ADDIS ABABA UNIVERSITY

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SCHOOL OF INFORMATION STUDIES FOR AFRICA

# DESIGN OF PROTOTYPE INFORMATION SUPPORT SYSTEM FOR BIODIVERSITY STUDIES ON ETHIOPIA

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTER OF SCIENCE IN INFORMATION SCIENCE

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# DECLARATION

The thesis is my original work and has not been presented for a degree in any other university.

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31 May 1994

The thesis has been submitted for examination with our approval as university advisors.

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DEDICATION

To W/ro Shashe Abeje and Ato Emerie Kassahun, my parents.

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## ABBREVIATIONS

| | |
|---|---|
| AEZ | - Agro-Ecological Zonation Plan |
| ASL | - above sea level (altitude) |
| CHA | - Controlled Hunting Area |
| CITES | - Convention for the Control of International Trade in Endangered Species |
| EFAP | - Ethiopian Forestery Action Programme |
| EWCO | - Ethiopian Wildlife Conservation Organisation |
| EWNHS | - Ethiopian Wildlife & Natural History Society |
| IUCN | - International Union for the Conservation of Nature & Natural Resources, also known as the World Conservation Union |
| km | - kilometre |
| m | - metre |
| mm | - millimetre |
| mn | - million |
| MNRD&EP | - Ministry of Natural Resources Development & Environmental Protection |
| NGO | - Non-Governmental Organisation |
| NP | - National Park |
| OPHCC | - Office of the Population and Housing Census Commission |
| SIDA | - Swedish International Development Agency |
| UNESCO | - United Nations Educational, Scientific & Cultural Organisation |
| US | - United States |
| WCA | - Wildlife Conservation Area (NP, WR, Sanctuary & CHA) |
| WCI | - Wildlife Conservation International, of NYZS (now NYZS The Wildlife Conservation Society - International) |
| WR | - Wildlife Reserve |
| WWF | - Worlddwide Fund for Nature, also known as the World Wildlife Fund |

## ABSTRACT

The direct benefits of biological resources to humanity (for food, fuel, fibre, medicines, drugs, and raw materials for a host of manufacturing technologies and purposes), and the intangible scientific, ethical/moral, aesthetic, recreational values and the ecological services (in protecting watersheds, cycling nutrients, combating erosion, enriching soil, regulating water-flow, trapping sediments, mitigating pollution, and controlling pest populations) have been recognised for a long time. However, biological resources have not been given due care and attention by policy makers, planners, and the public. Indeed, the large scale problems of population growth and inappropriate development strategies are degrading the land, water, and atmosphere and progressively extinguishing the Earth's organisms and habitats they inhabit. The great loss of biodiversity suggests the need for conserving and managing it to ensure sustainable development. The thesis discusses some of the research areas/topics critical to the conservation of biodiversity. It highlights the biological aspect as well as the socio-economic factors and cultural context that must be considered in

successful, longterm conservation work and finally proposes and briefly discusses a national biodiversity conservation strategy to be drawn and implemented.

As part of conserving and managing biodiversity, it is necessary to identify what is not known about biodiversity and create the means to increase and disseminate knowledge. The challenge of biodiversity conservation, management, and research entails not only gathering of information, but its management, application, and communication. Provision of the information needed to decision makers in monitoring, formulating policy and designing programs to conserve biodiversity is critical. To enhance the availability and application of scientific information for managing and conserving biological diversity, setting up computer databases and inventories and networks and harnessing the capabilities of remote sensing and geographic information systems are examined. From this point of view, again, a survey has been conducted on local institutions concerned with biodiversity, the findings analyzed, current problems and constraints identified. Prototype databases for plants, animals, national parks, germplasms, referral and reference services have been designed; strategies for developing and implementing the databases discussed; and a national biodiversity information and monitoring system (NBIMS) proposed.

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# CHAPTER ONE

## 1. INTRODUCTION

## 1.1 BACKGROUND INFORMATION AND JUSTIFICATION FOR THE PROJECT

### 1.1.1 Biodiversity: Definition

Biological diversity (or biodiversity, as it has come to be called) refers to the variety and variability among living organisms and the ecological complexes in which they occur. Diversity can be defined as the number of different items and their relative frequency. For biological diversity, these items are organized at many levels, ranging from chemical structures that are the molecular basis of heredity to complete ecosystems. Thus, the term encompasses different genes, species, ecosystems, and their relative abundance (OTA, 1987). Species is the taxonomic category ranking immediately below genus; it includes closely related, morphologically similar, individual organisms that play a particular ecological role. Species diversity refers to the variety of different species. Genes represent the basic unit of inheritance, the strands of deoxyribonucleic acid (DNA) polymers that are found in the chromosomes in cell nuclei and control the genetic identity of individual organisms. Genetic diversity refers to the variety of genes. Whereas species diversity normally refers to the diversity among species, genetic diversity refers to the diversity with in species. Ecosystem (derived from "ecological system") refers to the functional system that includes the organisms of a natural community together with their physical environment. Ecosystem diversity is the diversity among systems in a given area.

### 1.1.2 Values, Benefits/Significance of Biodiversity

The direct benefit of biological diversity to humanity are myriad: We depend on animal, plants, fungal, and microbial species for food, fuel, fibre, medicines, drugs, and raw materials for a host of manufacturing technologies and purposes. The productivity of agricultural systems is a result of our continual alteration, over thousands of once wild plants and animal germplasms, and still rests on interactions of diverse organisms within agroecosystems. Genetic engineering, especially in the pharmaceutical and food processing industries, uses natural genetic diversity from sources world wide. Biomedical research requires comparative information on other species-models such as the mouse and the fruit fly. Although such direct values of biological diversity are not always reflected in market prices, they are more amenable than other values to economic analysis; hence most economists have focused on this aspect of biological diversity.

Beyond such direct values, biological diversity provides ecological services that are more difficult to calculate with precision. Living organisms are an important part of the processes that regulate the Earth's atmospheric climatic, hydrologic, and biogeochemical cycles. The dynamics of these global processes were understood only very recently, and discerning the functional role of biodiversity within them remains a fundamental and challenging question. This is especially important as we seek to understand how biological systems may affect, and be affected by, global climate change resulting from the emission of green house gases in the atmosphere.

It is easier to comprehend (and measure) the ecological services that biological diversity provides more locally in protecting watersheds, cycling nutrients, combating erosion, enriching soil, regulating water flow, trapping sediments, mitigating pollution, and controlling pest populations. As human activities alter landscapes and ecological processes on larger scales, the need for management and conservation of land, water, and marine resources will require greater understanding of ecosystem composition, structures, and functions. The value of biological diversity in this sense is fundamental.

Finally, ethical and aesthetic concerns direct us to respect, and strive toward rational management of the world's heritage of biological resources. The non-economic, intangible, and inherent values of biological diversity take us beyond the traditional realm of sciences, into the realm of the arts and humanities, language and history, religion and philosophy. These varied forms of human perception and expression have a fundamental stake in the fate of biological diversity. Although the values they embody may be less quantifiable, they are nonetheless real and pervasive. To regard biological diversity only for its tangible economic and instrumental values even where these might be fully taken into account paradoxically reduces its value.

In sum, the diversity of life on Earth the variety of all plants, animals, micro-organisms, and ecological systems is the basis for our food and environmental security. It is the source of food, fuel, clothing, shelter and medicine besides its role in maintaining the Earth's life support systems needed for the sustainable production of these essentials. FAO's Director on the occasion of

World Food Day (WFD, 1993) stated: "Biodiversity is the bases for the environmental health of our planet and the source of economic and food security for the following generations. Cut it off and we will not exist." [quoted in the Ethiopian Herald oct., 1993]. From the above discussion, it is obvious that biodiversity is and must be real concern of the people at global, national, regional, local, and individual level. Next, we shall examine the situation and perception on biodiversity in developing and developed nations.

### 1.1.3 Loss of Biodiversisty and Its consequences

During the next 20 to 30 years, the world could lose more than a million species of plants and animals primarily because of environmental changes due to humans [UNESCO-UNEP, 1992]. At 100 species per day, this extinction rate will be more than 1000 times the estimated "normal" rate of extinction. The list of lost, endangered and threatened species includes both plants and animals. About 10% of temperate region plant species and 11% of the world's 9000 bird species are at some risk of extinction. In the tropics, the destruction of forests threatens 130,000 species which can live nowhere else. This alarming rate of extinction is the global problem which has kindled world-wide interest in biodiversity.

The Convention on Biological Diversity, signed by over 150 countries (including Ethiopia) at the Earth Summit at Rio De Janeiro in June 1992, to provide a broad legal framework for conserving and utilizing biodiversity of all nations was made necessary in response to the pressing demand for attending to the near-crisis situation.

The degradation of ecosystems throughout the world has been well documented by scientists and is now widely reported in the media. The degradation of natural ecosystems and habitats, and the loss of their characteristic species diversity, are occurring in nearly every part of the globe as human population and their support systems expand . We are at a critical juncture for the conservation and study of biological diversity; such an opportunity will not occur again (NAP, 1992). The Earth's biota is experiencing its greatest episode of species loss since the end of the Cretaceous Era 65 million years ago. More importantly, it is the first mass extinction event that has been caused by a single species, one that we now hope will act, to stem the tide (NSB, 1989).

The proximate causes of biodiversity loss are biological, but the root causes of the problem include sociological and economic processes that operate on a global scale. A thorough understanding of the phenomenon will require the investigation and elucidation of both biological and social components, and international co-operation will be necessary to develop both this scientific knowledge and successful mitigation and management strategies. Unless the international community can, indeed, reverse the trend over the next few decades, the erosion of the Earth's biological legacy will continue and accelerate (NRC,1992).

The diversity of life on Earth has never been, and never will be, static. Global biodiversity has fluctuated through geologic time as evolution has added new species and extinction has them away. Evolution and extinction are natural processes, the responses of population of organisms to changes in their physical and biological environment. Change is, in a very real sense, a basic fact of life (Jablonski, 1991). We may, then, raise a question: If change is the norm, why are we now concerned about conservation of biodiversity?

The environmental changes affecting biodiversity today have a different origin, order, and magnitude than those recorded in geologic annals. Today, the rate and scale of environmental changes brought about by human activities have increased to the point where a great species may not have sufficient time or space in which to migrate or adapt.

The current loss of biodiversity has several causes (Mc Neely et al., 1990; Soule, 1991). The direct destruction, conversion, or degradation of ecosystems results in the loss of entire assemblages of species. Overexploitation, habitat disturbances, pollution, and the introduction of exotic species accelerate the loss of individual species within communities or ecosystems. Exploitation, habitat alteration, the presence of chemical toxins, or regional climatic changes may eliminate some genetically distinct parts of a population yet not cause extinction of the entire species. As genetic variability is lost, however, the species as a whole becomes more vulnerable to other factors, more susceptible to problems of inbreeding, and less adaptable to environmental change.

As Robinson (1988) notes, "we are destroying irreplaceable species on unprecedented scale without regard for their potential economic, aesthetic, or biological significance." Even conservative estimates of species loss rates suggest that unless current trends are reversed, more than one-quarter of the Earth's species, may vanish in the next 50 years (Raven, 1988; Wilson, 1989; Reid and Miller; 1989; Ehrlich and Wilson, 1991).

The causes for resource degradation include: Population growth, continuing military conflicts, misguided or misapplied policies that discourage conservation and, above all, persistent and crushing poverty all of which leave people with few choices in managing land and natural resources.

Generally, we as a species are rapidly altering the world that provides our evolutionary and ecological context. The consequence of these changes are such that they demand our attention. The large scale problems of unprecedented population growth and inappropriate development are degrading the land, water, and atmosphere, and progressively extinguishing a broad array of the Earth's organisms and the habitants they inhabit. By paying no attention to these problems or putting them aside in favour of what seem to be more imperative personal, group, or national priorities, we are courting global disaster. By attending to them, we can begin to build a more stable foundation for lasting peace and prosperity (NAP, 1992).

The level of concern among world leaders, including the international development agencies, has risen. Many are rethinking their priorities with respect to the allocation of resources to slow the degradation. Alhough the choices are not easy ones, there can be no turning back to the time when the short term enrichment of human societies entailed the long term impoverishment of the living world on which the societies depend. We can change our behaviour and stop the acceleration of environmental degradation and species loss, thereby safeguarding species, their habitats, and our own future options for their use and enjoyment (i.e. to ensure sustainable development). In sum, loss of biodiversity is a problem; conserving biodiversity is the science to understand the problem and propose solution; and <u>efficient information dissemination and environmental education is the means of getting solutions implemented.</u>

### 1.1.4 Scientific Understanding of Biodiversity

Our information about and understanding of the Earth's biological diversity has significant gaps which is to be filled promptly through intensive and extensive researches. Currently, this lack of information hampers the ability to comprehend the magnitude of the loss of biodiversity, prevent further losses, and formulate sustainable alternatives to resource depletion. **Answers are still unavailable for seemingly simple but important questions: How many species are there? Where do they occur? What is their ecological role? What is their status common, rare, endangered, extinct?**

Although schemes for classifying organisms date back at least to Aristotle, biologists are still very far from completing an inventory of the Earth's animals, plants, fungi, and microorganisms. The idea of producing encyclopedic treatments of the world's animals and plants began about 300 years ago, towards the close of the seventeenth century. In the eighteenth century, the Swedish naturalist Linnaeus, building on this encyclopedist tradition, devised the system of plant and animal taxonomy involving binomial Latin names that is still used today, in essentially the same form (Mayr, 1982).

