biotechnology should maintain (e.g. through the standardised *in vitro* propagation techniques) or increase (e.g. through the production of genetically modified organisms) agro-biodiversity. Biotechnology could introduce a greater diversity of genes into organisms, including genes from unrelated species, than traditional methods of breeding and selection. The main thrust of biotechnology research in Zimbabwe has been the promotion of available technologies in crops such as tobacco, wheat, sugarcane, irish potatoes, sweet potatoes and maize through tissue culture techniques for disease elimination; rapid propagation; the development of transgenetic plants (e.g. in tobacco) and the development of biopesticides and biofertilisers. Work in the animal sector has focused on laboratory diagnosis of diseases, vaccination development and vector control.

Given the increasing awareness on the adverse effects of persistent chemical pesticide use on the environment, biotechnology can also contribute to reduced pesticide use. In this regard, work is underway on cloning Cowpea Aphid-borne Mosaic Virus (CabMV) in order to confer resistance to CabMV in cowpea using the coat protein approach and transdominant lethal mutations in the viral replicase.

Biotechnology applications in Zimbabwe are also used in disease detection. They range from field applications in microscopy and cow mastitis testing in commercial dairy operations to more specialised laboratory testing operations such as microbial culture and serological testing for antibodies and antigens for a wide variety of microbial diseases. Biotechnology is also used in artificial insemination, based on selected animals, and to assist in economic translocation of selected breeds over long distances, thus obviating the more difficult quarantine procedures for grown animals.

The above examples show that biotechnological developments can play an important role in maintaining, protecting and improving agro-biodiversity in Zimbabwe. However, such developments and their products (e.g. transgenic plants) if not carefully pursued, reduce biodiversity. There are also concerns on the potential risks to biodiversity and human health posed by Genetically Modified Organisms (GMOs) released into the environment. Such concerns include: unintended changes in competitiveness; virulence or other characteristics on target species (non- target species) and ecosystems, hence threatening the local landraces with extinction; and unintended gene transfer. There is therefore need to develop safety measures under which biotechnology should operate in order to ensure the safe transfer, handling, use and release of its products. It is against this background that the Conference of Parties to the Convention on Biological Diversity established an open Adhoc Working Group on Biosafety in order to develop a protocol on biosafety. As a signatory to the Convention, Zimbabwe has prepared draft biosafety guidelines with technical assistance from the Special Programme on Biotechnology of the Netherlands Ministry of Foreign Affairs. The Research Council of Zimbabwe has decided to incorporate the guidelines into the Scientific and Technological Research Act of 1998. This will require an amendment of the Research Act to allow for the setting up of a board that implements biosafety policies and procedures in the country.

2.5.3. Conservation and sustainable use measures

2.5.3.1. Status of monitoring approaches

Although, there are no specific biodiversity monitoring programmes in the agricultural sector, two related programmes are underway at Matopos Research Station. They are the Vegetation Monitoring and the Soil Erosion and Runoff Monitoring Programmes.

The objectives of the Vegetation Monitoring Programme are to:

- determine species composition, herbage yield and basal cover on the veld under continuous and rotational grazing schemes subjected to different stocking rates; and
- monitor tree density, species frequency, height classes and available browse resulting from variations in weather conditions and browsing by livestock and wildlife.

The Soil Erosion and Runoff Monitoring Programme aims at:

- estimating soil loss from a given piece of land under given rainfall amounts and intensity and vegetation cover; and
- measuring and estimating runoff from grazing and arable land under certain rainfall and vegetation conditions.

The methods used in both monitoring programmes include observations, measurements and physical counts in the field. Grass measurements are done five times per year, while trees are measured annually.

2.5.3.2. *In- situ* conservation

Techniques used in the *in-situ* conservation of agricultural biodiversity include the use of genetic reserves (i.e. protected and non protected areas) and on-farm conservation.

Genetic reserves in protected and non protected areas

About 13% of Zimbabwe's land area consists of national parks and wildlife estates, which contain a wide range of flora and fauna. Wild crop relatives such as cowpeas, bambaranut, sorghum, cotton, rice and many indigenous vegetables are quite abundant in these areas, which are managed by the Department of National Parks and Wildlife Management. Unfortunately, no mechanisms have been put in place to facilitate the surveying, inventory, monitoring and conservation of these plant genetic resources.

Non-protected areas in Zimbabwe harbour some plant and animal biodiversity. Such areas include cattle ranches and communal grazing lands which are rich in domestic animal diversity. However, breeding is not normally controlled in the latter situation resulting in greater genetic diversity, when compared to commercial farms where breeding is controlled. Notwithstanding, no efforts have been made to map out the distribution of important plant and animal species in non- protected areas in order to determine their diversity, threats and appropriate conservation strategies.

On-farm conservation

On-farm conservation involves the maintenance of traditional crop varieties or cropping systems by farmers within traditional agricultural systems. For example, some farmers still use landraces of traditional crops such as sorghum, millet, cowpeas, bambaranuts, pumpkins and water melons for food security. However, agricultural commercialisation has adversely affected this practice leading to the loss of valuable biodiversity. A number of initiatives have been mounted to arrest this trend by government and non-governmental organisations and they include:

- Mapping the distribution of local landraces and documentation of traditional knowledge systems in order to facilitate their on-farm conservation. This is being done by the Gene Bank of Zimbabwe;

- The promotion of on-farm conservation of traditional landraces of sorghum, pearlmillet, cowpeas, and bambaranuts by Environment Development Activities (ENDA-Zimbabwe); and
- The promotion of *in-situ* conservation and sustainable utilisation of traditional vegetables and fruits by the Community Technology Development Association (COMMUTEC).

2.5.3.3 Ex-situ conservation

Ex-situ conservation of agro-biodiversity involves the establishment of gene banks and botanic gardens as discussed below:

Gene banks

Most of the germplasm collected in Zimbabwe is in the hands of plant breeders. The breeders' working collections (active collections) consist of seed (for field crops and forest trees) and living collections of horticultural trees and crops. The germplasm in the breeders' active collections include: local landraces of wild crop species; introduced varieties, lines and populations; locally bred populations or breeding material stored for re-selection or insurance against disasters; and locally bred elite lines (e.g. parents of commercial hybrids) and commercial varieties. Breeders' collections are stored in medium-term cold storage facilities at below 10 °C and about 40% relative humidity and then rejuvenated after every five years. A list of some of the crop germplasm stored at plant breeding institutes in the country is presented in Table 2.5.8. Considerable pasture legume and pasture grass germplasm is also held at the research stations of the Department of Research and Specialist Services (DR&SS) in the Ministry of Lands and Agriculture (see Annex 6.5.1).

The Gene Bank of Zimbabwe; which is housed in DR&SS collects, characterises, evaluates and stores plant genetic resources that are agriculturally important in the country. The Genebank is in the process of relocating some germplasm that was in the hands of breeders for safe keeping. Germplasm that is already at the Genebank include: sorghum, pearlmillet, fingermillet, cowpeas, bambaranut, water melons, rice and some indigenous vegetables. However, some of these accessions have yet to be classified, characterised, evaluated and documented.

Germplasm collection plays a very crucial role in ensuring that species threatened with extinction are conserved. Most of Zimbabwe's local germplasm collection was done in 1982 and 1987 by DR&SS in collaboration with the International Plant Genetic Resources Institute (IPGRI), the International Institute of Tropical Agriculture (IITA) and ICRISAT. Currently, the Gene Bank of Zimbabwe in collaboration with IPGRI, the SADC Plant Genetic Resources Centre (SPGRC) and IRRI is collecting wild relatives of rice and traditional vegetables. So far 12 accessions of wild vegetables including *Oryiza barthii, O. Longistaminata, Lersia lexaudra* and *L. denudata* have been collected. The Horticulture Research Institute of DR&SS has been involved in collecting germplasm of traditional vegetables for conservation and utilisation in

breeding programmes (Table 2.5.9). Non Governmental Organisations such as ENDA and COMMUTEC have started collecting and storing local germplasm for multiplication and subsequent repatriation to communal areas.

Table 2.5.8. Some germplasm stored at plant breeding institutions in Zimbabwe.

Crop	No. of Accessions	Description
Maize	28	landraces
Sorghum	1 829	landraces
Pearl millet	47	local lines
Finger millet	456	local lines
Barley	350	local lines
Winter wheat	715	local lines
Field beans	100	local lines
Cowpeas	30	local lines
Groundnuts	800	local lines
Soyabeans	1 140	local lines
Sunflower	40	local lines
Potatoes	30	breeding lines
Potatoes	6	commercial varieties
Cotton	2 500	acquisitions & breeders' lines
Cotton	garden (*ex-situ*)	wild cotton relatives
Tea/Coffee	living collection	duplicate of Mt. Mulanje collection
Tobacco	800	local lines, breeding lines & landraces

With respect to the conservation of domestic animal biodiversity, *ex-situ* conservation means storage. It involves the preservation of animals as a sample of a breed in a situation removed from its normal production environment/habitat, and/or the collection and cryopreservation of genetic resources in the form of living semen, ova and embryos or tissues that can be used to regenerate the animal (Hammond, 1994). In Zimbabwe, the *ex-situ* conservation of domestic animals largely involves cryopreservation of semen, ova and embryos in liquid nitrogen.

Botanic Gardens

The main centre for *ex-situ* conservation is the 68ha National Herbarium and Botanic Garden in the Ministry of Lands and Agriculture. It is responsible for the propagation and conservation of plant species such as tea, coffee, cotton, rubber, sugar, sisal, oil palm, lemon grass, jackfruit, pomegranate and pecan nuts.

Table 2.5.9. List of vegetable crops collected by the Horticulture Research Institute.

Scientific Name	Shona Name	Ndebele name
Amaranthus hybridus	mowa guru/bononwe	imbuya
Amaranthus thunberguii	mowa	imbuya
Bidens pilosa	muuwu/nhungunira	umsubo
Celesta trigyna	mundawarara	ulililnkomo
Cigna anguiculata	nyemba	inama
Cleome gynandra	nyevhe/runi	elude
Corchorus olitorius	gwisha/nyevhe/gusha	-
Galinsoga parviflora	teketera	-
Hibisscus articulatus	derere rehambakachera	idelele
Senecio erubescens	chirevereve	indumba
Solanun nigrum	musungusungu	-
Sonchus oleraceus	rurimirwemombe	edelele
Triumfetta annua	derere renama	isihlabe

2.5.3.4. Access to biological and genetic resources and property rights.

Intellectual property rights generally take two forms namely plant variety protection and utility patents (Jandle, 1990). Plant variety protection in Zimbabwe is instituted through the Plant Breeders Rights Act of 1973. The Act allows breeders to register a variety that meets the criteria of novelty, uniformity, stability and distinctiveness and authorises the owner to exclude others from selling the variety for 20 years.