To date, some 1.4 million kinds of organisms have been assigned names, but coverage is complete for only a few well studied taxonomic groups such as vertebrates, angiosperms, and butterflies (Wilson, 1988). Most groups and many major habitats,such as, coral reefs, the deep sea floor and thermal vents, tropical soils and forest canopies, remain poorly studied.

Current estimates of the Earth's total species diversity range from 10 million to 100 million (Wilson, 1988; Ehrlich and Wilson, 1991; Erwin, 1991). Thus, as Wilson (1988) has pointed out, we do not know even to within the nearest order of magnitude the number of species on the planet. Even among those species that have been named, very few have been subject to close biological description or study (NSB, 1989). **For instance, although work in plant taxonomy continues, no coordinated effort to inventory the plants of the world has been initiated, and no general data bank exists from which information about such plants can be retrieved. International networks of botanical gardens, seed banks, and other ex-situ strategies for preserving plants are in place in some regions but need to be strengthened.** Of special concern in this regard is the accelerated loss of genetic diversity in domesticated crops, their varieties and land races, and their wild relatives. This diversity of germplasm resources has been largely responsible for the gains made in agricultural productivity in recent decades, but even as that diversity is being called upon to meet new agronomic and environmental needs, it faces growing threats(NRC, 1991b).

The expansion of plant inventories, screening, the dissemination of information, and conservation efforts on a global basis which can build on efforts at the national level, should be matters of high priority, based on our absolute dependence on plants and our ignorance of the properties of most of them. Hence, there is the need for further research in this area.

### 1.1.5 Bidiversity Conservation Research

Conservation, in this context, should not be construed to mean either strict preservation or intrusive management, but these measures and all others that can protect and restore the biological diversity inherent in an area while improving the long term well being of the people who live there. This entails a spectrum of appropriate land uses, from parks and natural areas to extractive reserves to sustainably managed agroecosystems. In this effort, it is important to appreciate the different spatial scales on which different land uses operate; to understand them in their landscape, regional, and even global contexts; and to coordinate them so as to conserve their full range of values. This is a massive challenge, and the role of the international development community ( with providing institutional and financial support ) is critical. Research on conservation must integrate and extend the basic information gathered through biological surveys and inventories to increase our understanding of ecological dynamics in different systems and regions. There is a continuing need for research on biodiversity that improves our knowledge base and our management capacities, and leads to the development of new ways for people to live with, and not at the expense of, their biological resources.

Biodiversity conservation research has three aspects; namely the socio-economic, the cultural and the biological aspect. In our remaining discussion emphasis will be on the biological aspect.

1.1.5.1 <u>The Socio-Economic Aspect</u>

The loss in the world's biological diversity can be attributed, in large part, to socio-economic factors that encourage exploitative development practices while discouraging conservation resource use. The economic aspects of biodiversity conservation in developing countries demand sophisticated analysis, necessarily involving economists and ecologists working together and with other researchers. The overall objectives of an economic research agenda are to identify the economic forces leading to the loss of biodiversity within a country; to determine the role of international economic institutions and trends that support this depletion; to elucidate the principles operant in cases of successful development and conservation; and to develop and test economically viable mechanisms for slowing resource depletion and stimulating conservation.

1.1.5.2 <u>The Cultural Context</u>

Biological diversity has been also lost as a result of social processes, and will ultimately be conserved only through adjustments in these processes. Unless and until they are understood, there is little lasting hope for conservation. As a result, areas of emphasis include:

o. Research to provide information on local management system;

o. Research to promote the application of local knowledge to modern resource management (adapting local knowledge);

o. Research to promote the idea that local knowledge and practices remain relevant for contemporary natural resource management, especially in terms of the scientific insights they provide, the rational for examining local knowledge and rules should be communicated to professional groups;

o. Research to select the cultural groups for studying existing or possible resource use patterns, traditions, combinations and relationship as it is clearly impossible to study all. Of highest priority are those use patterns and knowledge systems that are changing most rapidly or disappearing and groups that have successfully adapted traditional technologies and resource use patterns in developing market opportunities.

1.1.5.3 The Biological Aspect of Conservation

The state of knowledge of biological diversity suggests that the most basic research requirement is to gain a better, more complete sense of **"what is out there."** At the same time, we need to know more about how biological diversity is distributed, how it is faring, how to protect it and use it in a sustainable manner, and how to restore it. We also need to improve our ability to gather, organise, communicate, and apply this basic biological information/knowledge. The research agenda of critical importance in this regard are (NAP 1992):

#### 1.1.5.3.1 *Biological Surveys, Inventory, Screening, and Monitoring*

Successful, long term conservation of an area or ecosystem relies on knowledge of its biological diversity coupled with integrated efforts to protect and manage that diversity in a sustainable manner. One of the first steps in this process is to ascertain its fundamental biological characteristics: the genetic strains, species, and ecological assemblages present; their distribution, abundance, and patterns in the landscape; their role in ecological processes; their proven or potential utility for human benefits; and trends in their status as a result of human or natural disturbances. Full understanding of biological diversity, even in a small area, is a task requiring decades, if not centuries, of intensive research. Biological surveys, inventories, and monitoring can, however, provide the basic knowledge required to enhance local scientific and technical expertise and to initiate sound conservation strategies.

Biological surveys, focusing on species diversity, are necessary on both national and global scales. National biological inventories provide a finer-grained view of biological diversity and can be used to establish national conservation programs and policies, whereas a global survey will provide much needed information on the extent, distribution, status, and fate of biodiversity worldwide. Such a survey can serve not only to tell us the status of biodiversity, but to serve as an index to the pattern of species distribution and the nature of communities on Earth, and would provide the cornerstone for a global scale effort to identify valuable biological resources, some of which are unknown, while others are locally known but have potential for much wider use.

Inventories and surveys also provide base line data against which changes in biological diversity and environmental impacts of development projects can be monitored and traced, respectively. For all groups of organisms, sampling those that occur in threatened regions is of special importance because natural communities are being altered or destroyed so rapidly. Large number of endemic species are being lost in the world's critical centre of endemism, or " hot-spots" (Myers 1988). In cases where immediate information on area-species diversity is needed, new rapid assessment methods may be required ( Roberts, 1991). Particularly in species rich areas but throughout the developing nations and in threatened habitats world wide, inventory and preservation are of immediate and critical importance. Finally, the screening of plants, animals, fungi, and microorganisms for features of potential human benefits should be systematized and accelerated through strengthened programs.

1.1.5.3.2 *Site Specific Research*

Progress toward truly sustainable land use systems requires information on the effect of management options on the ecosystem dynamics. To advance the understanding of ecosystem composition, structure, and function; to use this knowledge to link basic and applied research, sustainable land use and development and the conservation of biological diversity; and to provide baseline data for environmental monitoring, long term ecological research should be supported at selected sites in developing nations.

1.1.5.3.3 *Conservation Biology Principle and Methods*

Research on biological diversity in developing countries should focus on the application and further development of the methodologies and principles of conservation biology. Most of the principles and concepts are developed by the developed nations and as a result they shall be tested and compared for elucidating principles that can be more widely and appropriately applied to developing nations.

1.1.5.3.4 *Sustainable Use of Biological Resources*

Research should be conducted on strategies for the sustainable use of biological diversity and for returning something of the value of biodiversity to developing countries. Sustainable use implies that current human needs should be met without degrading the resource base for future generations.

1.1.5.3.5 *Restoring and Utilizing Degraded Lands*

Research on the restoration and utilization of degraded lands and ecosystems in developing countries should be given increased support. Currently, only a limited theoretical foundation can be applied to site restoration, and there are very few cases in which these theories have been tested.

1.1.5.3.6 *Information Needs*

To enhance the availability and application of scientific information for the purposes of managing and conserving biological diversity, research in developing appropriate computer database and inventories, the use of remote sensing and Geographic Information Systems for ecosystem monitoring in developing countries, and in setting up and strengthening information networks to improve communication among researchers in developing nations, between researchers in different countries, and between researchers in both developing and developed countries is very critical.

From the discussion we had so far, we can see that the issue of biodiversity has managed to draw the attention of the world community in that international development agencies are making a sustained effort to undertake and coordinate research on biological diversity as a fundamental part of their mission. It has also been made explicit that research on developing computer databases and inventories for the purpose of efficient and effective management and conservation of biological diversity; setting up and strengthening information networks for an efficient information communication and dissemination; and using remote sensing and geographic information systems for agroecosystem monitoring should receive priority in research agenda for conserving and managing biodiversity. In the above respect, therefore, any effort made towards developing an information system to support biodiversity studies will be useful to various groups at local, national and international level. Hence, the reason for choosing the subject for the thesis and efforts at designing prototype information support systems for biodiversity studies relating to Ethiopia to fill the gap in knowledge in this area. The demand for such work is indeed very pressing for Ethiopia. Before a discussion on Ethiopia's biodiversity and current conservation and management strategies, however, it is essential that we see general information needs for biodiversity conservation research and biodiversity conservation and management.

### 1.1.6. Information System Needs for Biodiversity Conservation Research and Bidiversity Conservation & Management

Information on the extent, status, value, use, and preservation of biological diversity must be coordinated, accessible, and applicable. This is especially important in developing nations, where inadequate infrastructure, information technologies, and networks can be primary constraints on research and effective conservation activities. Information must both be made available to and draw on the work of researchers, resource agencies, national institutions, and non-governmental organizations in developing countries. The rapid evolution and increasing availability of information technologies, in particular personal computers and geographic information systems, have significant implications for the conduct and application of biodiversity related research. Information networks do not only allow in-country researchers to take advantage of the work of other scientists but give them a greater sense of purpose and a broader understanding of the context in which they are working. This knowledge is especially important to scientists working in the same region, in similar systems from different regions, and on elements that move between regions. Determining and coordinating local, national, and regional information needs, however, represent major challenges. Computer inventories, remote sensing devices, and identification and classification programs facilitate researches on biodiversity. Generally, to enhance the availability and application of scientific information for the purpose of managing and conserving biological diversity, the following actions are needed.

1.1.6.1 *Developing Computer Databases and Inventories*

Resources should be devoted to the development of computer databases, inventories, and information networks for efficient collection, storage, retrieval, dissemination, and utilization of information. Support should be given to the improvement of inter institutional coordination, system design, and operational administration through the establishment of national biological institutes or equivalent centres.

As conservation faces greater competition for resources, the need for coordination and shared information to prevent duplication of efforts becomes paramount. To select and design new reserves, efficiently manage and monitor existing reserves, take advantage of opportunities for sustainable land use and restoration, and coordinate ex-situ conservation efforts, researchers and administrators must have access to information on the classification, distribution, characteristics, status, and ecological relationships of species. Much of this information, if it exists, is scattered and difficult to obtain. The development of computer databases and inventories would be a major factor in overcoming this constraint. National biological institutes can provide a central location for these databases, inventories, and information networks and promote the inter-institutional coordination necessary to their success.

Computer based systems specifically for the long-term management of information necessary for the conservation of biodiversity are available. In the United States, these include the Heritage and Conservation Data Centres (CDCs) of the Nature Conservancy; the databases of botanical gardens, arboreta, museums, herbaria, aquaria, and zoos; the breeding bird and waterfowl surveys of the U.S. Fish and Wildlife Service; the Christmas Bird counts of the National Audubon Society and the lepidoptera surveys conducted by the Xerces Society. Notable examples in other countries are the databases of INBio in Costa Rica.

The Nature Conservancy's Conservation Data Centres are continually updated inventories of the most significant biological and ecological features of the country or region in which they are located. **These computerized centres offer a readily accessible source of information on biological diversity that can be used in conservation and development planning.** All 70 Conservation Data Centres now operating in the Western Hemisphere employ the same methodology and computer hardware (NAP 1992).

A quite different example is Tropicos, the botanical database of the Missouri Botanical Garden, which serves as a tool in systematic research and in the production and revision of flora. It includes programs for managing herbaria, producing herbarium specimen labels, maintaining horticultural information on living specimens, and managing botanical libraries. The database currently contains about 400,000 names of taxa. Entries include information concerning synonyms, literature citations, description, and distribution at the country level. The system also has the capacity to generate plant description for floras, character lists, chromosomal analyses, and information on the taxonomic status of specimens.

Jenkis (1988) lists the following principal uses of these kinds of data:

o. facilitating continuing inventory by organizing data well enough to determine what is and is not known;

o. setting and revising conservation priorities through an ever improving picture of the relative endangerment and status of species, habitats, etc.;

o. selection and design of reserves through the identification of areas containing critical species or habitats and an understanding of their ranges and needs;

o. facilitating more efficient and sophisticated use of land protection methods by conservation administrators;

- o. monitoring and managing biological elements /species, community type, or other feature of interest/ by enabling users to make rapid field assessments of their status and ecological response to management options;
- o. site management;
- o. providing information about sensitive sites and project design requirements to developers and development agencies in the planning process;
- o. providing real data for environmental impact analysis and review;
- o. providing access to additional information by including references to original sources, published and unpublished documents, professional sources, museums/institutions, files, databases, and maps;
- o. providing data for extrapolation in predictive modelling; and
- o. providing field localities, biogeographic information, and other baseline data necessary for research concerning conservation priorities;

Given the myriad applications of a coordinated, well-designed, and well-maintained database network, this will clearly be an important tool for developing countries. Fortunately, the examples cited above, as well as most others, can be run on personal computers that do not require large investments in software or hardware.

### 1.1.6.2 Adopt Remote Sensing and Geographic Information Systems

The data from remote sensing techniques, coupled with the data management capacity of geographic information systems (GIS), offer unprecedented opportunities to assess and monitor ecosystem processes.

No one source of remotely sensed information is likely to supply all of the data to address biodiversity research needs in developing countries. Coarse spatial resolution sensors with high rates of data acquisition (e.g., the Advanced very High Resolution Radio-metre of the National Oceanic and Atmospheric Administration) are needed to accommodate the vast land areas studied in tropical surveys. High resolution sensors, for example, the Landsat MSS ( Multispectral Scans) and TM ( Thematic Mapper), the system probatoire d'Observation de la Terre (SPOT), aircraft scanners, and mapping cameras, are needed to record spectral and spatial information to link intensive field level ecological studies to forest community and biome level assessments (NAP, 1992). In regions with frequent cloud cover, active microwave sensors can provide information about the land surface and forest canopy that would otherwise be unobtainable (Sader et al., 1990).

The benefits of geographical information system technology go far beyond its ability to maintain information in a geographically referenced format. Information on soils, topography, climate, distribution of organisms, land use, and protected areas can both clarify and augment the measurements provided by remotely sensed data (Green 1981).

Gap analysis is one important application of remotely sensed data ( Barley, 1988; Scott et al.,1991a, 1991b). Gap analysis identifies gaps in the network of protected areas and compares these against the background of the distributions of ecosystems, vegetation types, and plant and animal taxa. Gap analysis can reveal priorities for conservation in a more systematic and quantified manner than previous methods, and can pave the way for the protection and management of sensitive areas. By adopting a broadly based ecosystem approach, it seeks to prevent species and communities from becoming endangered, allowing scarce human and financial resources to be applied more effectively.

Other applications of remotely sensed data are already in use and producing much needed information on the status of resources in tropical regions. Remote sensing was used, for instance, to estimate available habitat for migrating birds in the Yucatan of Southern Mexico (Green et al., 1987). In Thailand Vibulsresth (1986) was able to differentiate "disturbed" from "undisturbed" dry dipterocarp forests. Perhaps the most notable use of remote sensing data was the publication in The New York Times of images of the burning forests of Rondonia in Brazil (Maston and Holben, 1987).

### 1.6.1.3 Setting up Information Networks

The effectiveness of all scientists depends in large part on their access to professional colleagues and to information in their field. Researchers on biodiversity in developing countries face special difficulties (NAP 1992). Traditional sources of scientific information, libraries, museums, universities often lack the resources to maintain up to date collections and to disseminate the findings of their own researchers. The cost and inconvenience of travel to scientific meetings and conferences can be prohibitive; modern communication technologies are often unavailable. As the need for scientific information on biological diversity grows, and as the volume and quality of information increase, scientific networks must keep pace. These networks should serve to improve communication among scientists in developing countries, between scientists in different countries, and between scientists in the developing and developed world.

The following steps, if taken, can improve communication among scientists in developing countries and would directly promote the formation and strengthening of network (NAP, 1992):

o. improve access to bibliographic resources and other databases by providing scientific and educational institutions with funds for journal subscriptions and book purchases

o. support the publications of findings in international journals and local publications, especially those in vernacular languages( a considerable amount of data on the flora of many countries has gone unpublished for lack of funds)

o. support the publication of newsletters

o. finance the compilation of a world wide directory of individuals working in the area of local knowledge systems, and support the preparation and publication of annotated bibliographies on selected topics related to local knowledge

o. sponsor local, national, and regional workshops and conferences on biological diversity.

### 1.1.7 Biodiversity:A Glimpse of the Situation in Ethiopia

1. Ethiopia has a large wealth of natural resources; and among them are the flora and fauna of the country. The diversified and the wide range of habitat in the country has favoured the existence of varied species of wildlife and bird life. Types of wild life species in Ethiopia range from the smallest to the largest land living mammal in the world. The distribution of wild life in the country ranges from the desert type ecosystem to sub-desert, low land and mountain forest to sub-alpine and alpine regions. The wild life do follow these ecological patterns in their distribution and are found mainly in the south and south west both in number and variety of species.

2. Wild fauna and flora of Ethiopia are critical to the continuing functions of various natural processes on which the country's population depend, as a

store of genetic material with many and varied potential uses to man, and as a heritage.

3. Many forms of Ethiopian wildlife are especially adapted to the environmental conditions of the extensive Ethiopian highland massifs. They are thus especially valuable as a genetic resource for future land use planning within Ethiopia. Such genetic materials specifically suited to Ethiopian conditions does not exist elsewhere in the world. The endemic fauna and flora of Ethiopia include 27 out of 845 bird species (3%), 22 out of 242 terrestrial mammal species (9%), and at least 1000 out of 6000 plant species (16%). Research into the wild fauna and flora is relatively recent and as a result the flora and fauna of Ethiopia are not yet completely known in numbers and classifications.

4. Wildlife can and does make significant and tangible contributions to the national economy through tourism, hunting, wildlife products (medicine, perfumes, honey and wax, timber and other products), ranching and farming.

5. Wildlife makes significant but intangible contributions to the maintenance of natural

ecological processes on which man depends. These contributions are taken for granted, but are critical to man's continued support by the environment in agriculture and forestry.

6. Systems of Wildlife Conservation Areas, comprising National Parks, Sanctuaries, Wildlife Reserves, Controlled Hunting Areas, Wetland Reserves and others, have been established some two decades ago. This covers at present only about 2% of the country's land surface. These wildlife conservation areas have been established according to international criteria and guidelines, within Ethiopia's membership of the International Union for the Conservation of Nature and Natural Resources [IUCN ] and of UNESCO. The rest of the world, therefore, looks to their continued existence and maintenance by Ethiopia according to the International Standards for such areas and their eventual legal gazzettement by the government. In selecting the Conservation Areas, particular attention has been paid to those endemic species and their habitats that are only to be found in Ethiopia, and for which Ethiopia has total responsibility to the world.

7. Responsibility for the continued existence of Ethiopian wildlife rests in a large measure with the Ministry of Natural Resources Development and Environment Protection in particular through its Wildlife Conservation Organization, as well as with some other Government and Non-Government Organizations. The broad objective of the Ethiopian Wildlife Conservation Organization is the conservation of the natural Wildlife of Ethiopia. Thus information as to which areas of land deserve special protection has to be made available.

8. A policy document towards the sustainable development of the ecological resource base through the subsequent implementation of a policy aimed at the preservation of genetic diversity and the sustainable utilization of the biological resources has been prepared by a task force established by the Prime Minister and is now under discussion as per the requirements of the Rio Biodiversity Convention.

The Government of Ethiopia as well as other organizations have generally given due attention to the protection of wildlife of the country, and necessary infrastructure such as responsible Government agencies equipped with manpower, facilities, finance, materials, authority are being established. However, in spite of this attention paid to wildlife preservation in the country, results have not been up to expectations. Among the possible reasons for the short falls, the followings are the major ones:

1. **Inability to maintain sufficient and representative areas of biodiversity together with the lack of** adequate, accurate and timely information for **deciding which areas of land deserve special protection.** The crucial wildlife conservation network does not also sufficiently cover all ecological zones of biodiversity. Provision must, therefore, be made for expansion of the wildlife conservation area network to include all ecological zones of biodiversity.

2. Inadequacy of the attention paid to sensitizing the people about the role of biodiversity and people's responsibility in its preservation. As a result there is little knowledge among the people of the part played by wildlife in their daily lives, and particularly in the maintenance of vital natural ecological processes, as a store of genetic material for future utilization by man and in the

economic development of the country.

3. Population explosion, hunger, poverty, and malnutrition which are potential hazards of biodiversity conservation and these need to be solved by the committed efforts of the national and international community. Wildlife conservation should be integrated with other forms of land use in Ethiopia, for efficient and effective use of the country's natural resources. Hence, the need for an integrated management of the utilization of land and its natural wildlife components in the areas of cultivation, forestry, pastoralism, wildlife, mining, industry, urban developments, water storage, power production and other human activities.

4. **Failure to take a complete stock of all aspects of the environment on which the Ethiopian people depend for their livelihood (including the components comprising wild living plants and animals). This has resulted in:**

--incomplete knowledge about the extent, status, and usefulness of the genetic diversity of Ethiopian indigenous fauna and flora;

--problems of adequately characterizing, classifying, and evaluating traits of indigenous species due to information gaps that need to be filled in by taking inventory and keeping an updated record of them;

--failure to get and protect patent rights of existing but unidentified species due to inadequate availability of information about their genes and local uses.

--absence of any base line data against which monitoring and screening is made.

5. **Absence of an environment for governments, institutions, NGOs, industry and individuals working together as stewards of nature's diversity.** This would imply the need for maintaining an information network between and among the coordinating entities.

6. Failure to develop an alternative source of fuel supply to avoid destruction of trees and shrubs for fuel and the inadequacy of knowledge of legal measures and implementation against the maltreatment of wildlife.

7. Inefficient exploitation of wildlife products and failure to assess the full potential for generating

income from wildlife products, hunting, and tourism.

8. Absence of efficient monitoring mechanism. For instance, the utility and capability of remote sensing technology and geographic information system are not well tapped.

9. Absence of efficient and effective information system to support the activities involved relating to biodiversity conservation and related matters. The problems that exist in this regard include:
   - Problem of getting timely, reliable and consistent information on the true status of wildlife resources (as endangered, extinct, common, and rare), their habitat (as to forest deforestation and degradation) which are relevant for carrying out practical management and formulation of plans and strategies;

   - difficulty in realizing information exchange between and among localities, regions, countries, and organizations (both inside and outside the country.);

- difficulty in maintaining an integrated, centralized data bank on fauna and flora species (including information about their genetic variety) and the ecological zones (habitats) that can be searched and data retrieved quickly and easily on demand and in anticipation of demand:

- difficulty in providing an efficient multi-use service supporting different user groups ( resource planners and administrators, environmental engineers, biologists/taxonomists, academics, agricultural professionals and farmers, researchers, tourists, international development agencies, medicine people, and interested individuals). Access to information on the plant genetic variety, for instance, helps to minimize environmental risks around the world and formulate plans and strategies for conservation and management.

Given these problems, it is felt that they can be met at least partly by designing and developing an efficient and effective information system which will support the effort made towards conserving, managing and ensuring sustainable utilization of the biodiversity of the country in general and the wildlife resources in particular. This proposition is further reinforced by considering the overall activities performed by organizations (Government and non-Government) concerned with biodiversity. These activities include:

- identifying, registering, and maintaining records of the important ecological zones and the biodiversity species (biological survey, inventory, screening, and monitoring)
- recording details of the habitats and genetic variety of those species that acquire best traits, are endangered, rare, common, and nearly extinct;
- adequately characterizing and classifying of biodiversity components;
- providing information for ensuring sustainable utilization;
- keeping the community aware of the importance of maintaining biodiversity of nature;
- information exchange between and among organizations and countries on the subject;
- planning and managing of the above activities.

Indeed, supporting these activities by modern information systems would make the task efficient and permit the provision of other additional services. Hence, the justification for the thesis proposal for designing prototype databases and information retrieval system on biodiversity of Ethiopia. More specifically the information system when established would permit addressing the following issues:

1. At present it is not possible to find complete, accurate, relevant and reliable information about the essential natural ecological zones of the country and the number and variety of the wildlife species. Such information is needed for various purposes such as; natural resource development planning, environment protection management, tourism planning, land use planning. In the absence of such organized information, currently, questions such as the following cannot be answered efficiently and effectively:

   - Which plant and animal species are to be found in such and such habitats?
   - What is the current status of the habitat - endangered or nearly non-existent?
   - How accessible the habitat is? what lodging facilities are available in the vicinity? What means of transport one may use?
   - What calamities are happening frequently in the region?