Utility patents are applied to live organisms in some countries. These patents use different criteria such as novelty, utility and non-obviousness and are more restrictive than plant variety protection. Being a signatory to the General Agreement on Tariffs and Trade (GATT), Zimbabwe is in the process of developing the patenting system.

Since breeders and technologists are compensated for their innovations by Plant Variety Protection and Patents respectively, farmers should, by right be afforded similar benefits for their landraces, most of which are in international Genebanks or were the raw materials for the breeders and biotechnologists. However, the current plant breeders' rights act only applies to propagatory materials that are distinct, uniform and can therefore be identified, but do not apply to the farmers' landraces which are variable and evolving. This absence of fair and widely accepted international standards of protection for intellectual, genetic and cultural property rights raises equity issues and may discourage some forms of biodiversity conservation, research and development, since international seed banks, private companies and research institutes collect samples of germplasm freely from developing countries. Recent trends in conservation are however emphasizing the need to ensure a fairer distribution of

economic returns partly on equity grounds and to provide stronger economic incentives to local populations to help conserve the resource base that generated this revenue.

2.5.3.5. Local participation, indigenous knowledge systems and gender.

The importance of local participation and indigenous knowledge in agro-diversity conservation stems from the fact that the best place to maintain genetic resources is in their original natural habitat and cultural context. Smallholder farmers in Zimbabwe possess a unique understanding and knowledge of their natural environment. The farmers' knowledge of the environment and its inherent production factors such as soil, fauna, flora and climatic conditions enables them to make appropriate decisions on the sustainable use of natural resources. For example, crops such as okra (*Abelmoschus esculentus*), pumpkins (*Cucurbita spp.* and *Lagenaria spp*), tsunga (*Brassica juncea*) and sweet sorghum (*Sorghum bicolor)* which require considerable moisture and high soil calcium and potassium were grown exclusively on ant hills, which are more fertile and retain more water.

Women also played a key role in agro-diversity conservation as they comprise 75% of the smallholder farmer population in the country. They selected seed with preferred characteristics such as colour, size, genetic stability, disease tolerance, palatability and good processing qualities for planting. Furthermore, they grew "women's crops" such as groundnuts, pumpkins, leafy vegetables, cowpeas, cucumbers and sweet potatoes, which had the effect of raising biodiversity and food security on the farm. Such crops required a lot of precision and patience in planting, weeding, harvesting, processing, preservation and food preparation.

There is therefore need to fuse such valuable indigenous knowledge with contemporary knowledge systems in agro-biodiversity conservation.

2.5.4. Legislation and policy

A number of Statutes regulate the various aspects of agricultural activities in the country. However, no one Act attempts to comprehensively cover these activities as the issues sought to be regulated are manifold. Several of these statutes have implications on agro-biodiversity. They provide for the control of, and regulate different sections of the agricultural environment. Some of the key statutes include the Plant Pests and Disease Act; the Plant Breeders Rights Act; the Sericulture Act; the Agriculture Research Act; the Animal Health Act; the Bees Act; the Quelea Control Act; the Noxious Weeds Act; and the Fertilisers, Farm Feeds, and Remedies Act.

The Plant Pests and Diseases Act provides for the eradication and prevention of the introduction and spread of plant pests and diseases in Zimbabwe. It applies to both live and dead plants, namely, tubers, bulbs, corn, root cuttings, grafts, seeds and fruits. The object of the Animal Health Act is the eradication and prevention of the introduction and spread of animal pest and diseases. The animals covered under the

Act include any class of vertebrate animals whether domesticated or wild as may be specified. This Act establishes a strict regulatory framework with regards to the control, importation and destruction of diseased animals and gives the administering Minister wide and sweeping powers. The Plant Breeders Rights Act regulates the registration of new varieties of plants and enjoins the holder of a plant breeders right to maintain the reproductive material. Other legislation provides for the eradication of noxious weeds and places a duty on owners of infested land to eradicate noxious weeds. The importation of noxious weeds and their introduction onto any land, or into any water body is expressly prohibited by the Noxious Weeds Act. Locusts are controlled in terms of the Locust Control Act, which basically seeks to eradicate four species of locusts which are harmful to agriculture.

The Bees Act aims at the control of diseases in bees and generally seeks to regulate the conservation of bees found in the wild. The Act makes provision for the declaration of diseased bee areas in which the responsible Minister is empowered to destroy bees. Bee conservation is sought to be achieved primarily through measures restricting the removal of bees found in natural hives and creates an offence where this is done without the express consent of the appropriate authority for the land on which the natural hive is located. The Quelea Control Act makes the quelea bird a notifiable pest. The primary objective of the Act is the prevention of massive damage to agricultural crops and hence it employs drastic measures in the control of quelea.

Looked at together, the above pieces of legislation provide a fairly reasonable regulatory framework to advance agricultural objectives in the country. However, measures for the control of soil erosion and soil conservation are generally lacking in the legislative instruments regulating the agricultural sector. Yet agriculture forms the backbone of the country's economy and many of Zimbabwe's environmental problems are related to land degradation due to poor agricultural practices. Soil conservation is treated in the Natural Resources Act in terms of which the administering Minister may order the carrying out of steps to prevent and mitigate soil erosion or promote soil conservation

2.5.5 Institutional framework, cross sectoral linkages and the human resource base.

2.5.5.1 Institutional framework and cross sectoral linkages.

The Ministry of Lands and Agriculture through its line departments (Department of Research and Specialist Services, Department of Agricultural and Technical Services, Department of Veterinary Services and the Agricultural and Rural Development Authority) is the major player in agro-diversity management. Other players include the Department of National Parks and Wildlife Management, the Department of the Surveyor General, the Forestry Commission, the Department of Natural Resources, Universities, non governmental organisations and the private sector.

The bulk of agricultural research and extension in Zimbabwe is carried out by the Department of Research and Specialist Services and the Department of Agricultural, Technical and Extension Services respectively. However, government funding to

these two departments has been declining over the years with an adverse effect on the smallholder farming sector; which is the major beneficiary of their efforts. It is however, heartening to note that there has been an increase in privately funded research and extension over the last few years. Key players in the field include the Seed Coop, Pioneer Seeds, Pannar Seeds, National Tested Seeds, Fertiliser Companies, the Zimbabwe Sugar Association, the Pig Industry Board, the Tobacco Research Board and the Agricultural Research Trust Farm. The Agricultural and Rural Development Authority is responsible for planning, co-ordinating and implementing fairly large agricultural and rural development projects on behalf of the government while the Department of Veterinary Services is responsible for the prevention and control of animal diseases.

The Department of National Parks and Wildlife Management is involved in plant and animal biodiversity in the Parks and Wildlife estate. While as the state forest authority, the Forestry Commission is responsible for all wild flora outside the parks and wildlife estate and is involved in certain research and extension aspects of agroforestry. The Department of the Surveyor-General provides a full range of surveying and mapping services which are critical for land use planning and agri-diversity monitoring. The Department of Water Resources is responsible for the provision and conservation of water through dam construction. Although the departments' policy of two dams per district per year has not been realised due to financial constraints, centres of agricultural biodiversity have been created where irrigation schemes have been established. On the other hand, the Department of Natural Resources regulates and enforces broader environmental issues such as soil conservation while the Department of Rural and Urban Planning formulates local by-laws for resource conservation with the involvement of Rural District Councils who are closer to the natural resources.

Apart from providing appropriate training, a number of departments at the University of Zimbabwe have been involved in agricultural research and training efforts especially in the smallholder farming sector. While a number of non-governmental organisations such as ENDA-Zimbabwe and COMMUTEC have been actively involved in the collection and storage of local landraces of traditionally important crops.

The fact that most of the services offered by the above organisations are complementary provides opportunities for cross sectoral and cross-institutional linkages in specific areas. However, given the large number of players involved, there is considerable scope for improving upon such linkages.

2.5.5.2. Human resources

The previous section has highlighted the presence of a wide range of expertise in the various institutions involved in agricultural biodiversity management and the existence of financial constraints in some of the institutions. The latter highlights the need for

inter-institutional linkages in order to maximise the use of available specialised human and limited financial resources.

2.5.6 Economic factors.

2.5.6.1 Valuation of agro-biodiversity

The forecast values of crop production for the 1996/97 season are presented in Table 2.5.10. However, this table excludes a number of key agricultural commodities hence it does not reflect the true value of agro-diversity in Zimbabwe. For example, sugar contributed 25% of the total value of agricultural production in 1995; livestock slaughtering, milk and butterfat production amounted to Z$1.6 billion in 1996; while fruit, dry beans, vegetables and fodder crops are likely to contribute about 10% of total agricultural sales in 1997. Once these issues are incorporated, the value of agricultural sales for 1997 can be estimated at Z$19 billion.

Table 2.5.10. Estimated crop production values for 1997 by sector.

Crop	Sector			
	Large scale commercial		Communal areas	
	Quantity (000tons)	Value (Z$million)	Quantity (000tons)	Value (Z$million)
Maize	738.3	849	1 483.0	1705
Sorghum	14.9	21	115.1	161
Wheat	182.0	473	-	-
Cotton	70.2	380	198.0	1 071
Groundnuts	3.6	12	149.3	478
Sunflower	1.5	3	32.1	58
Soyabeans	89.6	314	2.6	9
Burley tobacco	2.9	59	5.1	101
Flue cured tobacco	208.6	6 257	-	-
Total value		8 368		3 583

Source: Ministry of Agriculture (1997)

2.5.6.2. Economic incentives and perverse incentives

The major challenge to biodiversity conservation and sustainable use in general is the problem of striking a balance between the quest for economic development and the conservation of natural resources. Unfortunately, various national policies are in most cases, unintentionally, the major causes of environmental degradation and biodiversity losses. This section reviews perverse and positive incentives to agro-biodiversity conservation.