- When is the convenient time to visit a particular national park? animal species?
- What sources of fuel supply other than forest wood do the people in the vicinity have for use?
- What are the conservation and protection mechanisms under use? How effective are they?

In the information system to be designed an attempt will be made to provide information to such queries.

2. It is impossible to find complete information about the types and true status of the country's total wildlife. It is also difficult to find adequate characterization and classification of wildlife elements. Consequently at present it is difficult to respond to queries about a plant/animal species such as:

   - Name of the plant/animal local and scientific );
   - How many species are there?
   - What special trait does it posses or has acquired?
   - What are the different uses of it? (medicine, perfume, food, oil, timber, construction use, fuel, ecological value, tourist attraction, scientific use, and others).
   - Which ecological zone does it belong to?

- Which climate/soil/seasons does it require for healthy development?
- What is its current status? (endangered, common, rare, nearly extinct both at national and international level, preserved in the genetic resource centre (its genetic element or the gene plasm)).
- Is hunting possible? When is it possible to see? What does it feed on?, and other such questions.

The proposed information system is expected to respond to such queries.

3. The current situation does not also lend itself to an efficient information exchange between and among localities, countries, and concerned organizations both indigenous and external. As a result, there is an information gap that needs to be filled by searching sources (data banks) located elsewhere. The proposed system would facilitate information and data exchange.

4. Some of the existing information systems are manual; and it is difficult to provide efficient and effective services. Searching for the appropriate

material and retrieving the desired information is time consuming and involves much effort. Moreover, the information retrieved is often

- not prepared and presented with the different user groups in mind;
- incomplete as to the content;
- not easy to replicate; and
- inhibits multi-use.

The proposed information system is expected to meet the above problems at least in part. The records will be prepared to correspond to different users' needs, organized and displayed in various forms, and produce different information products for dissemination to users. The benefits that may accrue from the information system will include:

1. Multipurpose databases, covering documentary materials, profiles of experts, institutions, ongoing research projects, information systems, numerical data, object- oriented descriptive records on selected species of fauna, flora, and systems of wildlife reservation (habitats).

2. Provision of information about researches and developments on biodiversity issues of potential

interest to users i.e. selective dissemination of information (SDI) service;

3. Search and retrieval of information to respond to various types of inquiries as indicated above;

4. Producing publications on biodiversity topics

5. Access from remote terminals to the central biodiversity databases; and

6. Possibilities of information exchange through on line access, on diskettes.

It is in this context that designing of an information support system for biodiversity studies on Ethiopia is justified.

## 1.2. STATEMENT OF THE PROBLEM

As it is explicitly stated in the previous section (section 1.1.6 and 1.1.7), to enhance the availability and application of information for the purpose of managing and conserving biological diversity, the existence of the following things are essential:

1. Entities listed on page 26 and 27
2. Information networks between and among biodiversity concerned agencies/institutions. Networks satisfy a broad range of purposes and meet various requirements such as to provide improved and better human communication (like teleconferencing) i.e. network users, located geographically apart, may participate in an international session through the network; to provide sharing distant resources (databases as well as efficient and effective technologies); to provide an efficient means of transporting large volume of data among remote locations; and to provide distributed data collection and central management of resources.

   Those resources and services stated are of particular importance to biodiversity researchers in developing countries who are relatively short of finance and convenient means of transport to attend scientific meetings and conferences; opportunities for modern communication technologies; and modern information services which maintain upto date collections and disseminate the findings of their own researchers as well as outside counterparts. As the need for scientific information on biological diversity grows, [illegible] volume and quality of information [illegible] therefore, biodiversity information [illegible] pace.

Despite [illegible] necessity [illegible] conserving [illegible] [illegible] cannot [illegible] this [illegible] in [illegible] for [illegible]

[illegible]

[illegible] overall aim of [illegible] understanding of the essence and different ramifications of biodiversity researches; to examine major activities/functions performed by institutions and

agencies concerned with biodiversity; and to design a prototype information support system that can address the problems stated in sections 1.1.6, 1.1.7 and 1.2.

### 1.2.2. Specific Objectives

With the view to achieving the general objective stated above, this study has the following specific objectives:

- o. to obtain an understanding about the essence and different categories of biodiversity researches through surveying literatures in the area.
- o. assessing the major activities of biodiversity related government and non-government organizations, such as: The Ethiopian Wildlife Conservation Organization [EWCO], The Plant Genetic Resources Centre [PGRC], The Ministry of Natural Resources Development and Environmental Protection, The Ethiopian Wildlife and Natural History Society [EWNHS], The Ethiopian Tourism Commission, Food and Agricultural Organization of the United Nations [FAO], the International Union for the Conservation of Nature and Natural Resources [IUCN], United Nation Environmental Program [UNEP], Centre for Reproduction of

Endangered Species [CRES], ILCA, AAU (Arat killo plant and animal herbarium), Wondo Genet Forestry College, Institute of Agricultural Research; and Forestry Research Institute, in regard to biodiversity conservation and management.

o. to identify the potential users, their information needs, and corresponding sources.

o. to identify the existing information support facilities and examine their contributions to support in planning and policy development for conservation and management of biodiversity, information exchange among government and non-government organizations, sensitizing the population about the role of biodiversity in improving services, identifying, classifying, and characterizing different biodiversity species.

o. to identify those activities and/or biodiversity components that can best be supported by computerized information system .

o. to design a prototype information services/

support systems that:

--best link the user's needs and the sources;

--improve efficiency and effectiveness of current activities undertaken;

--permit additional services and enhance the effectiveness of the existing systems.

The above objectives will be achieved by designing prototype databases of:

--profiles of institutions, experts, projects, information systems

--documentary materials

--object-oriented databases of endemic plants and animals.

--Systems of Wildlife Conservation Areas comprising National Parks, Sanctuaries, Wildlife Reserves, Controlled Hunting Areas, Wetland Reserves and others.

--plant genetic resources (domesticated)

o. to draw the implementation strategy for the designed system.

o. to sensitize users (through demonstration) of the system as to the advantages to be gained from introducing modern information systems as a support to their activities.

## 1.3. SCOPE AND LIMITATIONS OF THE STUDY

As previously mentioned, a complete treatment of biodiversity research should consider the three aspects: namely the biological, soco-economic, and cultural context which when taken together could become very wide and unmanageable within the short time available for this work. The scope of this thesis is, therefore, mainly limited to the biological aspect with some attention being given to the other two aspects. Apart from delimiting the subject area to a manageable size, the biological aspect has a direct relationship with biodiversity as compared to the other aspects.

With regard to the information support system, again, it would have been more complete and informative, had it been possible to integrate the geographic, numerical, and descriptive type of databases. However, this particular work is confined to the descriptive aspect for the reason that given the time and technology available the other two were not found to be feasible. Further, with regard to the implementation, this work will only design prototype databases and propose strategies for the implementation. This is again because of time and technology constraints. On the other hand, once the foundation work is laid, further developments will not be difficult.

Much of the data for this investigation has been collected from secondary sources. The questionnaire survey covers only those Ethiopian institutions which are directly involved on biodiversity conservation and management mentioned earlier in this chapter. Nevertheless, the prototype can be used to develop databases of all types of institutions, local or foreign.

## 1.4. METHODOLOGY:

The methodology adopted for data collection,data analysis, and systematization /synthesis/ are as follows:

### 1.4.1.Data Collection:Sources and Methods

Data were collected pertaining to the databases. The sources and methods used are as follows:

#### 1.4.1.1 Sources

HUMAN SOURCES: Employees of the various government and non-government organizations, which directly or indirectly are involved in collecting, analyzing, maintaining, and interpreting biodiversity data

INSTITUTIONAL SOURCES: The various government and non-government organizations (including the documents they generate and use). Such organizations include:

--The Ministry or Natural Resource Development and Environmental Protection;

--The Ethiopian Wildlife Conservation Organization [EWCO];

--The Plant Genetic Resource Centre [PGRC];

--The Ethiopian Tourism Commission;

--Arat Killo Science College [AAU];

--Alemya Agricultural University [ALAU];

--Wondo Genet College of Forestry;

--The Ministry of Health;

--The Ethiopian Wildlife and Natural Resource History Society;

--Institute of Agricultural Research [IAR];

--Food and Agriculture Organization [FAO];

--International Livestock Centre For Africa [ILCA];

--Forestry Research Institute.

DOCUMENTARY SOURCES: These include maps, documents on biodiversity, periodicals, gazettes, reviews, abstracts, and others (both in paper form and on diskettes).

1.4.1.2 Method of Data Collection

The methods to be used for data collection from the above sources include: observation, interview (with checklist), questionnaire survey, and document searching.

1.4.2 **Population Size**

The major sources and users of biodiversity data are government and non-government organizations and a few others, taken together add up to a small number. Therefore, an attempt was made to cover all the sources mentioned in the data collection section.

1.4.3. **Data Analysis and Design Activity**

Analysis **of the data collected:**

1. identifying entities (objects ) about which data is to be collected for use.
2. selecting attributes of the data entities of interest to users.
3. determining the relationships among entities and their attributes (entity, attribute, and relationship)

4. establishing data and process definitions in a data dictionary.

**Design steps from the output of data analysis:**

5. mapping the entities and their relationship into the database structure for using micro CDS/ISIS, that is

5.1. Creating Data Definition Table

5.2. Create Data Entry Work sheet(s)

5.3. Creating Display Format

5.4. Create Field Select Table

6. Formulating Queries

## 1.5. SIGNIFICANCE OF THE STUDY

As discussed earlier in this chapter, the wild fauna and flora of any country are critical to its continuing functions of various natural processes on which man depends, as a store of genetic material with many and varied potential uses to man, and as a heritage. This is even more so to a developing country such as Ethiopia with its wealth of fauna, flora and other biodiversity and cultural resources. Wildlife can and does make significant and tangible contributions to the national economy through tourism, hunting, wildlife products (like medicine, perfume, honey and wax, timber, ranching and farming). Wildlife in addition, make significant, but intangible contributions to the maintenance of natural ecological processes. These contributions are critical to man's continued support by the environment in agriculture and forestry.

As the situation now obtains, there is little knowledge among the broad masses of the part played by wildlife in their daily lives, and particularly in the maintenance of vital natural ecological processes, and as a store of genetic material for future utilization by man. Indeed, unplanned, unchecked, and non-sustainable use of biodiversity resources together with alteration to climate and natural ecological processes have brought extensive land degradation, loss of habitat together with loss of valuable genetic reserves. On the other hand, again, being host to and nurture ground for many endemic species of wildlife rarely found in other parts of the world, Ethiopia has also an international responsibility to conserve and inherit these resources to future generations. This and other many related problems call for an urgent task of formulating and drawing up strategies by the concerned bodies on how best to conserve, manage, and utilize sustainably the country's biodiversity resources to meet both national and international commitments. As an instrument to achieving inventories) would, therefore, be a major factor in overcoming this constraint. National institutions in charge of conserving and managing biodiversity (partly the Ethiopian Wildlife Conservation Organization and partly the Ethiopian Plant Genetic Resource Development Centre) can host such databases, inventories, information networks and promote the inter-institutional coordination necessary to their success.

2. Information networking through the use of computers permits improved and efficient communication among local researchers and agencies, and between them and those outside the country. This will make researchers, who have been unable to participate in many international and regional conferences and constrained with lack of appropriate information system, to be more effective in their work.

3. Answers to queries such as the following: How many species are there? Where do they occur? What is their ecological role? What is their status? augments the ability to comprehend the magnitude of the loss of biodiversity, prevent further losses, and formulate sustainable alterations to resource depletion. However, getting answers for those

queries is not possible in the absence of an information system that coordinates and organizes the data on biodiversity into a form convenient for search and retrieval purpose. The present work is, therefore, significant in that it would address such queries.

4. Pertinent information on biological diversity is too sparse or scattered to be of practical use to formulate development plans, appropriate conservation and management strategies and specific projects that are both successful and sustainable. A good deal of unpublished reports, files in government archives, studies of limited distribution exists. But, the absence of a well organized information system (including networks) is primarily a constraint on research and effective conservation and management activities. To strengthen the entire research process, the above sources and other required information should be analyzed, organized, and disseminated in a systematic manner. The present work would be useful in this regarded also. It permits provision of selective dissemination of information (SDI) services, current awareness services, and search and retrieval services.

5. Finally, this particular work is also important for the uses mentioned in section 1.2.

Generally, the proposed information system can be made to provide information about organisms (plant and animals); ecosystems; biodiversity related institutions; biodiversity related bibliographies; experts in the field; and services like SDI services, current awareness services, and search and retrieval services for various inquiries efficiently and effectively on a regional, national, or global basis. Such information, if available, will be of special service to resource planners and administrators, academics, researchers, agricultural professionals and farmers, biologists /taxonomists, international development agencies, tourists, and finally to the general public. The databases can be continually updated and can help in simplifying the coordination of surveys by providing a regional picture of biological diversity. These national and regional efforts, building on existing conservation data centres in other countries, can well add up to a global strategy.

Local institutions (including employees working there) such as the Ministry of Natural Resource Development and

Environmental Protection; Wildlife Conservation Organization, Plant Genetic Resource Centre; Tourism Commission; Forestry Research Institute; Plant and Animal Herbarium at Arat Killo Science College ( AAU); Universities and Colleges will find this work significant for:

- o. resource stock taking, better understanding and sustainable use of the country's biodiversity resources;
- o. providing policy and decision makers and resource administrators with sound information in conserving and managing biodiversity;
- o. dissemination of information to raise public awareness or sensitize the people to the importance of biodiversity (environmental education); and
- o. data exchange among organization and countries about biodiversity and environment matters.

### 1.6. ORGANIZATION OF THE THESIS

This study is composed of six chapters. Chapter 1 deals with background information about the study area, the statement of the problem and the justification for taking up the study, scope and limitations of the study, methodology adopted, and the significance of the study.

Chapter 2 is status survey of major biological resources in Ethiopia and discusses the natural and socio-political and economic environment, the wildlife resources and crop germplasm. Chapter 3 deals with survey of the biodiversity concerned institutions, biodiversity information users, information needs of biodiversity users, sources of biodiversity information and existing information systems and services, and analysis of survey findings.

Chapter 4 deals with the database design activity; and as a result it discusses, in general terms, the procedures and activities involved in establishing an information system and methods of database design; the entities/data stores selected; attributes/data items of the entities, and design of the prototype databases for the selected entities as per the requirements of the selected software (MicroIsis in this case).

In continuation, again, chapter 5 deals with the implementation strategy. It gives an account of the general considerations and activities involved during system development and implementation.

Finally, chapter 6 presents the summary and recommendations.

# CHAPTER TWO

# STATUS SURVEY OF BIOLOGICAL RESOURCES IN ETHIOPIA

## 2.1 THE ENVIRONMENT: NATURAL AND SOCIO-POLITICAL AND ECONOMIC FRAME WORK

Ethiopia comprises of a complex gradient between the extremes of altitude, climate, vegetation and the resulting ecosystems. This chapter briefly describes the environment, socio-political and economic conditions of the country in order to illustrate the context within which conservation and management of the biological resources will have to be achieved.

### 2.1.1 Topography and Geography

The main geological and topographical feature of Ethiopia, with respect to conservation and management of biological diversity, is the very great contrast between highland and lowland areas, and the great expanse of the highlands. The formation of the Ethiopian highlands date back to the Oligocene period, 40 million years ago, when extensive outpouring of lava began (Hillman, J.C., 1993). That event resulted in splitting into two main blocks in a north-east/ south-west axis by the formation of the great rift valley, forming the basis of the western ( or northern) highlands, and the eastern (or southern) highland areas that remain today. The western block is more extensive, though greatly dissected by river action, especially by the Abay river ( or Blue Nile) basin. The eastern block is less extensive, and has been considerably modified along its eastern edges by river action of the Wabe Shebele basin in particular.

The formation of the Rift valley, which continues today, also opened up the broad funnel that is the north-eastern area of the country, and resulted in the Danakil Depression that is as deep as 100 metres below sea level at its deepest part.

Subsequent to, and during, these two major occurrences - the Oligocene lava outpourings and the formation of the Rift valley - modifications of the land surface has occurred through rainfall, river erosion, glaciation of the highest areas ( above 3000m ASL), and the effects of animal and plant life - on soil formation.

Thus Ethiopia ranges in altitude between 100m BSL to over 4000 ASL in its highest mountains. However, an extensive highland plateaux over 2500m ASL comprises the most significant part i.e. 40% of the country. These same areas, through their extensive nature and their isolation from similar areas on the continent, have stimulated the evolution of a wide spectrum of endemic species of wildlife and the highland ecosystems they comprise.

In brief, the topography and geology of Ethiopia today present a wide spectrum of habitats and ecosystems, with their component wildlife arrays in remarkable scenery.

### 2.1.2 Climate

Although the entire country lies within the tropics i.e $3^0\ 48''$ and $18^0$ N latitude and $33^0$ and $48^0$ E longitude ), the wide range of altitudes results in considerable variation in climate. The climate of the hot low lands is dry and semi-arid in the coastal plains and tropical/semi-arid in the deep valleys, with average annual temperatures varying from $20^0$ C to $29^0$ C. The plateaux have a temperate climate where the altitude produces an average annual temperature of $16^0$ C to $20^0$ C, whilst the high mountains are characterized by a cold, alpine climate with average annual temperatures between $10^0$ C and $16^0$ C. Relative humidity is very low on the eastern and western plains, but increases on the plateaux from 20% in the north to 80% in the south. Rainfall increases concurrently from 200mm/year in the north and on the eastern plains, to over 2000mm in the south-west (FAO/UNEP, 1981). The main rainy seasons last from June to August, with light rains from February to April.

### 2.1.3 Drainage

A system of rivers has evolved that drain the land of rainfall and other water sources. Overtime 12 major catchment basins have developed, which are mapped and described by both Daniel Gamachu (1977) and the National Atlas of Ethiopia ( EMA, 1988).

### 2.1.4 Soils

The details of the soils of Ethiopia are given in the National Atlas (EMA, 1988). Basically the highland soils are more fertile and better watered than the lowland soils. This has supported the development of dense human populations in the highland blocks, to the considerable modifications and eventual exclusion or destruction of natural ecosystems and their fauna and flora.

The situation is different in the lowlands where the soil is less fertile and the rainfall is lower than that of the highland blocks. However, lowlands are potentially irrigable as they are close to permanent sources of water, especially, rivers. This will, again, affect wildlife already concentrated there.

### 2.1.5 Political Regions

The land area of Ethiopia has most recently been divided into 25 regions, in addition to 5 autonomous areas. Immediately prior to that a system of 14 regions had been used for over a decade and the boundaries have been based partly upon natural features such as rivers, but have also been determined by human population densities and landuse. There are likely to be further changes in the future, as a new system of government evolves ( Hillman, J.C., 1993). Present perceptions of the sub-divisions of the country are along broadly ethnic lines which are of little relevance to biodivesity resources conservation and management.

### 2.1.6 Human Population

The distribution of the human population of Ethiopia is split between the densely populated highlands, and sparsely populated lowlands. Overall population was estimated at 42 million people in the 1984 census (OPHCC 1984).

Sixty percent of the population is estimated to reside in the highlands that comprise 40% of the total land surface of Ethiopia ( 1.2 million $Km^2$ ). This gives an average human population density of approximately 63 persons/$km^2$ in the highlands, and 28 persons/$km^2$ in the lowlands.

Such high densities in the highlands, in a cultivating culture, leave little space for the larger species of wildlife, or natural habitat for even the smaller species.

### 2.1.7 Landuse

Broadly speaking, Ethiopia's land surface can be divided into three major landuse categories in relation to wildlife:

- intensive, mainly cultivation in the highlands
- extensive, mainly pastoralism in the lowlands
- areas that are less used, due to extremes of aridity or altitude

Cultivated lands tend to support the least wildlife, due to the extent of the land area taken up by crops for much of the year, to the damage that larger animal wildlife species exert on crops, to the effect of land clearance on natural vegetation, and to the sheer numbers of people and their general attitude to wildlife.

Pastoralism has less effect upon wildlife, except in the attempt to eradicate large carnivorous animal wildlife species, the modification of the natural vegetation types to increase availability and palatability of grasses year round for the livestock, and the modification wrought by sheer numbers of domestic animals through their passage and overgrazing in many areas.

The area of the country covered under the third category mentioned above is limited to the highest parts of the mountain blocks and the driest desert and semi-desert areas. These thus so called marginal areas have not been used so far; but it may no longer be apparent under the situations and trends we see today i.e in unprecedented growth in population and development in knowledge and technology that can convert such areas into a productive one.

### 2.1.8 Socio-Political Systems

The system of centralized decision making has resulted in policies of landuse being applied in a "blanket" fashion over large areas of the country, that in fact differ very greatly in ecological conditions (Hillman J.C., 1993). Further, the available information on the natural resources, climate and terrain of the country is limited, such that there has been no time to carry out the research necessary prior to the application of these policies and changes in landuse.

The policy of state ownership of land, intended to maximize production and reduce the very great gap between rich and poor in the country, has had the side effect of removing the incentives for land husbandry and longterm investment in the conservation of the land and its resources.

Thus, while wildlife has benefited to some extent from the state ownership of wilderness and authoritarian control of land use, it has also lost out to the general effects of the exploitative robber economy of living natural resources that belong to everyone, but belong to no one person in terms of the longterm husbandry needed (Hillman J.C., 1993).

### 2.1.9 Religions

Ethiopia is dominated by two main religions, namely the Ethiopian "Tewahido" Orthodox Church and Islam with the first being the predominant one. A relatively small proportion of the population belongs to neither of the above religious group, being considered "animist" or of "pagan" or of "tribal religion" and occurring mainly in the lowlands.

There is a general abhorrence of wildlife by both major groups where cleanliness and edibility is concerned. Therefore little necessity for the husbandry of wildlife. On the other hand, the wildlife of certain areas is protected through religion. These include places of worship and burial. Christian churches are generally located high on hill tops. There is a taboo on the cutting of trees around churches, and the encouragement of tree growth and planting at these sites, as compared with the surrounding heavily utilized areas, has made them havens of mature tree growth, that support birdlife in particular, and to some extent other forms of wildlife, though usually smaller species.

### 2.1.10 Economic Incentives

Wild plants and animals contribute to the daily requirements of individual Ethiopian people. Examples can be given of the Civet musk industry, fishing, fuelwood, honey harvesting, traditional house construction materials, the supply of traditional medicines, etc., all of which result from wildlife and/or require wild habitats for the continuity of this supply.

Further economic benefits can be seen in the Tourist industry - wildlife viewing ( photographic safaris, bird watching, mountain walking, horse trekking, river rafting, etc.) and sport hunting, and in the harvesting of wildlife or its products by the government such as, crocodile ranching, live primate exports, etc.; but these benefits accrue to the government at the present time. Recently new policies have been announced whereby private investors can participate in such exploitation, and it is to be hoped that these new openings will be taken up.

The most important contributions, taken for granted by the majority of the people, of wildlife to the economy is, however, in supporting human life with agriculture and forestry, power production, and even the exploitation of minerals. For instance, natural wild vegetation regulates the movement of rainwater when it reaches the ground as it slows down the speed of water flowing over the ground and cause to percolate into the soil rather than flow across the surface. As a result, less erosion results. Unregulated exploitation and loss of the natural vegetation cover as fuelwood, construction timber, or in land clearance for agriculture, modify this process of water flow regulation. The results are reduced vegetation growth and loss of that material resource, soil erosion, seasonal spring and river flow, and reduced transpiration that contributes to changes in patterns of rainfall, both locally and down wind.

## 2.2 THE WILDLIFE RESOURCES

The wildlife of Ethiopia is rich in quality, if not in quantity, compared with other similar parts of the world (Hillman 1993). Present evidence suggests that the extensive and unique conditions in the highlands, together with their isolation, led to the development of a large number of endemic species there. An indication of the significant statistics concerning the wildlife of Ethiopia is given in Table 1, showing the numbers of species and proportion of endemics in different wildlife groups.

Table 1: Summary Statistics of the Wildlife of Ethiopia (adapted from Hillman J.C., 1993)

| Group | No. of species | No. endemic | %total |
|---|---|---|---|
| Mammals(terres.) | 277 | 31 | 11.2 |
| Birds | 861 | 28 | 3.3 |
| Reptiles | 201 | 9 | 4.5 |
| Amphibians | 63 | 24 | 38.1 |
| Fresh water Fish | 150 | 4 | 2.7 |
| Butterflies | 324 | 7 | 2.2 |
| Plants | 5,712-6,034 | 1150 | 20 |

### 2.2.1 Flora

The flora of Ethiopia is still rather poorly known (Hepper, 1979) and a major new project to prepare an inventory of flora of Ethiopia was launched in 1980 (Hedberg, 1986). The vegetation of the country is very heterogeneous and has a rich endemic element. Estimates put the size of Ethiopia's flora at about 5,765 species (IUCN, 1986) with Brenan (1978) estimating endemism to be of the order of 20.9% i.e. approximately 1155 species.

Detailed studies of the flora of Ethiopia, particularly an inventory of species and their distribution, is currently underway, conducted by the Flora of Ethiopia Project, based in the National Herbarium, Department of Biology, Addis Ababa University.