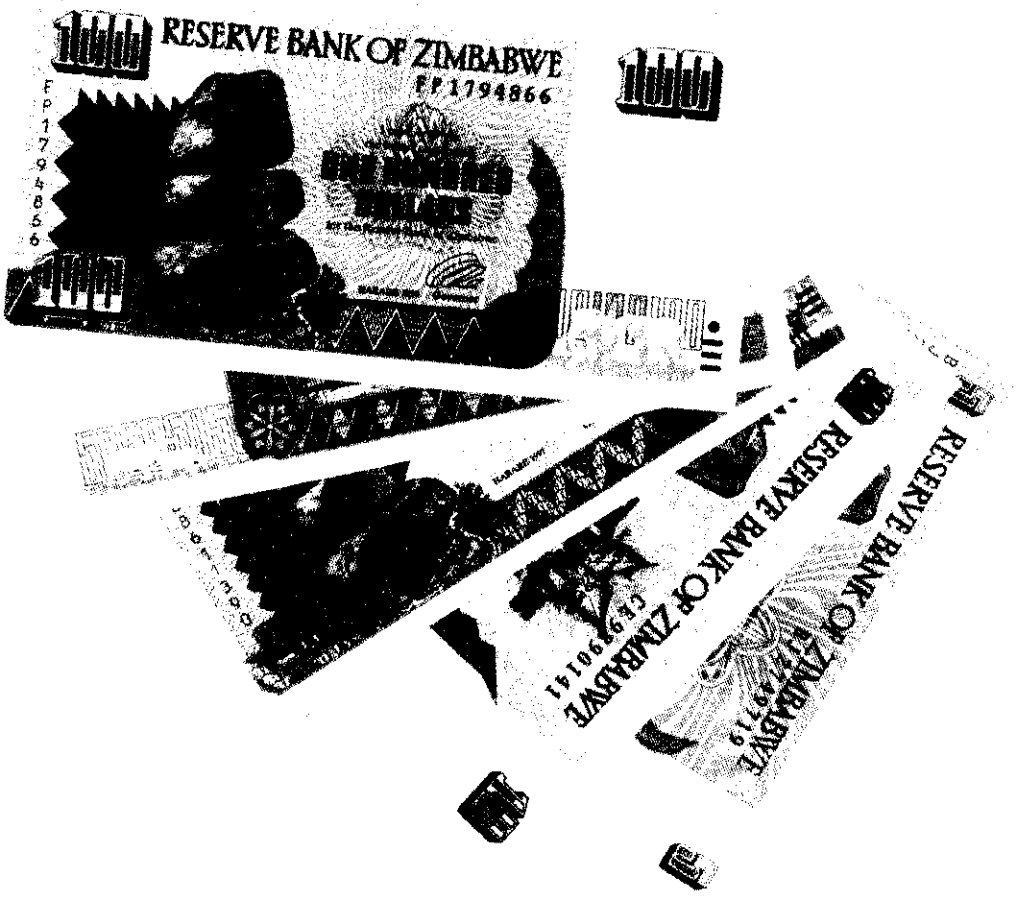
Perverse incentives

Agro-biodiversity in Zimbabwe has been affected by an array of colonial socio-economic and political policies that affect the large scale commercial and smallholder farmers in a variety of ways. For example, the colonial legacy of locating smallholder farmers in the low rainfall areas with inherently infertile soils limited their potential to diversify their agricultural production. Rather, they are limited to the production of basic food crops like maize, sorghum, millet and groundnuts. Insecurity of land tenure in the communal and resettlement farming sectors also affects agro-biodiversity. While there is no clear evidence of lack of appropriate conservation measures on arable land, lack of security on communally owned grazing land significantly contributes to land degradation. Furthermore, the setting up of producer pre-planting prices by the government before the market reforms tended to limit agro-biodiversity.

Positive incentives

A number of policy frameworks that promote agro-biodiversity (in terms of broadening the crop range) have been put in place by government since independence. For example, the land redistribution programme aims at allocating more productive land to communal farmers. In addition to easing land pressure in the communal areas, such relocated farmers can diversify their agricultural production base and increase their contribution to the national economy. Credit is still substantially subsidised by government through the Agricultural Finance Corporation (AFC), where interest rates for seasonal loans to smallholder farmers are between 19% and 22%. Such an arrangement encourages the use of improved technologies and diversification into higher value crops. Furthermore, government has been injecting between Z$10 million to Z$20 million annually over the last five years for smallholder irrigation development. While the large scale commercial farmers are benefiting from the highly subsidised National Farm Irrigation Fund, which aims at reducing the cost of wheat production. However, such initiatives tend to have an adverse effect on the low value but traditionally important food crops.

COSTS AND BENEFITS OF CONSERVING BIODIVERSITY



CONSERVATION AND SUSTAINABLE UTILISATION OF BIOLOGICAL RESOURCES

2.6. BENEFITS AND COSTS OF CONSERVING BIODIVERSITY.

2.6.1. Benefits of biodiversity conservation

Overview

When evaluating biological resources, one objective is to estimate what society is willing to pay to enjoy the derived benefits or to accept as compensation if benefits are lost. The concept of "total economic value" is normally used to group different types of values together as shown in Figure 2.4. The total economic value can be split into use and non-use values.

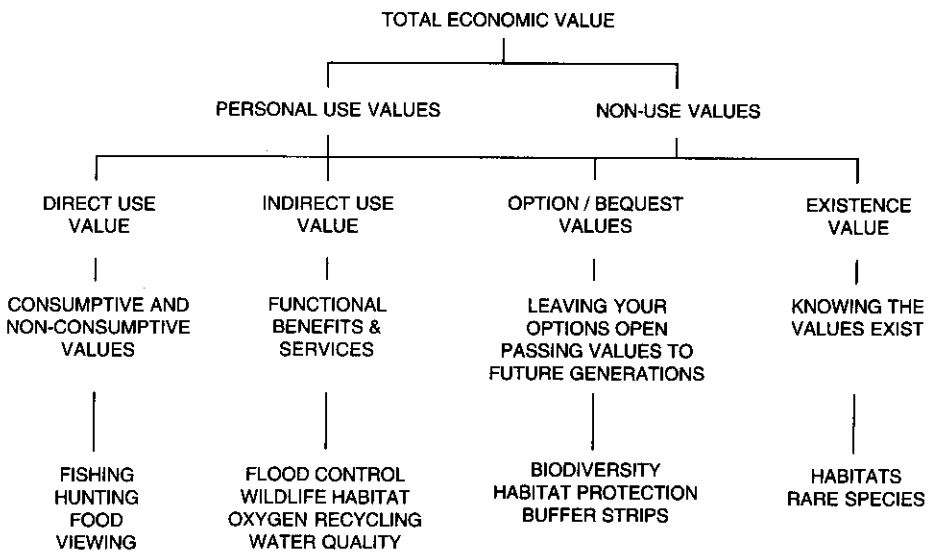


Figure 2.4. The concept of "total economic value"

Use values are held by most people for participating in some activity involving natural resources and the environment and fall into the consumptive and non-consumptive use categories. Consumptive uses are those activities that consume the resource such as fishing, cutting fuelwood and hunting. Non-consumptive uses include activities such as wildlife viewing, ecological tourism and camping where the good or service is not actually consumed or removed. Other non-consumptive uses include people viewing biological resources (like wildlife) in magazines, on television or in books. For example, an individual might not want to visit, or may never get the chance to visit Hwange National Park to see elephants, but could still gain some value from viewing the wildlife on a television show. The true economic value for most consumptive and non-consumptive use sub-categories can be represented by the amount of money which people would be willing to spend over and above their actual out-of pocket costs of enjoying the resource.

Non-use values are more complex and relate to values held by the individuals for goods and services they do not actually participate in or consume. The knowledge that a natural resource or environmental benefit exists to be passed on to future generations is an important value to many people. For example, although most Zimbabweans have probably never seen a black rhino in the wild and are unlikely to do so in the future due to the small herd size, they still contribute to various "Save the Rhino" campaigns. In this case, people might value the existence of the rhino (existence value) and may want to preserve the species for future generations (bequest value). They might also want to conserve the species to have the option of enjoying direct and indirect use values in the future (option value).

Summary of benefits from biodiversity conservation

This section summarises direct use benefits derived from forestry, wildlife, aquatic life and agro-biodiversity. A detailed description is presented under the relevant sectors.

Forest biodiversity

The forestry sector contributes around 3% to Zimbabwe's Gross Domestic Product (GDP) largely from exotic plantations and the exploitation of commercial indigenous timber species. On the other hand, natural woodlands generate a wide range of timber and non-timber forest products and services whose value was crudely estimated at around Z$4.2 billion per annum (see Section 2.2.6.1).

Major indirect use benefits of forest biodiversity, which have not yet been fully evaluated in Zimbabwe include: the provision of windbreaks, shade and soil stability; and the regulation of water quality and run-off.

Wildlife biodiversity

The direct use benefits from wildlife biodiversity include tourism income which accounts for about 6% of the GDP and the sale of hunting concessions in CAMPFIRE project areas which is now generating about Z$25 million per year. The other direct use benefits include wildlife products (e.g. meat, hides and ivory) from commercial hunting and game ranching and insects such as mopane worms, which are gathered for food and for sale by local communities. These other benefits are not quantified in this study.

Aquatic biodiversity

Direct use benefits from aquatic biodiversity include fish from both wild capture and commercial fish farms. For example, the gross kapenta value is estimated at Z$270 million per year. Other direct use values centre around tourism related to aquatic ecosystems mainly around Lake Kariba and Victoria Falls. For example a study carried

out in Victoria Falls showed that water related tourism activities of canoeing/kayaking, white water rafting and river cruises generated about Z$70 million per year (Dube and Milne, 1995).

Agro-biodiversity

The primary and secondary agricultural sectors contribute as much as 20% to the country's GDP. Agro-biodiversity also has indirect use values or ecological services which include the maintenance of natural cycles, reservoir of natural biological control systems, symbiotic associations and genetic resistance. These aspects are not quantified in this study.

2.6.2. Costs of biodiversity conservation

Overview

The costs of current biodiversity conservation measures are important in determining future strategic directions. In a limited sense, current expenditures are a measure of the value placed by decision makers on biodiversity conservation. However, such expenditures are limited by income. For example, a developing country like Zimbabwe might place a high value on protecting biodiversity, but cannot adequately address conservation objectives due to fiscal constraints. Consequently, current expenditures alone could significantly underestimate the value of biodiversity conservation to the country. Notwithstanding, information on current expenditures can be useful in 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 the values generated) and other options for public expenditures.

Costs of biodiversity conservation

Long term biodiversity conservation in Zimbabwe is undertaken by the government through various departments, which are described under each sector. The government's budget allocation to the key departments involved with biodiversity conservation and management increased from Z$171 million in 1987/88 to Z$801 million in 1997/98 (Table 2.6.1). This represents a 369% budget increase over the eleven year period in nominal terms. However, when inflation is accounted for by using the GDP deflator at factor costs (1990=100), it becomes apparent that government expenditure levels on biodiversity conservation fell by 49% from Z$276 million in 1987/88 to about Z$137 million in 1996/97, the last year for which published price indices are available (Figure 2.5). Put simply, a dollar of expenditure on biodiversity conservation in 1996/97 actually has about one-half the purchasing power it had a decade before.