Additional research on the natural vegetation of an ecological nature is being undertaken by associates and staff of the flora project, some of these within National Parks (Friis 1981, 1986, 1987; Gilbert 1985, 1986; Lissanework Nigatu 1987; Lissanework Nigatu & Mesfin Taddesse 1989).

### 2.2.2 Fauna

Ethiopia is well endowed with wild animal species. Excellent inventories exist of the current situation with respect to mammals (Yalden, Largen & Kock 1974-1986) and birds (Urban & Brown 1971), although our knowledge of these groups is far from complete. Details of the birds and mammals of Ethiopia are included here (see Appendix 1 and 2) respectively. Species lists of these two groups exist for most of the National Parks and Sanctuaries (Hillman J.C., 1993 vol.II).

Information on other animal groups is far less complete. Species lists for Ethiopia have been compiled by Malcolm Largen for Snakes, Lizards and Amphibians and is presented in wildlife conservation compendium (Hillman 1993), and he is currently preparing detailed lists of each group for publication. Shibru Tedla prepared a list of the Freshwater Fish of Ethiopia (1973) which was also presented in a modified form in wildlife compendium ( Hillman 1993). A list of Butterflies occurring in Ethiopia is prepared by Stephen Collins of Nairobi to augment the information for Ethiopia available in Carcasson (1981) and Carpenter (1935).

Generally, the results of recent inventory research have indicated the degree to which the fauna and flora of Ethiopia are still unknown. A three-week expedition to the Harenna Forest of the Bale Mountains, for instance, yielded four amphibians new to science, two shrews new to science, and a monkey and a rodent new to Ethiopia (Hillman 1986; Larger & Drewes 1989; Huttever & Yalden 1990; Yalden 1988; Yalden & Largen 1992).

### 2.2.3. The Wildlife Conservation Areas

The focus of wildlife conservation in Ethiopia has been on the system of Protected Wildlife Conservation Areas (WCAs), concentrating on larger species, especially mammals. These reserved areas include National Parks, Sanctuaries, Wildlife Reserves, and Controlled Hunting Areas. There is in addition the term "Wetland Reserve" in the policy (EWCO 1992) but no reserved area has been yet proposed under this term. Wildlife Conservation Areas that come under each one of the above headings/terms is indicated in Appendix 3 categorized in to two as principal and secondary Wildlife Conservation Areas (WCAs). The principal WCAs include almost all National Parks and Sanctuaries, where characteristically conservation in some form has been active for some time, a degree of development has been reached, and staff and facilities have been assigned and developed. The principal WCAs are 13 in number, covering an area of 32,000 $km^2$ in total, or 2.7% of the land surface of the country. They are located primarily in the lowlands surrounding the highland blocks, with only two in the main high altitude areas ( the simien and Bale Mountains National Parks). They are also mainly in the southern part of the country, apart from those along the Rift Valley, due to the extreme arid conditions of the northern lowlands, combined with the prolonged effects of man in the northern areas and the resulting limited biodiversity, especially where natural vegetation and the larger animal species are concerned.

The secondary WCAs include all the Wildlife Reserves and Controlled Hunting Areas. There are 11 Wildlife Reserves and 18 Controlled Hunting Areas, covering a total of approximately 161, 600km$^2$ or 13.5% the land surface of the country. They are mainly located in the lowlands; no one of them is gazetted; and no development has occurred in any of the secondary WCAs. Management has been limited to the control of activities by professional hunters and their foreign clients by one or two wildlife scouts assigned to accompany them for the few days they are hunting in an area. They are essentially "paper" WCAs with no staff, buildings, resources, or even in most cases any boundary description.

Technically EWCO has responsibility for all wildlife in Ethiopia, but in practice its activities have been almost entirely limited to the WCAs, and then only the National Parks and some Sanctuaries, due to the lack of resources for dealing with wildlife elsewhere, and the perception that all wildlife in the end should be in the WCAs (Hillman J.C., 1993).

### 2.2.4 The Legal Structure for Wildlife Conservation

The laws of Ethiopia pertaining to wildlife conservation are detailed in Appendix 4.

### 2.2.5 Research

Wildlife research has provided the information necessary for decision making in wildlife conservation in Ethiopia. It was knowledge of the considerable number of larger endemic mammals and birds in the country that largely stimulated the initial interest by the New York Zoological Society (NYZS), UNESCO, IUCN, Wildlife Conservation International (WCI), and World Wildlife Fund (WWF) in Ethiopia, and led ultimately to the formation of the wildlife conservation Department, later EWCO, and the system of wildlife conservation Areas that exist today.

Currently, considerable research is being conducted into various aspects of wildlife, most of which seek to plan the conservation management of wildlife and its habitat. Current research work is detailed in Table 2.

Table 2 Recent and current wildlife conservation research on Ethiopia

Key: ANP - Awash National Park
ASLNP - Abijatta-Shalla Lades NP
BMNP - Bale Mountains NP
KMMNS - Kuni-Muktar Moutain Nyala Sanctuary
NNP - Nechisar NP
SMNP - Simien Mountains NP
SSHSct - Senkelle Swayne's Hartebeest Sct.
Ysct - Yabello Sct.

| | |
|---|---|
| General EWCO research | . Regular ground monitoring of larger wildlife species of parts of few wildlife conservation Areas, opportunistic data from dead animals, aspects of climate data collection<br>. Elephant survey & management recommendations |
| Specific EWCO resea. | ANP:<br>.Management planning<br>.Swayne's Hartebeest survival<br>.Vegetation growth parameters<br>.Oryx & Gazelle population dynamics<br><br>ASLNP:<br>.inventory and ecology<br>.lake level monitoring<br>.water table changes,<br>.vegetation productivity<br>.waterbird census<br>.socio-ecological survey<br><br>BMNP:<br>.Management planning 1986<br>.Harenna Forest Expedition1986<br>.Simien Jackal-ecology, breeding, dispersal, genetic rodents, vegetation with respect to rodents, managt.<br>.heather regrowth after fire<br>.Giant Lobelia growth dynamic<br>.Use of plants by local people |

| | |
|---|---|
| | .Wattled Crane |
| | KMMNS: .inventory and ecology<br>SSHsct: .Swayne's Hartebeest ecology and conservation<br>YSct: .management planning research<br>.bird inventory, observation |
| other instits. & individuals | BMNP:<br>.Leicester Univ. Expedition, use of mineral 'horas' 1990<br>.Ethiopian Flora Project, Harena Forest soil and vegetation stud.<br>.Ethiopian Flora Project, numerous flora studies<br>.Univ. Gottingen Univ., alpine flora studies, climate<br>.Univ.,copenhagen, flora & conservation studies<br>.Biology Dept., AA univ.,biology of Giant Molerat, 1986<br><br>NNP:<br>.Cambridge Univ. Expedition, inventory 1990<br><br>Menagesha Forest NP:<br>.Biology Dept., altitude zonation effectiveness of historical conservation<br><br>SMNP:<br>.Kyoto Univ., Gelada ecology & behaviour |

### 2.2.6. Support

The Ethiopian Wildlife Conservation Organization is a government department, and as such receives government support in the form of staff salaries, running costs, and capital grants for development.

In addition it has received assistance from other sources ever since its inception. These have mainly been international wildlife conservation agencies ( Non-governmental organizations - NGOs), with some limited foreign governmental assistance in addition. Much of the assistance has been linked to wildlife research, with more emphasis in the recent past in management-oriented research linked to the development of managerial skills and infrastructure.

Current level of support, both from government and from aid sources, together with incomes accrued due to wildlife conservation activities, is detailed in Appendix 5.

## 2.3 THE ETHIOPIAN GERMPLASM

The wide range of agro-climatic conditions and the Ethiopian farmers' traditional method of conserving and utilizing germplasm have contributed to the existence of crop genetic diversity in the country.

The existence of crop genetic diversity has special significance for Ethiopia whose predominant economic activity is agriculture. However, the broad range of genetic diversity that exists in Ethiopia, particularly that of primitive and wild gene pools, is at present subject to serious genetic erosion and losses due to various reasons among which displacement of indigenous landraces by exotic ones, predominance of genetically uniform crop varieties, changes and development in agriculture can be cited as most important factors.

The famine, for instance, that persisted over the years in some parts of Ethiopia has forced the farmer to eat his own seed in order to survive or to sell his seed as food commodity, and thereby posing the threat of massive displacement of native seed stock by exotic seeds introduced in the form of grains donated through relief agencies. This compounds the already existing genetic erosion.

The above problems together with the International Board of Plant Genetic Resources' (IBPGR) recognition of Ethiopia as one of the priority regions for collection and preservation of germplasm created the need for the establishment of a gene bank in Ethiopia, and as a result we have today the Plant Genetic Resource Centre/Ethiopia ( PGRC/E) to address the problems mentioned. It was established in 1976 with the following major objectives.

- To promote the collection, evaluation, documentation and scientific study of crop germplasm in Ethiopia, East Africa and adjacent regions.
- To preserve germplasm by longterm storage and maintenance in order to make valuable germplasm available to breeding programmes.
- To provide germplasm for breeding programmes aimed at the development of such characters as higher yield, better quality, disease and pest resistance.
- To provide new crop germplasm to Ethiopia by means of exchange with other institutions.

Accordingly, the main operational activities of PGRC/E are: collection of germplasm; conservation/maintenance;

evaluation and documentation; and exploitation of the genetic variability.

Through active collection, donations and repatriation of germplasm a considerable number of accessions i.e. about general current holdings of 53,399 (see Appendix 6 for details) and a large amount of information on them have been acquired by the PGRC/E. The information on current holdings is useful for:

- seed inventory, monitoring and handling (seed storage and testing file);
- assisting the Exploration and Collection Division to plan collecting missions by area, crop and time;
- planning and decision making in germplasm rejuvenation, multiplication and/or characterization;
- facilitating exchange of germplasm through the publication of lists;
- supporting plant breeders' use of germplasm by analyzing the data and publishing the available information in crop catalogues;
- helping the users of germplasm to make a ( first rough) selection from the available germplasm based on specific criteria;

- analyzing the available information on accessions and collection sites to predict possible areas where a germplasm with specific traits can be found;
- carrying out taxonomic analyses and classification using the characterization data; and
- identifying of duplicate accessions, unknown accessions.

# CHAPTER THREE

# SURVEYS AND ANALYSIS OF FINDINGS

## 3.1 SURVEYS

### 3.1.1 Introduction

In order to propose useful recommendations and an appropriate strategy for their implementation, it is essential that existing situations in the country in relation to biodiversity information sources, systems and services be analysed and assessed. Therefore, this chapter discusses surveys carried out on the following:

- Information users (their characteristics and information seeking behaviour);
- Biodiversity information needs;
- Biodiversity information sources; and
- Existing information service systems ( libraries and documentation centres together with the supporting facilities);

This chapter also discusses the analysis and findings/results of the surveys, the problems and constraints.

The methods used in the surveys have been discussed in chapter one under the methodology for data collection. These were interviews and discussion with key personnel; observation of the activities carried out; intensive documents surveys; and surveys using questionnaire (see appendix 7). The findings of the surveys are discussed qualitatively. The reasons for such treatment include:

-This study is essentially an exploratory one and matters are explained better in words than expressed in numbers;

-The questionnaire responses alone could not be depended upon and therefore should be supplemented with the information gathered through observation, discussion and interviews. In fact the latter methods provided greater insight into the situation than a mere questionnaire survey would have given.

### 3.1.2 Biodiversity Information Users

As the survey indicated, the following people and institutions represent the major users of information on biodiversity resources and biodiversity studies (here after called biodiversity information):

-Resource planners and policy makers;
-Conservation administrators and decision makers;
-Researchers ( including ecologists, biologists, taxonomists, zoologists, botanists, foresters, silviculture people);
-Academics ( instructors and students);
-People in charge of protecting the environment (such as, environmental engineers);
-International development agencies;
-Local healers and pharmaceutical companies';
-Agencies and people who are concerned with nutrition;
-Tourism agencies and tourists;
-Extension workers and farmers ( breeders);
-Private enterprises related to forest and forest products;
-Agencies and people who deal with forage;
-Ministry of information;
-International Wildlife Conservation Organizations and Genetic Resources Centers;
-Information storage, processing and disseminating centres and information personnel;
-General public at large.

As regards their characteristics, some of the users are highly educated in the fields related to biodiversity (ecologists, botanists, zoologists, silviculturist, foresters); some are, again, novice though they also specialize in an area with little relationship to biodiversity (like planners and policy makers, development agency individuals, and information people); and others are a little educated such as local healers, farmers, entrepreneurs. Differences in the knowledge and skills background of users is also reflected in the difference in terms of the the amount, quality, media for transmission, and presentation style required by the professionals, the para professionals, non-professionals and the general public. For instance, germplasm professionals are more interested on detailed data of characterization for each genetic variety, expressed in technical terms, and in printouts while farmers and entrepreneurs are most interested on the reproduction potential, power of resistance against hazardous situations, nursery techniques presented in a clear and comprehensible manner with even some demonstration on the field.

### 3.1.3 Users Requirement for Biodiversisty Information

From the survey again it becomes evident that the following general information need situations do exist:

- -information on habitats and ecosystems;
- -information on plant germplasm ( crops, forage, and forest tree seeds);
- -information on wild animals;
- -information on flora (trees, shrubs and herbs);
- -information on information services (documentary, institutional, and human sources).

To elucidate the above need situations further a discussion on each one of the above in relation to the purposes for which they are required and the corresponding user group follows:

#### 3.1.3.1 Information on Habitat and Ecosystem

The requirement for such information is to select and design reserves, manage and monitor developments of an established system of conservation; ensure and promote an effective and efficient system of landuse; identify the major wildlife components and their distribution. Conservation managers, resource planners and policy makers, tourism agencies, international development agencies and Wildlife Conservation Organizations are the major users of such information.

3.1.3.2 <u>Information on germplasm</u>

The group of users interested in germplasm information include: genetic resource centres, genetic resource centre managers, researchers, breeders, extension workers, and nutrition people/agencies.

The requirement for germplasm information is for taking appropriate management action on time, research, and utilizing germplasms by breeding in the field. Germplasm centre managers, for instance, want timely information on the level and life of base and active collection for deciding to rejuvinate and multiply before providing germplasms to breeders, respectively. Managers also want to know general current holdings and storage conditions for taking appropriate action in relation to storage space, the appropriate biotechnolgy to use, and arrangements for further collection programme.

Researchers, on the other hand, require data and information on the characteristics of the different genetic varieties in order to screen out those germplasms

with selected traits and conduct further analysis on crossbreeding/interbreeding.

Farmers and private entrepreneurs again require information on germplasm for actual use on their field and/or knowing the taxonomic classifications of a given germplasm, respectively. Finally, plant genetic centres abroad also want periodically information on current holdings in the country for planning and arranging exchange and disseminating updated information.

3.1.3.3 Information on Individual Fauna Species

Information on individual animal species is sought for:

- inventorying
- identifying and determining its habitat, requirement for food and water, shelter, mating and breeding;
- knowing its reproductive potential (no. of young/clutch per period normally);
- knowing its uses and values (economic, scientific, aesthetic, ecological);
- knowing the species status (endangered, common, endemic, rare, indeterminate) for drawing up and

implementing appropriate management and control mechanisms.

Users of such information are researchers, tourism agencies, and conservation organizations.

3.1.3.4 Information on Individual Plant Species

Information on a plant species is generally collected for inventory, management, ensuring and promoting sustainable development and utilization. The specific information are enumerated below:

- on taxonomic classification of a given plant species for inventory to provide baseline information;
- for the different known uses and values such as (agroforestry services and uses, economic uses, and cultural, aesthetic and ecological values);
- to know the appropriate ecology and habitat for its development;
- for the management requirement for its sustainable development;
- on the status of a plant (as endangered, endemic, common, rare, exotic, indigenous).

Institutions, such as, pharmaceutical companies, the National Plant Herbarium, ILCA, PGRC/E, FAO, International Board for Plant Genetic Resources Centers (IBPGRC), Forestry Research Centre (FRC), private botanic gardens and individuals such as botanists, foresters, silviculturist, extensionist, farmers, local healers, researchers, academics, and private entrepreneurs, information people constitute the major users of such information.

#### 3.1.3.5 Information on Referral Services

Information on such services are needed to identify and contact the documentary and institutional sources and expertise in the area. Information on documentary sources, institutional sources, directory of expertise are frequently requested for by researchers, students, instructors, information centres and information personnel.

### 3.1.4 Biodiversity Information Sources

Normally, information sources can be categorized into three as documentary, institutional, and human sources. In respect to these categories the survey revealed the following facts.

Though it is difficult to find the above sources in a systematized manner, documentary sources such as /books, periodical, research reports, databases, institutional publications, conference proceedings, maps, statistical reports, posters and brochures/, institutional sources like /PGRC/E, EWCO, Wildlife and Natural History Society, Forestry Research Centre Ethiopia (FRC), National Plant Herbarium and Natural History Museum, Ministry of Natural Resources and Environmental Protection, ILCA/ and specialists and expertise working in these institutions are good sources of biodiversity information.

### 3.1.5 Information Service Systems and Support Facilities for Biodiversity Information

Information service systems are the connectors which link users with sources. Efficiency and effectiveness of this linking will promote user satisfaction and ensure effective contact of users with sources. In order to evaluate existing biodiversity information service systems from this perspective, a discussion of survey findings for each of the institutions will be useful.

#### 3.1.5.1 Ethiopian Wildlife Conservation Organization (EWCO)

The documentation centre at EWCO is very resourceful. However, it is not as useful as it should be for various reasons among which the very limited space, inadequate staff (both in number and quality), and under-utilization of the information support facilities (one reprography and one micro computer) can be cited as major ones. The cumulative effect of all these results in poor service, that is, almost none of basic services of a documentation and information centre are provided. This situation presents special difficulties for external users.

#### 3.1.5.2 Ethiopian Wildlife and Natural History Society

As an institution established to encourage and support research concerning Ethiopia's flora and fauna and disseminate information for creating awareness among all the learned community (especially students at all levels), the society managed to have a mini-documentation unit where periodical publications entitled "AGAZEN", "WALIA", newsletters and posters, research reports, and wildlife related books are maintained. With regard to information support facilities, there is one microcomputer and one reprography machine.

#### 3.1.5.3 Ethiopian Forestry Research Centre

This centre has an information centre, the Forestry Research Library and Documentation Centre, with:

- a sizable document collection on general forestry and seed germination;
- four staff members (one professional, two subprofessional, and an assistant);
- five microcomputers which run applications like CDS/ISIS, Word Processing, Data Base III+, Lotus, Harvard Graphics, and Statistical Package;
- one microfiche reader, and
- a good layout and just enough space.

The centre provides services, such as, reference, database search (bibliographic and abstracts of research on forestry) though it was not operational during the survey, and selective dissemination of information through their FRC Newsletter to registered users. The Centre also claims to have other information delivery mechanisms, such as, extension services and exhibitions.

#### 3.1.5.4 Plant Genetic Resource Centre/Ethiopia (PGRC/E)

The PGRC/E has a library and documentation centre. The library consists of a large collection of documents on germplasm (crop, forage, forest tree seeds) and it is part and parcel of the documentation centre where important information is stored, processed, and retrieved for internal as well as external use. The total number of staff in both sections are eight of which two are professionals and the remaining ones are subprofessionals. The documentation centre has ten microcomputers running under MS-DOS and applications for Dbase IV, Wordperfect, Excell, Lotus, Foxpro and one minicomputer (AS/400 operating system and its program). Furthermore, the documentation centre is currently preparing for establishing a local area network. Though it has not become operational, this institution is proposed to act as a center to coordinate and supervise activities on biological resources at the national level.

The services provided by the Centre include: Reference, database search, reprography, current awareness (for internal users), and selective dissemination of information with its Newsletter entitled PGRC/E.ILCA NEWSLETTER. Information delivery mechanisms used by the Centre include magnetic tapes and diskettes and extension services besides the conventional types. Except that it is limited in its scope to plant germplasm, the centre is the best among all the institutions surveyed - it has qualified staff, adequate facilities, and provides better services.

### 3.1.5.5 Ministry of Natural Resource and Environmental Protection

Being a ministry office which coordinates and supervises the institutions mentioned above, it has a large information centre named as the Library and Documentation Service. It has five staff in total (two professional, two subprofessional, and an assistant). With regard to the information support facilities, it has one microcomputer with application software CDS/ISIS. The services provided by the facility are reference, database search (bibliographic), and reprography. This center was serving the Ministry of Agriculture before it came under the current Ministry. As a result, many of its collections are on agriculture and rural development with many have little relevance to biodiversity subjects.

## 3.2 ANALYSIS OF FINDINGS OF SURVEYS

Analysis of surveys revealed the following:

-All the institutions have a library and/or documentation centre though different in the size of their collection, space they utilize, number of staff and their qualifications, support facilities (information technology), and extent of services they provide. The PGRC/E library and documentation centre is well equipped in many respects and can be easily made to incorporate additional services required. It has collected and maintained different biodiversity information sources (published as well as unpublished) which would have been difficult otherwise to access. Moreover, this has created a convenient base to plan and arrange for exchange of materials and providing additional services. The existence of basic infrastructure such as buildings, materials, manpower, and machines and equipments indicates the importance given to collecting and maintaining biodiversity data by the institutions' authorities, though much more needs to be done.

-While all the institutions surveyed are performing related tasks, there is little coordination and interrelationship among them. As a result, it is hardly possible to find comprehensive and an organized biodiversity information at any of the institutions surveyed. On the other hand, since there is no means of knowing what work has already been done or being done by others, there is a great chance of duplication of effort and wastage of resources which could have been minimized had there been coordination and mechanism for information exchange.

-The services currently available at all the institutions except at PGRC/E are all conventional ones and as a result do not satisfy the range of biodiversity needs mentioned in section 3.1.3. Computer databases to respond to queries on biodiversity components ( wildlife species, ecosystems and habitats, plant germplasms) and referrals (information on documentary, institutional, and human sources) are not available. On the other hand, biodiversity information sources exist, though it is difficult to have easy access to them. In brief, there are problems with the links between sources and users. Further analysis of the problems revealed the following constraints:

(1) lack of trained personnel;
(2) little professional incentive to employees in charge of documentation and information centre;

(3) lack of adequate finance;

(4) lack of necessary software packages and standardization problem among systems in use in the institutions mentioned;

(5) lack of perception or awareness of the importance for improved information system by the management and the community at large;

(6) inhibiting policies (such as free exchange of information on germplasm and acquisition of materials and equipments freely from outside sources).

In the hope that the above problem situations and constraints will be addressed by the concerned authorities, it is the belief of the researcher that the current information services can/will be improved if databases for (1) Conservation Areas, (2) Wildlife species ( useful fauna and flora), (3) Plant Germplasm (crop, forest tree, and forage seeds), and (4) Referrals (documentary, institutional, human sources of information) are designed, developed and put into service. The design of the prototypes for the above databases are discussed in the succeeding chapters.

CHAPTER FOUR

DATA BASE DESIGN

## 4.1 INTRODUCTION

### 4.1.1 Design of a Computerized Information System

The main purpose of a computerized information system is to make information available to the users according to their needs. An important aspect of systems design, in this respect, involves establishing the database(s). It consists of three phases (Rao 1991).

(1) Assessing the feasibility of the system;

(2) Designing the database;

(3) Organizing access to the information system (for users).

#### 4.1.1.1 Assessing the Feasibility

System feasibility is a test or evaluation of the complete system plan. Such an evaluation is necessary to define the application area along with its extent and complexity, to provide the scope of computerization together with suggested output and input formats and potential benefits. To establish that the proposed system is feasible, the following criteria may be applied (Rao 1991).

(1) Ability to meet user needs

(2) Use of resources to generate benefits

(3) Workability of the system

The first criterion about user needs can have multiple forms. In many cases, users' needs change and grow; users' needs can be determined by a thorough systems study or by comparing the system (to be computerized) to a similar one which has already been computerized.

The second criterion is a comparison of resource benefits against resource investment (cost benefit analysis). As far as human resources are concerned, what needs to be determined is whether the computerized system optimizes the use of available human resources. While implementing the computerized information system, it may be necessary to upgrade the skills of the existing personnel, so that they can handle input scheduling, checklist correction, output monitoring, etc.

The third criterion is basic to the first two feasibility criteria mentioned above. In order to find out whether a system's plan is workable, development of a working model or prototype is involved on a limited basis. A test can be conducted by adjusting the workability of one or more aspects of the total system.

#### 4.1.1.2 Design of Database

A database is a mechanized, formally defined, centrally controlled collection of data in an institution /organization. The data records are physically organised and stored so as to promote shareability, availability, evolvability, and integrity (Davis and Olson 1985).

Database design is the process of arranging the datafields needed by one or more applications into an organized structure. The two parts of the process are logical database design and physical database design.

Logical database design is an implementation independent exercise that is performed on the fields and relationships needed for one or more applications. It describes the users' view of data.

Physical database design is an implementation-dependent exercise that uses the results of logical database design and further refines them according to the characteristics of the particular database management system in use. The selection of a physical database structure such as the indexed sequential or direct access method of the DBMS to be used is, for instance, part of physical design activity.

Careful database design is essential for a variety of reasons including data redundancy, application performance, data independence, data security, and ease of programming. All are important factors in the data processing environment, and all can be affected adversely by a poor database design (Brathwaite 1988).

The two most common database design methodologies are data normalization and data structuring and the entity-relationship methods. The first methodology is representative of a class of methods that take as input a list of fields and the associations among those fields. The second method, the entity-relationship method, is representative of the class of methods that take entities and relationships as input.