Table 2.6.1. Nominal Zimbabwe government expenditure on issues related to biodiversity conservation: 1987/88 to 1997/98

Government department	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 Commission	12.4	14.5	18.0	19.3	19.0	21.2	19.7	18.5	16.3	23.2	36.3
Natural Resources	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
Agric. Extension (AGRITEX)	35.4	39.4	42.4	53.1	63.9	185.1	111.5	152.8	216.2	169.5	399.6
Agric. Research (DR&SS)	16.9	19.2	19.6	24.9	26.7	29.5	37.6	43.2	53.1	73.2	135.4
Water Resources	80.3	103.9	51.4	100.3	92.2	169.0	185.3	148.4	124.7	145.9	169.8
Total (current $)	171.4	201.2	163.6	237.0	246.3	451.9	406.6	424.2	474.9	481.7	801.3
Total (real $)[2]	276	274	187	237	187	272	202	169	162	137	—

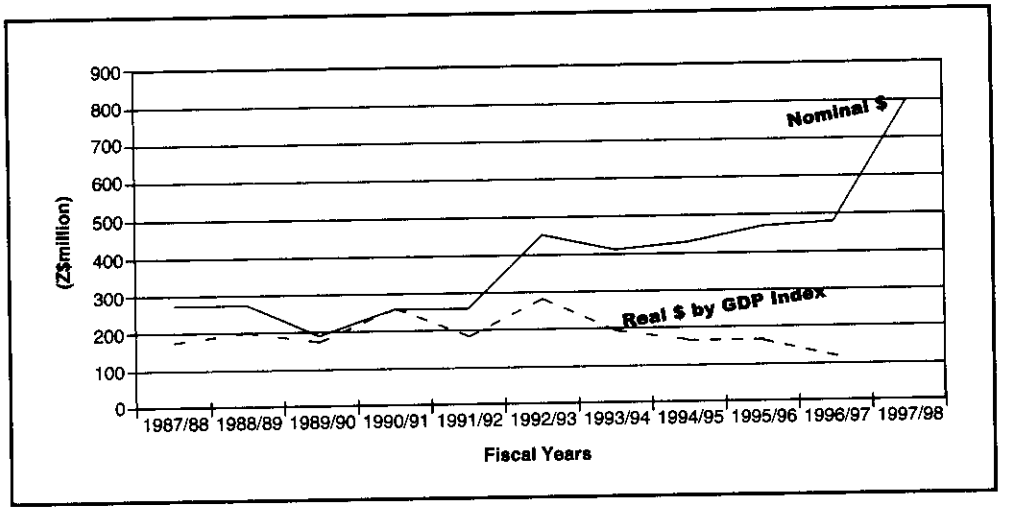


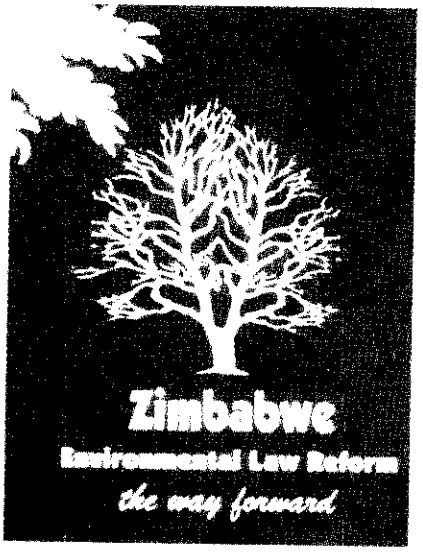
Figure 2.5. Nominal and Real Zimbabwe Government Expenditure on issues related to Biodiversity Conservation

[2]Real expenditures are deflated by the GDP index, 1990=100 (source CSO, 1997) to account for inflation. Nominal expenditures were also deflated by the CPI index with little difference to the results. In this report, the GDP deflator is used.

Apart from central government, a number of local and international non-governmental organisations (NGOs) and land owners are actively involved in financing biodiversity conservation in Zimbabwe as highlighted in the sector presentations. However, no comprehensive data base containing summaries of in-country expenditures by NGO exists. In addition, it is difficult to identify the budget components that go directly into biodiversity conservation.

THE WAY FORWARD

ENVIRONMENTAL MANAGEMENT BILL



3. UNMET NEEDS ANALYSIS IN ZIMBABWE'S BIODIVERSITY PROGRAMMES.

3.1 Introduction

The development of Zimbabwe's Biodiversity Strategy and Action Plan is based on a gap analysis of the current biodiversity status in the country. The latter is presented in chapter 2 of this report. In line with the requirements of the Convention on Biological Diversity, gaps and needs are identified in the areas of biodiversity conservation and equitable distribution of the resultant benefits. The analysis is done at both the sector (*viz.* forestry, wildlife, aquatic life and agriculture) and inter sectoral levels. The current status provides a strong foundation, while the unmet needs give a clear sense of direction in the development of a comprehensive biodiversity strategy and action plan for the country.

3.2 Forestry

3.2.1. Conservation of forest biodiversity

The following issues/needs are identified in forest biodiversity conservation:

1. The Forest Act gazetted the establishment of demarcated indigenous forest areas on the Kalahari sands of western Zimbabwe for: the sustainable extraction of timber; to act as reservoirs of wildlife and water catchment; and, for the conservation of biological diversity. These gazetted forests, which cover about 2% of the country's land area, are being threatened by communities living on the "forest edge", who illegally obtain timber and non-timber forest products from them. Furthermore, the selective logging and extraction of indigenous commercial timber species by concessionaires in the protected forests "cream off" phenotypically superior trees and lead to a gradual genetic impoverishment of the forests. In addition, the stumpage price assessed on these valuable commercial species does not reflect the economic rent of the resource. In order to address these problems, there is need to replace the protectionist approaches to conserving gazetted forests to those that consider neighbouring communities as partners in the conservation, management and sustainable use of forests. This can be achieved by adopting the CAMPFIRE concept, which has been quite successful in the wildlife sector. Such a concept could also reduce the currently high administrative cost to government of protecting the forests. With respect to reducing genetic erosion associated with the selective extraction of commercial timber species, there is need to expand and strengthen the Strict Natural Reserves (SNRs) concept being implemented in some gazetted forest areas. SNRs are like "witness stands" and are not "touched" during a timber harvesting concession. Notwithstanding, the success of the SNR concept will depend on a good understanding of the genetic variability of the tree species in question. This aspect has not been well studied. Some species such as *Chlorophora excelsa* have been fragmented to such an extent that *in-situ* conservation is no longer possible. Resource conservation stands should, therefore

be established in such cases. In addition, the whole aspect of indigenous commercial timber valuation and concession fees should be reviewed along with the process of allocating commercial timber cutting rights within a broader context of forest management responsibilities and associated costs.

2. The loss of forest land to agriculture due to human population pressure is a major cause of forest biodiversity losses and land degradation especially on communally owned land. Consequently, it is difficult to find pristine miombo woodlands on the central watershed of Zimbabwe, as most have disappeared to give way to cropping and grazing land. Furthermore, the purposeful extraction of certain tree species by local communities is leading to their over exploitation. Such threatened tree species include: *Warburgia salutaris* (muranga), a medicinal plant on the verge of extinction in the Chipinge area; and certain indigenous fruit trees harvested for sale in urban markets. Causes of this over exploitation include poor enforcement of the Communal Land Forest Produce Act (CLFPA) and the Natural Resources Act; the erosion of powers of the traditional leadership; economic hardships and loss of cultural values. The latter included prohibiting the cutting of tree species such as *Julbernardia globiflora* and *Warburgia salutaris* which were considered "sacred" and indigenous fruit trees such as *Uapaca kirkiana* and *Strychnos,* which could not be cut under any circumstances. To address some of these problems, there is need to: harmonise the application and enforcement of the Forest Act, the CLFPA and the Natural Resources Act; further improvement of the monitoring capacity of the appropriate state authorities, and increase penalties for non-compliance; promote indigenous knowledge in the identification of useful species and their appropriate conservation measures; and create opportunities for alternative livelihood outside agriculture.

3. Although a number of 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. Such studies are necessary for the design of effective forest biodiversity conservation and utilisation programmes. Furthermore, although 66% of the country is under indigenous forests, there is no corresponding information on timber volumes by species and age class for planning purposes. In addition, no accurate economic values have been established for the various goods and services that can be derived from the existing forest biodiversity. In situations where forest biodiversity has been lost (e.g. degraded lands), strategies to re-introduce such biodiversity are required. Furthermore, there is need for a systematic and long-term research programme to identify and quantify the socio-economic values of forests. Such information is critical for more effective decision-making and policy formulation with respect to biodiversity conservation.

4. The loss of forest biodiversity through deforestation in Zimbabwe is associated with the erosion of beneficial and harmful organisms including micro-organisms that co-exist with certain tree species. For example, there has been a decline in the diversity of mushrooms in line with decreases in the symbiotic tree species in

both the miombo and teak forests. Such losses in beneficial *Mycorhizae* adversely affect the rejuvenation of the associated tree species. There is therefore need to study and monitor *mycorhizal* associations in different woodland/forest types and to find ways of enhancing them in situations where they are threatened or have been lost.

3.2.2. Equitable sharing of benefits from forest biodiversity conservation.

The following needs and concerns are identified in the equitable sharing of forest biodiversity benefits in Zimbabwe.

1. The access to commercial timber resources in gazetted forests is through concessions administered by the Forestry Commission, the State Forest Authority. All proceeds from the resultant timber sales are ploughed back into the management of the forests. With respect to commercial timber on communal land, logging concessions are issued by the appropriate Rural District Council (RDC) on the advice of the Forestry Commission. All proceeds from the timber sales are retained and ploughed back into developing the appropriate areas by RDCs. However, such allocations of revenue from logging concessions do not create a sense of forest ownership by communities living on the "forest edge" in the case of gazetted forest areas and those "living with the trees" in the case of communal areas. Consequently such people have no incentive to conserve the adjacent forest. There is, therefore the need to institute legislation and other ways of sharing revenue and other benefits from forests with the appropriate shareholders in order to motivate them to conserve the forests. Furthermore, resource rents paid by concession holders, and mechanisms for allocating commercial timber should be reviewed to ensure that the state maximises its income from commercial forestry operations such as logging.

2. Concern is increasing that uncontrolled access to forest resources particularly in communal areas, could be abused by outsiders especially in the case of plants with intrinsic medicinal and economic value. This can be avoided by instituting comprehensive and effective legislative and monitoring mechanisms that recognise intellectual property rights of the local people.

3. Access to tree seed in Zimbabwe is through the Forestry Commission's Tree Seed Centre, which distributes genetic material at cost or free in the case of experimental material. However, access to improved genetic material might become an issue once forestry companies opt for clonal propagation and thus require elite cloning material. Such a situation could require a change in the policy on access to forest genetic resources for experimental purposes. A new policy could introduce access charges based on intrinsic genetic values. It could also introduce agreements/ contracts for profit sharing and the tendering of rights to access. Such initiatives help to place a more realistic value on biological resources, which then acts as an economic incentive for better conservation.

3.3. Wildlife

3.3.1. Conservation of wildlife biodiversity

Issues and needs identified under wildlife biodiversity conservation are as follows:

1. About 13% of Zimbabwe is set aside as the national parks and wildlife estate under the Parks and Wildlife Act for the conservation and preservation of wildlife, fish and plants. These areas were selected largely because they are marginal for agriculture. The lack of joint planning between the Department of National Parks and Wildlife Management (the country's wildlife management and scientific authority) and the Forestry Commission (the state forest authority) on forest conservation and management matters in these areas tends to compromise the balance between forestry and wildlife biodiversity issues. In addition, despite the stringent policing and existence of the CAMPFIRE Programme in communal areas that border the national parks and wildlife estate, there is considerable local, national and transborder poaching of wildlife. There is therefore need for strategies that address these issues in order to enhance wildlife biodiversity in the parks and wildlife estate.

2. The most widely studied and monitored wildlife species are those of economic importance and international interest. They include mammals such as the elephant, buffalo, sable, antelope, kudu, lion, leopard and the rhino. Very little attention has been given to other wildlife species which though economically unimportant, are a vital component in the eco-system's food chain and to the local communities. In addition, no criteria and review mechanisms exist for the listing of endangered species such as the wild dog. Consequently, there is need to institute inventory and monitoring mechanisms for all wildlife species and to put in place criteria and review systems for the listing of specially protected species.

3.3.1. Equitable sharing of benefits from wildlife biodiversity conservation.

The following issues were identified in the equitable sharing of wildlife biodiversity benefits in the country.

1. 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, the participation in the CAMPFIRE programme in communal areas. This has led to an increase in species diversity and improvements in these ecosystems. There is, therefore a need to extend the CAMPFIRE concept to other districts with sizeable wildlife populations and to other natural resources such as forestry and aquatic life. With respect to conservancies, there is a need to balance them with crop and domestic animal production, as they seem to be spreading very rapidly at the expense of the latter.

3.4. Aquatic life.

3.4.1 Conservation of aquatic biodiversity.

The following issues and needs were identified in aquatic biodiversity conservation.

1. Zimbabwe relies on inland lakes and waterways for its aquatic fauna and flora of which fish are the most economically important. However, of the 123 fish species found in the country, only a few economically and biologically important ones have been monitored in Lakes Chivero, Kariba, Mutirikwi and Darwendale dam. Consequently, the composition and population status of many fish species in the country's water bodies are unknown despite their high food value to local communities and to the eco-system as a whole.

2. Apart from certain species of fish, reptiles, ducks and invertebrates of medical importance that have been studied and monitored, very little information, if any, exists on other aquatic fauna and flora considered to be of less direct economic importance. For example, despite the important role that aquatic plants play in the ecology of lakes and rivers, little information exists on their population status, trends and threats. Such an information void can be disastrous should there be a tilt in the water body nutrient balance (due to organic and inorganic pollution) as has occurred with the water hyacinth in Lake Chivero, Lake Manyame and Manyame river. This has resulted in huge costs of weed clearing, loss of fishing and boat sites, loss of fish and increases in the cost of purifying domestic water.

3. The lack of a comprehensive and elaborate inventory and monitoring system for aquatic/wetlands biodiversity makes it difficult to value the contribution of aquatic life to the economy and ecosystem in general and to local communities in particular.

4. Controls over aquatic flora and fauna in terms of the Parks and Wildlife Act are problematic as the Act's application only covers the parks and wildlife estate. With the exception of fish resources, areas outside the estate are regulated and controlled under other pieces of legislation. Furthermore, no regulations particular to aquatic life are available, except where plants have been declared to be specially protected or noxious weeds.

3.4.2. Equitable sharing of benefits from aquatic biodiversity conservation.

The following were identified as pertinent issues in the equitable sharing of benefits from aquatic biodiversity in the country.

1. An intractable problem associated with the conservation of shared aquatic biodiversity is often the lack of coordination in areas of management by states sharing the resource. By way of example, a well regulated fishing industry in one country can be threatened, if the other country over harvests. Consequently, this

can be a disincentive to biodiversity conservation hence the need for coordinated policies for allocating fishing rights and implementing monitoring programmes.

2. With respect to fishing rights on the country's major water bodies, there is need to review the current permit and quota systems in order to make fishing more accessible to local communities in these areas. At the same time, the review should assess the cost of the various permits relative to the value of the resources being harvested and the cost of their management and protection.

3.5. Agriculture

3.5.1. Conservation of agro-biodiversity.

The following issues and needs are identified in the area of agro-biodiversity conservation.

1. Several government policies have had an adverse effect on agricultural biodiversity and these include:

- The colonial policy of locating and concentrating smallholder (communal) farmers in the low rainfall areas and on infertile soils reduces the potential of agricultural diversification. Furthermore, the insecurity of land tenure especially on the communal grazing land has tended to limit the extent to which individual households can invest in agro-biodiversity conservation. On the other hand, the current subsidy on smallholder irrigation schemes has not stimulated farmers to diversify into high value crop enterprises. Consequently, there is need to: speed up the land redistribution programme; adopt appropriate land use systems; implement recommendations of the Land Tenure Commission with respect to communal land ownership; and, institute policies that encourage production systems that enhance biodiversity on smallholder irrigation schemes.

- The commercialisation of agriculture has tended to discourage the on-farm conservation of indigenous/traditional crops; and agroforestry and mixed cropping systems resulting in biodiversity losses at both the household and national levels. However, efforts are being made by a number of government and non-governmental organisations to map out the distribution of such local landraces as well as to collect and preserve them, albeit in an uncoordinated manner. Consequently, there is need to develop capacity in the identification, documentation, conservation and utilisation of these landraces and to co-ordinate efforts of the different actors. In addition, knowledge on how farmers currently grow and store the landraces should be actively sought and documented. Furthermore, there is need to strike a balance between the intensification of agriculture and the requirement for biodiversity conservation and enhancement as well as the incorporation of certain beneficial traditional agricultural farming practises into modern agriculture.

2. A number of wild relatives of crops such as cotton, rice, sorghum, pearlmillet, cowpeas and bambaranut are available, especially in the protected areas. These crops can be useful in the genetic improvement of their domesticated crop relatives. However, there is need to institute mechanisms that facilitate the surveying, inventory, monitoring and conservation of the wild crop relatives.

3. A number of research and development organisations are involved in the *ex-situ* conservation of plant and animal germplasm through storage facilities; in active collections (i.e. breeders' working collections which include local landraces of wild crop species; introduced varieties; locally bred elite lines and commercial varieties); and in gene banks dispersed in various national breeding institutes. There is, therefore, need for a central depository of all agriculturally important plant and animal genetic resources that is linked to other depositories in the country. This can be achieved by strengthening the Gene Bank of Zimbabwe (housed in the Ministry of Lands and Agriculture), through further infrastructural development, networking and building the human and financial capacity in germplasm classification, characterisation, evaluation and documentation.

4. Technological developments such as biotechnology can play an important role in maintaining, protecting and improving agro-biodiversity in Zimbabwe. However, if not carefully controlled and monitored, such developments and their products (e.g. transgenic plants) can reduce biodiversity. There are also concerns on the potential risks to biodiversity and human health which can occur if Genetically Modified Organisms (GMOs) are accidentally released into the environment. Such fears are worsened by the absence of agro-biodiversity monitoring programmes in the agricultural sector and the lack of a national policy on bio-safety.

3.5.2 Equitable sharing of benefits from agro-biodiversity conservation.

The following issues and needs were identified in the equitable sharing of agro-biodiversity in the country:

- Zimbabwe lacks a policy and legal framework governing intellectual property rights, particularly the Trade Related Intellectual Property rights regime (TRIPS) under the World Trade Organisation (WTO) and the General Agreement on Tariffs and Trade (GATT) framework. Furthermore, there are no legal mechanisms to control access to genetic resources and to protect and reward indigenous/traditional knowledge and innovations that arise from the conservation and development of genetic resources.

- The current plant breeders' rights act only applies to propagatory materials that are distinct, uniform and identifiable and not to the farmers' landraces, that are variable and evolving. This lack of recognition of the farmer's contribution discourages agro-biodiversity conservation, research and development at the household and community levels.

3.6. Intersectoral issues.

The following aspects and needs were identified in the inter-sectoral arena of biodiversity conservation.

1. Zimbabwe continues to prioritise infrastructural development and foreign investment in sectors such as tourism, agriculture and mining for economic growth often at the expense of biodiversity conservation *per se*. Consequently, there is need to develop a better appreciation of the economic value and benefits of biodiversity if a proper balance between economic development needs and natural resource conservation in the country is to be realised. The latter has tended to be blurred by the limited acknowledgement of the contribution of various biodiversity sectors to the national economy. For example, forestry, wildlife and aquatic life are major tourist attractions to Zimbabwe, but the financial gains from tourism only partly reflect the value of these natural resources to the country's economy. While wildlife resources such as insect species (e.g. bees) are an important and integral part of the agricultural sector, they do not have easily determined monetary values. There is also need to vigorously enforce the conduct of environmental impact assessments in all projects with potentially adverse effects on biodiversity and to place an economic value on the various components of biodiversity.

2. The sectoral approach to biodiversity conservation has adverse effects which include:

- The lack of joint planning among organisations with similar interests resulting in adverse effects on biodiversity. For example, uncoordinated planning between the Forestry Commission, the Department of National Parks and Wildlife Management and the Department of Natural Resources on forest conservation matters in the parks and wildlife estates, tends to give vegetation resources a subordinate role as they are considered "food" for wildlife with an adverse effect on both floral and wildlife biodiversity;

- Limited knowledge on the skills base in the various sectors. There is therefore need for inventory, rationalisation and development of skills in the various institutions involved in biodiversity conservation; and,

- The lack of recognition of cross sectoral linkages in policy formulation and implementation. For example, although forests provide crop nutrients, through leaf litter and regulate water flow and infiltration, the role of trees and woodlands is not clearly articulated in Zimbabwe's agricultural policy; smallholder sector land use plans; and the national and district development plans. This has contributed to rather poor linkages between the key economic sectors and forestry.

3. Conflicts between various pieces of legislation have tended to adversely affect biodiversity conservation. For example, there are conflicts between mining on the one hand and forest, wildlife, aquatic life and agriculture on the other. This is due to the supremacy of the Mines and Minerals Act over all other resource use legislations. This situation is being reviewed within the context of the environmental law reform by the Ministry of Mines, Environment and Tourism. Notwithstanding, there is need to explicitly incorporate biodiversity conservation issues into the on-going law reform process. Relevant laws should also be synchronised and harmonised with local needs.

4. The importance of environmental awareness, education and training derives from the fact that communities are the custodians and users of a nation's biological heritage. Although considerable progress has been made in this area, much still needs to be done, if the current natural resources are to be passed on to future generations in a reasonable condition. This requires that the content and communication channels of the existing environment awareness materials be improved by stratifying the target group to be reached, identifying their information needs and developing appropriate dissemination strategies. More importantly, there is need for a clear and definite national policy on environmental awareness, education and training and to coordinate the activities of various players involved in environmental awareness in order to develop an effective and viable environmental action programme. Consequently, the fact that the Ministry of Education, Sport and Culture is about to embark on a review of the national education system provides an ideal opportunity to incorporate environmental education at various levels of the formal education system. There is also a need for government to establish a body on Environmental Education and Training incorporating all key public and private sector players; and whose objective would be to develop, monitor and evaluate multi-sectoral programmes on environmental awareness, education and training.

5. A number of public and private sector institutions are undertaking or planning a range of biodiversity initiatives including research throughout the country. However, such efforts have not been well co-ordinated and documented. Consequently, there is a need to assess and rationalise such efforts as they provide useful lessons and can compliment any current or proposed initiatives in biodiversity conservation and sustainable use in the country. Furthermore, the need to create and continuously update a cross-cutting national meta-database on biodiversity issues can not be over emphasised. Such a meta-database can be maintained by one organisation with support from a wide range of government and NGO stakeholders and the local communities, who either keep or develop their own sector specific meta-databases.

6. There are no comprehensive and elaborate inventory and monitoring systems for biodiversity in Zimbabwe. Consequently, it is not easy to establish the exact status and changes in biodiversity for planning purposes. This also makes it difficult to value the contribution of the various biodiversity sectors (i.e. forestry, wildlife,

aquatic life and agriculture) to the national economy; the ecosystems in general; and, the local communities in particular. Such a lack of information also applies to micro-organisms (fungi, bacteria and viruses) associated with biodiversity in the four sectors.

4. ZIMBABWE'S BIODIVERSITY STRATEGY AND ACTION PLAN

4.1 Introduction.

In line with the requirements of the Convention on Biological Diversity Article IV, the objectives of Zimbabwe's biodiversity programme are to: conserve the country's biodiversity; sustainably utilise it and equitably share the resultant benefits for the present and future generations. These objectives will be achieved by developing and implementing strategies and action plans that address priority needs identified in the biodiversity status report (see Chapters 2 & 3).

4.2. Methodology used in strategy and action plan formulation

The verification of unmet biodiversity needs presented in Chapter 3 was done at the first national workshop held at Club Mazvikadei and at subsequent workshops held at the provincial level. The former workshop was attended by 41 environmentalists, ecologists, scientists, extensionists, agriculturists, foresters, wildlife experts, traditional healers and journalists with the following objectives:

- to analyse the draft Biodiversity Status Report and prioritise the unmet needs;
- to develop strategies that address the priority unmet needs; and
- to consider actions that should be taken to operationalise the developed strategies.

The unmet needs, draft strategies and action plans formulated during the first national workshop were revisited during the provincial workshops in order to give them a local perspective. Each provincial workshop was attended by between 60 and 80 people from government and non governmental organisations drawn from the district and provincial levels. The specific terms of reference for the provincial meetings were to:

- review the content of the biodiversity status report;
- review and revise the unmet needs based on local realities;
- review and revise the draft strategies based on local realities; and ,
- review and revise the draft action plans based on local realities.

The second national workshop was convened as the last stage in the stakeholder consultation process. It attracted 90 participants from both public and private sector institutions and had the following objectives:

- to review and revise the unmet needs, strategies and action plans formulated during the first national workshop and subsequent provincial workshops;
- to prioritise the resultant unmet needs; and,
- to suggest collaborative mechanisms for funding and implementing projects emanating from the national Biodiversity Strategy and Action Plan.

Criteria used to prioritise unmet needs included the following:

- the cross cutting nature of the unmet need. Needs that cut across sectors were given higher priority;
- the potential impact on biodiversity of implementing strategies that address the unmet need; and
- the feasibility of implementing the resultant action plan.

The above stakeholder consultation process was assisted by a comprehensive communication strategy aimed at raising awareness on biodiversity issues throughout the country which was implemented by the project. Components of the strategy included the following:

- Conducting a one day biodiversity awareness workshop for media personnel immediately after project inception;
- Holding a one day sensitisation workshop on biodiversity for parliamentarians mid-way through the project to catalyse national debate on the subject;
- Conducting radio and television interviews on specific aspects of the biodiversity project to enlighten the general public;
- Producing a quarterly Biodiversity Newsletter highlighting project progress; and,
- Formatting both national and provincial workshops in a way that gave more time to group discussions and interactions than formal presentations. Furthermore, the fact that provincial workshops were officially opened by Resident Ministers/ Provincial Governors and attended by traditional leaders gave the project the much needed local dimension.

Key institutions consulted during the BSAP formulation process are depicted in Appendix 6.6.1.

4.3. Prioritisation of unmet needs

During the second national workshop, five interdisciplinary groups consisting of about 15 participants each, were asked to prioritise the identified unmet needs based on criteria presented in Section 4.2. According to Appendix 6.7.1, the unmet needs were prioritised as follows:

1. The absence of comprehensive and elaborate biodiversity inventory and monitoring programmes.
2. Inadequate incentives for some local communities and individuals to undertake biodiversity conservation and sustainable use initiatives in both protected and non-protected areas.
3. Inadequate environmental awareness, education and training at various stakeholder levels.
4. Limited appreciation of the importance and contribution of biodiversity to the national economy and to local communities by policy makers.
5. Inadequate, conflicting and poorly enforced pieces of legislation that tend to adversely affect biodiversity conservation and sustainable use.
6. A limited financial base and institutional capacity to facilitate the formulation, implementation and monitoring of biodiversity projects at the local level.

7. Inadequate affordable alternatives to reduce the reliance on natural resources at the local level.
8. Inappropriate research and extension approaches in biodiversity conservation and sustainable use.

4.4. Biodiversity strategy and action plan development

Zimbabwe's biodiversity strategy and action plan aims at addressing the priority unmet needs listed in the previous section. Specific strategies formulated to achieve this are:

1. Development of comprehensive and elaborate biodiversity inventory and monitoring systems/programmes for all species of flora and fauna and micro-organisms;
2. Creation of opportunities and incentives for biodiversity conservation at the national and local levels;
3. Development of a clear, definite and co-ordinated national policy, legislative framework and implementation strategy on environmental awareness, education and training;
4. Improvement of the understanding of the importance of biodiversity at both the national and local levels and the strengthening of biodiversity initiatives at all levels;
5. Strengthening and harmonisation of relevant legislation that recognise the need for biodiversity conservation and the maximisation of synergies across sectors and the development of a comprehensive national policy on biodiversity;
6. Provision of a sustainable and readily accessible financial and institutional base to assist biodiversity projects at the local level;
7. Provision of affordable, viable and acceptable alternatives for human survival beyond the existing natural resource base; and,
8. Development and implementation of appropriate research and extension approaches in biodiversity conservation and sustainable use.

A number of broad actions have been developed to operationalise the foregoing strategies. These are elaborated in Table 4.1.

Table 4.1. Action plans for Zimbabwe's biodiversity strategies

Unmet need	Strategy	Action plan
1. Absence of comprehensive and elaborate biodiversity inventory and monitoring programmes	· Develop comprehensive and elaborate biodiversity inventory and monitoring programmes for all species of flora and fauna including micro-organisms.	· Develop or strengthen biodiversity instruments and monitoring mechanisms for all relevant projects. · Establish and implement inventory and monitoring systems for various

Unmet need	Strategy	Action plan
		species at the genetic, species and ecosystem levels · Identify, review and develop collaborative mechanisms for biodiversity initiatives undertaken by various players within and outside the country · Document indigenous knowledge on biodiversity conservation and sustainable use. · Involve local communities, institutions and traditional leaders in biodiversity inventory and monitoring. · Develop criteria and review systems for the listing of specially protected species of flora and fauna. · Create databases on biodiversity issues (including socio-economic aspects) at all levels and provide linkages among the levels. · Develop the human and infrastructural capacity to inventory, monitor, document and store biodiversity information at various stakeholder levels.
2. Inadequate incentives for local communities and individuals to undertake biodiversity conservation and	· Create incentives and opportunities for biodiversity conservation	· Review, modify and adopt appropriate methods in the conservation and sustainable use of all

Unmet need	Strategy	Action plan
sustainable use initiatives		flora and fauna (e.g. the CAMPFIRE approach). · Develop appropriate and transparent benefit sharing mechanisms. · Adopt a participatory approach in biodiversity conservation and sustainable use. · Establish and implement reward systems that recognise local biodiversity conservation efforts. · Develop a framework for protecting and rewarding local innovations and indigenous technical knowledge. · Increase the role of, and empower local institutions and communities in biodiversity conservation and sustainable use matters.
3. Inadequate environmental awareness, education and training at various stakeholder levels.	· Develop and implement a clear, definite and co-ordinated national policy and legislative framework on environmental awareness, education and training.	· Strengthen environmental education (including biodiversity) at all levels in the formal education curricula. · Review activities of players involved in informal environmental awareness education

Unmet need	Strategy	Action plan
		programmes and suggest ways of enriching and co-ordinating their activities. · Package biodiversity awareness, education and training materials and messages in local languages. · Establish an environmental watchdog (with private and public sector players) to develop, monitor and evaluate inter-sectoral programmes on environmental awareness, education and training. · Develop targeted information dissemination systems for resource user groups (including that targeted at traditional leaders, local institutions, the church and traditional healers). · Develop programmes to implement the environmental awareness, education and training policy and recognise the central role played by the print and electronic media in this process.
4. Limited appreciation of the importance and contribution of biodiversity to the national economy and to local communities by policy makers.	Improve the understanding of the importance of biodiversity to the national and local economies by policy makers.	· Establish the value of various biodiversity components at different levels and explore options to strengthen their contribution.

Unmet need	Strategy	Action plan
		· Use appropriate methods to analyse and evaluate current biodiversity conservation efforts. · Establish an inter-institutional framework for biodiversity monitoring at all levels
	· Strengthen and co-ordinate biodiversity initiatives at various levels	· Incorporate biodiversity issues into all land use planning . · Reinforce existing *in-situ, ex-situ* and on-farm conservation efforts. · Identify and establish areas of endemism and relevance for certain species. · Conduct detailed studies that establish and enhance the beneficial associations between micro-organisms and forestry, agriculture and aquatic life. · Enforce the conduct and compliance of environmental impact assessments in all development projects. · Develop appropriate community based land use systems that conserve and enhance biodiversity.
5. Inadequate, conflicting and poorly enforced pieces of legislation that tend to adversely affect	Strengthen and harmonise relevant legislation that has implications on biodiversity conservation and maximise	· Review and harmonise the various pieces of legislation on the environment.

Unmet need	Strategy	Action plan=
biodiversity conservation and sustainable use	synergies across the key sectors.	· Incorporate biodiversity considerations into the new environmental law. · Adopt a participatory approach during the policy formulation process. · Develop clearly defined roles and responsibilities for the different authorities. · Establish a central authority to coordinate biodiversity initiatives and policy issues
	· Develop and operationalise a comprehensive national policy on biodiversity.	· Formulate a policy and guidelines on biodiversity and develop programmes that implement the policy. · Develop biodiversity property protection systems specific to Zimbabwe's socio-economic and cultural contexts. · Develop biosafety guidelines with biosafety measures, protocols and code of conduct in order to foster a progressive biodiversity culture. · Mount biotechnology/ biosafety awareness campaigns with emphasis on socio economiscemphasis on socio political and economic implications. · Develop the capacity (human and infrastructural) to

Unmet need	Strategy	Action plan=
		implement biodiversity programmes (e.g. biotechnology). · Tighten all relevant legislation on the environment and find ways of enriching and co-ordinating activities of the key players. · Develop or strengthen local bye-laws on all natural resources and institute appropriate penalty levels. · Institute monitoring and enforcement mechanisms on all natural resources. · Introduce and enforce the "offender pays" principle.
6. A limited financial base and institutional capacity to facilitate the formulation, implementation and monitoring of biodiversity projects at the local level	· Provide a sustainable and readily accessible financial base and institutional capacity to assist biodiversity projects at the local level.	· Establish a biodiversity revolving trust fund controlled by RDCs and managed by the appropriate local authorities. · Develop a mechanism for tapping into the various financial institutions interested in biodiversity related initiatives. · Develop and implement capacity building programmes for local authorities, traditional leaders, religious institutions and local communities on appropriate biodiversity issues.

Unmet need	Strategy	Action plan=
		· Provide tax incentives to private companies financing biodiversity related initiatives at the local level. · Give funding priority to development projects that positively impact on biodiversity conservation at the community level.
7. Inadequate affordable alternatives to reduce the reliance on natural resources at the local level.	· Facilitate the development of affordable, viable and acceptable alternatives for human survival beyond the existing natural resource base.	· Broaden the country's industrial and manufacturing base. · Provide alternative energy sources in rural areas. · Develop alternative livelihoods outside the agricultural sector. · Provide incentives and build capacity for small scale enterprise development.
8. Inappropriate research and extension approaches in biodiversity conservation and sustainable use	· Develop and implement appropriate research and extension approaches in biodiversity conservation and sustainable use	· Review research and extension methods currently used in biodiversity conservation and sustainable use. · Develop and incorporate participatory methodologies in biodiversity research and extension initiatives. · Incorporate the gender dimension in the development, implementation and evaluation of biodiversity initiatives.

Unmet need	Strategy	Action plan=
		· Develop, adapt and adopt practical models for creating incentives for sustainable biodiversity conservation at the community level. · Develop human capacity for the development and implementation of appropriate research and extension methods.

4.5 Way forward

The foregoing broad action plans which are based on the country's priority needs in biodiversity, will form the basis for developing detailed project proposals aimed at enhancing biodiversity conservation and sustainable use. The resultant projects will be submitted to government and interested donors such as the Global Environment Facility for financial support. The key stakeholders in the process are discussed in Chapter 3.

In order to operationalise this national Biodiversity Strategy and Action Plan, participants to the second national workshop resolved that:

- A BSAP Project Co-ordinator be appointed within the Ministry of Mines, Environment and Tourism and that the current project office should remain operational after the strategy and action plan preparation phase is completed; and,
- An inter-sectoral committee be appointed to co-ordinate the mobilisation of resources and to monitor the implementation of the resultant biodiversity programmes and projects.

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6. ANNEXES

6.1 OPERATIONAL FRAMEWORK OF THE PROJECT

6.1.1. Composition of Project Secretariat, Steering Committee and Consulting Group

Project Secretariat

Dr. Enos Shumba, Project Coordinator
Ms Sarah Mangundhla, Executive Assistant
Dr. Grant Milne, Technical Advisor

Steering Committee

Mr. Devious Marongwe (Chairman), Ministry of Mines, Environment and Tourism
Mr. Mfaro Moyo, District Environment Action Plan Project
Mr. Moses Munemo, Department of Natural Resources
Dr. Todd Ngara, Climate Change Project
Mr. Muzondiwa Shoko, National Action Plan Project
Dr. Enos Shumba, Biodiversity Project
Mr. Lovemore Sola, State of the Environment Report Project
Ms. Sumie Utsunomiya, UNDP

Consulting Group

Mr. Tapera Chimuti
Mrs. Tsungai Chirara
Ms. Annie Chishawa
Dr. Langford Chitsike
Mr. Rabson Dhlodhlo
Dr. Ntombana Gata
Mrs. Winifred Goromonzi
Dr. Edna Kunjeku
Mr. Crispen Marunda
Dr. Grant Milne
Mr. Robert Mukwanda
Dr. Cecil Machena
Mr. Langton Mukwereza
Ms. Benhilda Mukonyora
Ms. Clara Musendo
Mrs. Edith Muza
Dr. Enos Shumba
Dr. Caroline Martinet, GEF Specialist
Ms. Lucy Emerton, GEF Specialist

6.2 FORESTRY

Annex 6.2.1. 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 - Gubourtia conjugata woodland thicket

C5 - Baikiaea woodland thicket on Kalahari sand

C6 - Baikiaea woodland on Kalahari sand

C7 - Baikaea-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-Julbermadia-Pterocarpus angolensis open woodland on sandstone plateaux

D4 - Brachystegia boehmii-Julbemardia woodland on shallow soils

D5 - Brachystegia-Julbermardia 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 - Julbernardia-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 stuhlmanii woodland

F3 - Colophospermum 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.

Annex 6.2.2. List of reserved indigenous tree species scheduled under the Communal Land Forest Produce Act of 1987

Acacia abida
Acacia abyssinica
Acacia nigrescens
Acacia senegal
Afzelia quanzensis
Aporrhiza nitida
Asbizia gummifera
Baikiaea plurijuga
Bolusanthus speciousus
Brachystegia glaucescens
Breonadia salician
Cassine schlechterana
Cataphractes alexandri
Celtis gomphophylla
Cobretum imberbe
Cordyla africana
Dalbergiella nyasae
Diospyros mespiliformis
Drypetes mossambicensis
Entada pursaetha
Erythrophleum suaveolens
Faurea saligna
Ficus vallis-choudae
Funtumia fricana
Galpinia transvaalica
Glenniea africana
Guibourtia coleosperma
Guibourtia conjugata
Haplocoelum foliolosum
Hexalobus monopetalus
Hyphaene benguellensis ventricosa
Hyphaene natalensis
Khaya nyasica
Maprounea africana
Milicia excelsa
Newtonia buchananii
Newtonia hildebrandtii
Olea europaea
Oncoba spinosa
Parinari curatelliforlia
Pericopsis angolensis
Prunus africana
Ptaeroxylon obliquum
Pterocarpus angolensis
Ricinodendron rautanenii
Sapium integerrinum
Schefflera umbellifera
Schotia brachypetala
Sesamothamnus lugardii
Spirostachys africana
Stadmania appositifolia
Stereospernum kunthianum
Sylotheca tettensis
Syzygium cordatum

Trichilia emetica
Uacapa kirkiana
Vitex doniana
Vitex payos

Warburgia salutaris
Widdringtonia nodiflora
Xylopia aethiopica
Zanhla golungesis

6.3. WILDLIFE

Annex 6.3.1. Population status of some common mammals based on the 1995 aerial surveys and other sources.

Species	Population status
Elephant	66 000 animals. Downlisted to Appendix II in 1997.
Black rhino	320. Increasing by 3%/yr. Specially protected. Listed on Appendix I.
White rhino	150. Specially protected. On Appendix 1
Buffalo	50 000. Decreasing by 2.5%/yr.
Eland	1 854. Population is decreasing.
Kudu	10 652 animals.
Nyala	Found in Save and Lower Zambezi Valley.
Bushbuck	Not very common.
Roan antelope	395. Specially protected.
Sable antelope	11 232. Increasing by 1.4%/yr.
Gemsbok	100. Population static for 25 yrs. Specially protected (Wilson,1997).
Waterbuck	4 400 animals.
Reedbuck	200 animals.
Blue Wildebeest	1 500 in HNP. Decreasing by 3.6%/yr.
Red hartebeest	Very few individuals present.
Tsessebe	20 in HNP. Decreasing by 3.8%/yr.
Bushpig	Common
Hippopotamus	Common
Giraffe	200 in Gonarezhou and 2 220 in HNP.
Burchell's zebra	Common.
Lion	1 000 in HNP, 300 in Zambezi Valley and 200 in SE lowveld. Increasing by 4% in HNP.
Leopard	14 650. Increasing by 4.3%/yr. Specially protected.
Cheetah	830. Increasing by 17%/yr. Specially protected.
Serval	Very secretive species.
African wild cat	Fairly large.
Caracal	Rare and shy species.
Spotted hyena	1 500 in HNP. Population static (Wilson, 1997).
Black backed jackal	Very common.
Wild dog	600-700. Needs legal protection.
Chacma baboon	Very common.
Vervet monkey	Very common.
Pangolin	Very rare. Specially protected
Scrub hare	Common

Species	Population status
Jameson's Red Rock Rabbit	Found in Save, Limpopo.
Porcupine	Common.
Striped polecat	Common.
Civet	Common.

Source: DNPWLM unpublished census records and local knowledge of field staff.

Annex 6.3.2. Number of some bird species of Southern Africa and in Zimbabwe

Family	Number of species in Southern Africa	Number of species in Zimbabwe
Rynchopidae (Skimmers, Terns)	23	5
Pelecanidae (Pelicans)	2	2
Phalacrocoracidae (Cormorants)	5	2
Anhingidae (Darters)	1	1
Ardeidae (Herons, Egrets)	19	17
Ciconiidae (Storks)	8	8
Scopidae (Hammerkop)	1	1
Phoenicopteridae (Flamingoes)	2	2
Plataleidae (Ibises, Spoonbills)	5	4
Heliornithidae (Finfoots)	1	1
Anatidae (Swans, Ducks, Geese)	20	16
Podicipidae (Grebes)	3	3
Rallidae (Coot)	1	1
Rallidae (Gallinule)	3	3
Rallinidae (Moorhens)	2	2
Rostratulidae (Painted Snipes)	1	1
Charadriidae (Plovers, Turnstones)	58	34
Recurvirostridae (Avocets, Stilts)	2	2
Burhinidae (Dikkops)	2	2
Glareolidae (Pratincoles and Coursers)	8	8
Otididae (Bustards, Korhaans)	10	4
Gruidae (Cranes)	3	3
Phasianidae (Quails, Francolins)	16	10
Turnicidae (Butoonquails)	2	2

Family	Number of species in Southern Africa	Number of species in Zimbabwe
Numididae (Guineafowls)	2	2
Struthionidae (Ostrich)	1	1
Sagittriidae (Secretary bird)	1	1
Accipitridae (Milvus kites)	3	3
Accipitridae (Snake eagles)	18	16
Accipitridae (Buzzards)	7	4
Accipitridae (Goshawks, Sparrowhawks)	9	9
Accipitridae (Harriers, Bat hawk)	6	6
Pandionidae (Osprey, Gymnogene, Cuckoo hawk)	3	3
Pandionidae (Falcons, Hobby, Kestrels)	16	16
Pteroclididae (Sandgrouse)	4	3
Columbidae (Pigeons, Doves)	14	14
Psittacidae (Parrots, Lovebirds)	8	5
Trogonidae (Trogons)	1	1
Musophagidae (Lowries)	4	3
Cuculidae (Cuckoos, Coucals)	18	16
Tytonidae (Owls)	12	12
Caprimulgidae (Night jars)	7	6
Hirundinidae (Swallows, Martins)	22	21
Apodidae (Swifts)	13	11
Colidae (Mousebirds)	3	2
Meropidae (Bee-eaters)	9	7
Halcyonidae (Kingfishers)	10	7
Coraciidae (Rollers)	5	5
Phoeniculidae (Woodhoopes, Scimitarbill)	4	3
Bucerotidae (Hornbills)	9	8
Capitonidae (Barbets)	10	7
Picidae (Woodpeckers)	9	6
Indicatoridae (Honeyguides)	6	6
Salpornithidae (Creepers)	1	1
Dicuridae (Drongos)	4	3
Campephagidae (Cuckooshrikes)	3	3
Corvidae (Crows)	4	3
Oriolidae (Orioles)	4	3
Pycnonotidae (Bulbulus)	11	9

Annex 6.3.3: Trophy values of larger wildlife species used in the CAMPFIRE programme (US$1= Z$10).

Species	Standard Value(Z$)
Elephant bull	60 000
Elephant cow	25 000
Buffalo bull	8 000
Buffalo cow	4 000
Lion	25 000
Lioness	12 500
Leopard	15 000
Hyena	500
Hippopotamus	9 000
Giraffe	7 500
Crocodile	11 000
Sable	11 000
Eland	7 500
Kudu	5 000
Nyala	8 000
Waterbuck	7 500
Genet	500
Porcupine	150
Spring Hare	25
Baboon	100
Velvet Monkey	50

Species	Standard Value(Z$)
Reedbuck	2 000
Wildebeest	4 000
Tsessebe	5 000
Zebra	4 500
Bushpig	450
Warthog	1 000
Impala male	500
Impala female	250
Duiker	750
Steenbok	500
Klipspringer	2 000
Grysbok	500
Honey Badger	500
Civet	600
Jackal	500
Wild Cat	500
Guinea Fowl	20
Francolin	10
Sandgrouse	10
Ducks/Geese	20

Source: Zimbabwe Government Gazette, 1996

6.4 AQUATIC FAUNA AND FLORA

Annex 6.4.1. Biodiversity trends of macrophytes on Lake Kariba

- 1959 – There was a population explosion of *mycrocystis* and floating *Salvinia molesta, Pistia stratiotes, Ultricularia spp.* and *Lemna spp.;*
- 1960 – There was an appearance of *Ceratophyllum demersum, Typha spp.* and *Scirpus curbensis*;
- 1962 – Twenty two percent of the lake surface was covered by *Salvinia molesta*;
- 1962 to 1966 – *Potamogeton pisillus* and *P. schweinfurthii* occupied depths of up to 4m whilst *Ceratophyllum demersum* first appeared in areas not occupied by *Salvinia spp.* and *Lagarosiphon ilicifolius*;
- 1969 – *Vallisneria aethiopica* first appeared; and,
- 1971 – First record of *Najas pectinata.*

6.5. AGRICULTURE

Annex 6.5.1 Pasture legume germplasm held at research stations of the Department of Research and Specialist Services.

Grasslands Research Station

Pasture Legumes

Species	No. of accessions	Species	No. of accessions
Acacia spp.	9	*Aeschynomene spp.*	20
Acrocarpus spp.	1	*Arachis spp.*	2
Altriplex spp.	1	*Atragalus spp.*	1
Altragalus spp.	1	*Albizia falcataria*	1
Alysicarpus sp.	10	*Antopititia abyssinica*	1
Crotolaria spp.	8	*Cassia spp.*	17
Cajannus spp.	17	*Clitoria ternatea*	1
Canavalia ensiformis	1	*Desmodium spp.*	81
Centrosemma spp.	29	*Desmanthus spp.*	13
Covonilla varia	1	*Dolichos spp.*	5
Eriosema spp.	4	*Flemingia macrophylla*	1
Galacta spp.	4	*Glycine spp.*	38
Indigofara spp.	30	*Kotschya spp.*	6
Lespedeza spp.	1	*Leucaena spp.*	28
Lotononis spp.	5	*Lupinus spp.*	10
Macrotyloma spp.	4	*Lotus spp.*	4
Mukuna puriens	4	*Medicago spp.*	45
Noenotania spp.	8	*Macroptilium spp.*	11
Phaseolus spp.	6	*Melilotus spp.*	1
Pseudarthria spp.	5	*Onobrychis spp.*	2
Rothia hirsuta	1	*Pssoralea spp.*	5
Serradella spp.	3	*Puraria phaseoloides*	1
Sphenstylis spp.	2	*Rhynchosia spp.*	14
Trifolium spp.	20	*Sesbania spp.*	9
Gotalaria juricea	1	*Stylosanhes spp.*	21
Teraminus spp.	8	*Trigonella foenum-graecum*	5
Vigna spp.	58	*Turbina shirensis*	1
		Tephrosia spp.	9
		Zonia spp.	5

Pasture grasses

Species	No. of accessions	Species	No. of accessions
Bracharia spp.	13	*Avena sativa*	1
Panicum spp.	26	*Cenchrus spp.*	6
		Setaria spp.	4

Henderson Research Station

Pasture Legumes

Species	No. of accessions	Species	No. of accessions
Acalla sp.	1	*Aeschynomene sp.*	10
Alysicarpus sp.	2	*Arachis sp.*	2
Cajanus sp.	2	*Cassia sp.*	8
Centrosema sp.	5	*Chemacrista sp.*	1
Clitoria sp.	2	*Crotalaria*	5
Codariocalyx sp.	2	*Desmodium sp.*	7
Glen giant vetch sp.	1	*Indigofera sp.*	7
Lablab sp.	7	*Lespedeza sp.*	7
Lotononis sp.	4	*Lotus*	4
Macroptilium sp.	11	*Macroptyloma sp.*	9
Medicago sp.	4	*Neonotonia*	6
Rhynchosia sp.	1	*Rothia sp.*	1
Sesbania sp.	1	*Sphenostylis sp.*	13
Tephrosia sp.	2	*Teramnus sp.*	4
Trifolium sp.	34	*Vigna sp.*	31
Zornia sp.	1		

Pasture grasses

Species	No. of accessions	Species	No. of accessions
Acrocerus spp.	1	*Axonopus spp.*	1
Bothriocloa spp.	10	*Brachiaria spp.*	13
Cenchrus spp.	12	*Cynodon*	86
Dicattium spp.	3	*Digitaria spp.*	17
Echinochloa spp.	1	*Eragrostis spp.*	4
Hymenachene spp.	1	*Hybrid Ray Grass*	1
Lolium spp.	1	*Panicum spp.*	12
Paspalum spp.	7	*Pannisetum*	11
Setaria spp.	13	*Urochloa spp.*	12
Sorghum Hybrid	1	*Vasey grass*	1

Appendix 6.6.1 Organisations consulted during the BSAP formulation process through national and provincial workshops.

Government ministries and departments

Department of Agricultural, Technical and Extension Services (AGRITEX)
Department of National Parks and Wildlife Management
Department of Natural Resources
Department of Research and Specialist Services
Department of Social Welfare
Department of Water Resources

District Development Fund (DDF)
Forestry Commission
Ministry of Education
Ministry of Finance
Ministry of Health and Child Welfare
Ministry of Local Government, Rural and Urban Development
Ministry of Mines, Environment and Tourism
Ministry of National Affairs, Economic Creation and Co-operatives
Ministry of Public Service, Labour and Social Welfare
National Economic Planning Commission
Parliament of Zimbabwe
Rural District Councils (RDCs)
Scientific and Industrial Research and Development Centre (SIRDC)

Non Governmental Organisations (NGOs)

Africa 2000
Africa Centre for Holistic Resource Management
Africa Resources Trust
Association of Women's Clubs
Chiefs' Council
Church in Zimbabwe
Commercial Farmers Union
Communal Area Management Programme for Indigenous Resources (CAMPFIRE)
Community Technology Development Association (COMMUTEC)
Environment 2000
Intermediate Technology Development Group (ITDG)
Legal Resources Foundation
Matebeleland Development Foundation
National Employment Services
Regional Environment Organisation (ZERO)
Southern Alliance For Indigenous Resources (SAFIRE)
The Zambezi Society
Timber Producers Federation
Wildlife Society of Zimbabwe
Women in Business
World Conservation Union (IUCN-ROSA)
World Wide Fund for Nature (WWF)
Zimbabwe Farmers Union
Zimbabwe National Traditional Healers Association (ZINATHA)
Zimbabwe Trust

Print and Electronic Media

Action Magazine
Africa Information Afrique
Chaminuka News
Community Newspaper Group
Development Media Organisation

Masvingo Provincial Star
South Media Features
The Chronicle
The Financial Gazette
The Manica Post
The Reporter
The Sunday News
The Zimbabwe Mirror
Zimbabwe Broadcasting Corporation (ZBC)
Zimbabwe Information Services (ZIS)
Zimbabwe Inter-Africa News Agency (ZIANA)
Zimpapers

Universities

Africa University
University of Zimbabwe

Donors

Department for International Development (DFID) – Central Africa
Royal Netherlands Embassy
United Nations Development Programme (UNDP)

Appendix 6.7.1. Prioritisation of the unmet needs during the Second National Workshop

Unmet need*	Priority ranking					
	Group					Overall
	1	2	3	4	5	
Inventory and monitoring programmes	1	9	2	2	2	16
Incentives for local communities	2	1	1	7	6	17
Appreciation of the importance of biodiversity	5	3	3	4	4	19
Environmental awareness	3	4	3	3	5	18
Inadequate legislation	7	5	2	4	1	19
Limited financial and institutional base	6	6	2	1	5	20
Inadequate alternatives	4	8	1	10	8	31
Inadequate research and extension approaches	9	10	3	7	7	36

** A full description of the unmet need is given in Section 4.3*