Database design using the entity-relationship model lists the entity types involved and the relationships among them. This method has been used in designing the prototype databases.

While designing a database, it is necessary to know the source of information, characteristics and the purpose for which data are collected and stored. For instance, sources can be single, or multiple and need careful identification by the analyst in the design process. In this connection, there are some questions to be answered about the accuracy and reliability of data inputs. These are:

(1) Whether the data are of real interest and important to the user
(2) Whether the intended use of data is potentially threatening to the source
(3) Whether the required preparation of input throws an additional burden on people at the source

Characteristics of data bases are determined by size, variability, volatility and activity. The size of a database has obvious implications in selecting the media in which the information is stored (tape or disk). The nature of processing is also determined by the size (such as avoiding sort/merge operations). Information which has shorter "life" may be stored on current transaction files. On the other hand, information which has a longer life may be stored in the master file on tapes/disks. If changes are made too frequently, the database is said to be volatile; otherwise it is called a static one. Costly storage space on disks can be released by keeping a careful watch on the volatility of information.

4.1.1.3 <u>Access to Information</u>

The methods for organizing and accessing information in a database are built around data records. Files may be organized in several ways, depending upon the requirements and the availability of appropriate hardware. The design of a system includes preparing a record layout which places together related data elements.

4.1.2 <u>Development of Information System</u>

After considering all these design aspects, the system analyst guides the programmer to develop the necessary software. This again depends on the operating systems and the hardware.

It is necessary to understand, at this stage, the physical flow of the data and their usage. The last step in the development process is full scale implementation together with comprehensive training and instructions to the user. Adequate user education is a must for the successful running of any computerized system, which can comprise of input preparation, checklist correction and output monitoring, at the working level, and general appreciation at the higher level.

## 4.2 DESIGN OF PROTOTYPE DATABASES

### 4.2.1 Scope of the Design Work

The scope of the design work is limited to database design with some attempt to assess feasibility and indicate possible strategy for developing and implementing it.

The procedures adopted to design the prototype databases are

- -statement of design objective
- -identifying and defining constraints and requirements
- -defining the entities on which records are to be maintained
- -identifing and describing the attributes for each of the entities defined (its information potential, its data source, and the valid values it can take)
- -Creating the database as per the constructs

provided by a database management system which in our case the micro CDS/ISIS version 3.03.

### 4.2.2 Design Objective

The objective in designing the prototype databases is to demonsrate provision of information on conservation areas, individual plant and wild animal species, plant germplasms, and referral services.

### 4.2.3 Requirements of the System to be Designed

Defining requirements is both logical and essential since they are basis against which the system's efficiency and effectiveness is tested and evaluated. Therefore, considering the above general objective and some other factors revealed during the survey, the system to be designed shall fulfil the following requirements:

- -the system should not frustrate current as well as potential users i.e. it should be convenient and easy to be used by an ordinary people
- -the system should not create much burden on data entry people
- -the system's outputs should be meaningful and presented in a way users can understand easily

-the system should not be too expensive as compared to the benefits it promises to give

-the system should be able to accept various queries on conservation areas and wildlife; process them and provide for timely, accurate, and relevant data; generate periodical reports useful for conservation administrators and managers

-it should also be able to accept queries on documentary, institutional, and expert profiles and provide for bibliographies and directories on the screen or in printout

-it should also be able to generate labels for the plant and animal specimens, inventory lists of plants and animals; and finally

-it should be able to provide selective information dissemination (SDI), current awareness services, abstracts and indexes, and information analysis and consolidation services.

### 4.2.4 Constraints

Constraints that require to be considered during the design and implementation activity are:

- lack of trained personnel to collect, extract, index and catalogue various sources; ready them in a form proper for the databases; accept queries or transactions and manipulate the databases accordingly; administer the databases; design and develop necessary programs;
- lack of finance and the appropriate machines and equipments;
- absence of a conducive environment to develop and get the service from databases (that is to say users' and institutions' authorities awareness of the value and use of information and computer is not up to expectation);

The above situations, if overlooked in the design and development activity, can limit the systems' use to provide the services promised.

### 4.2.5 The Entities/Data Stores

An entity is defined to be an object, real or imaginary, which can be thought of as having a distinct and identifiable existence. Entities are the objects which underlay all corporate functions. The data collected and processed within the organization represents the information about those objects relevant to the institution activities (Brathwaite 1988).

Entities can be described in terms of their attributes. Different views of the same entity can be obtained by selecting different attributes of that entity. A collection of attributes which provide a complete description of an entity in a particular role is called an entity class. The objective of data modelling is to identify the complete set of attributes which make up an entity class. Once an entity class is established, it can be viewed as the formal definition of a conceptual object which exists in its own right and interacts with other conceptual objects through well-defined entity relationships (Brathwaite 1988).

From the survey analysis (see chapter 3), the following entity types were identified:

- -Conservation Area (National Park)
- -Wild animal species (Fauna)
- -Trees and shrubs (Flora)
- -Documents, Institutions, and Experts which are together called reference and referral entities.

### 4.2.6 Attributes and their Definition

The attributes (of interest to potential users of the information systems) relating to each of the selected entities were identified and defined. An attribute is any property or characteristic of an entity which, individually or in combination with other attributes, provides description or view of the entity tailored to a particular environment (Brathwaite 1988). Attribute definitions describe both the coding schemes associated with an attribute and the role served by the attribute in relation to its parent entity. The components of an attribute definition include

- -The primary name and aliases used to reference the attribute verbally and in formal documentation
- -General descriptive information about the attribute

10. NUMBER OF ENDEMIC RECORDED

Known endemic animals conserved in the national park (only birds and mammals). Data for this attribute can be found in the wildlife compendium of EWCO.

11. OTHER NATURAL RESOURCE USES

The different uses and services a given national park provides for the local people and the country as well (fuelwood, hotspring, fishing, ranching, charcoal, timber production, etc.,).

12. TOURISM MATTERS

Matters found in a given national park and considered relevant for tourism such as beautiful scenery, visitors accommodation facilities, transport facilities, information facilities, etc.). The EWCO as well as the Ethiopian Tourism Commission are sources of data for this attribute.

13. MANAGEMENT ASPECTS

Matters that require the immediate/frquent attention of the manager in charge of the national park or national parks in general. Items to be included are permanent staff in the national park. rest houses. transport facilities. developing accommodation facilities, etc.

14. DESCRIPTORS

Key words/terms for use in information retrieval.

15. REMARKS

Important and useful matters left unexplained in any of the above categories may be included here.

The above attributes together with the corresponding values make up the TPARK DATABASE. The attributes are selected considering both data availability and the difficulty in handling when attributes become too many.

4.2.6.2 Attributes for the Plant Database (TFLORA DATABASE)

1. FAMILY

The plant family where this is known. This together with the scientific name can be filled in later after identification at the National Herbarium or after consultation with an expert.

2. SCIENTIFIC NAME

The Latin or Greek name: use of this name avoids any confusion with other species of the same local or vernacular name; hence this attribute is selected as record identifier.

3. VERNACULAR NAME

The vernacular name used by local people, or the common English name used to describe the plant. The language used is added in brackets after the name. There are good lists of vernacular Ethiopian plant names in several languages proposed by Azene Bekele Tesema, which is also helpful in finding the scientific name from the vernacular.

4. LOCALITY

The local name of the area, and conservation area, so that the place can be identified and located in a map.

5. ECOLOGY

Information regarding the occurrence of each species in the various agro-climatic zones, the altitude range, specific niches in the landscape, soil preference, occurrence of drought, vegetation types of the environment, the climate, etc.

6.USES AND SERVICES

Uses, utilities and services known for the plant - whether it is used by people in the area, and for what purpose (agroforestry, food, fuel, building, medicine, basket making, etc..), or by animals as food, nesting material, shelter etc.).

7.DESCRIPTION

A brief description of the plant itself including its type (grass, herb, climber, shrub, tree), approximate height, flower and bark colour, how common it is in that place, how it appears, the bark, flower, leaves and fruits, plant morphology (thorny/spiny, single stemmed, multi-stemmed, open canopy, deciduous dry season, evergreen,etc.)

8. PROPAGATION

The natural as well as suitable propagation methods (natural, or by direct sowing, seedlings, stake cutting, suckers, air layering, stumps, grafting, root stock, etc.)

9. SEED INFORMATION

Information on the number of seeds per kilogram, seed storage and pre-sowing treatment for those trees and shrubs which are propagated by seed.

10. SEASONALITY

The length of time the plant becomes viable (perennial/long lived, annual, biennial/short lived).

11. MANAGEMENT

Suitable management techniques to be applied to optimize tree and shrub products and services and reduce any negative effects such as coppicing, pollarding, trimming, lopping, prunning, etc.

12.PLANT STATUS

The number of and the state under which the plant species is found (endangered, common, rare, endemic, exotic, indigenous, indeterminate as to their number, range, and threat situation)

13. REMARKS

Any other useful or interesting information that does not fall into the above categories.

14. DESCRIPTOR

see attribute no.14 of TPARK database.

15. REFERENCES

Documentary and other sources of information about the plant should be entered in the reference database.

### 4.2.6.3 Attributes for the Wild Animals Database (TFAUNA DATABASE)

1. ORDER

Classification order to which an animal belongs or simply categorize as mammal, bird, amphibian, or reptile). The order of classification can be filled in later by consulting experts.

2. SCIENTIFIC NAME

see attribute number 2 of the plant database.

3. VERNACULAR NAME

see attribute number 3 of the plant database.

4. LOCALITY

see attribute number 4 of the plant database.

5. DESCRIPTION

Physical description of the size, shape, colour, basic temperament, interactions with its peers and the environment/habitat it prefers mentioning such items as altitude range, and topography (roughness of terrain and slope). surface drainage (poor. seasonally wet, well drained. etc):

6.ECOLOGY

The conservation area or ecological zone to which an animal belongs. If the locality field is filled in, this can later be filled by consulting the Ethiopian Wildlife Conservation Organization (EWCO). Peoples intervention in respect to the animal of interest is also entered in the field.

7. HABITAT

The kind of vegetation (grassland, swamp, riverbank, bush, forest, cultivated area etc) and terrain (flat, sloping, willy, mountainous, gorge, desert, etc.) where the animal is found.

8. FOOD AND FEEDING

The main food items/diet the animal feeds on, when does it search for its food (during night or in day time), its feeding behaviour(in group or privately), how it catches and kills prey, etc.,. This will help to carry some analysis, for instance, the specialized nature of its diet can be analyzed as traits of vulnerability. The data sources to fill this field are published and unpublished research outputs. This is a protected information which will be filled in when sources become available.

9. TERRITORY AND HOME RANGE

The defined area delineated for peers of this species that serves for the provision of adequate food, a mechanism for establishing and maintaining the pairing bond, regulation of population density, reduction of interference with breeding activities, reduction of predation losses, and reduction of infectious-disease transmission. Information on the area over which an animal habitually travels while engaged in its usual activities and if possible aspects of social structure, is also entered in this field.

10. SPECIES STATUS

The total number of species estimated to exist and their status (endemic, rare, common, endangered, indeterminate as to their number, home range, being under threat). EWCO is a good source on this attribute.

11. SPECIAL TRAITS

The capacity to tolerate stresses/undesirable happenings such as drought, heat, disease and parasites, etc. This attribute field is also to be filled in after consulting documents e.g. research reports.

12. BREEDING POTENTIAL

The number of young/ clutch size normally produced and the courtship and mating habits. Low biotic potential, for instance, puts at stake the long term viability of the species.

13. USES

The different uses and services reported or claimed to be obtained (nutritional, aesthetic, ecological, economic, recreational, medicinal, scientific, etc., values)

14. SOCIAL STRUCTURE

The friendship and neighbourhood habits of the animal in question with/and across its genetic group.

15. MANAGEMENT

Important management strategies drawn and/or to be drawn and actions taken and/or to be taken such as protective laws e.g. Convention on International Trade for Endangered Species (CITES), prudence in the introduction of exotic species, predator control, habitat development, identify the habitat for the endangered species and map its distribution for monitoring, etc.

16. TIME TO VISIT

Convenient time (month and hour) when an animal of interest can be seen.

17. REMARKS

Any other useful or interesting information that does not fall into the above categories.

18. DESCRIPTOR

see attribute number 14 of the plant database

18. REFERENCES

see attribute number 15 of the plant database

### 4.2.7 The Referral Databases

The entities considered under this include documents, institutions, and experts. The reason for maintaining record for these entity types is to respond to the needs for referral services as revealed during the survey and to meet the design requirements.

Databases for these entity types are treated differently from the previous types. The reason for this is the existence of a model database structure, ABNCD, already developed to handle design activities involve for each one of these entities.

ABNCD is a prototype for an integrated information storage and retrieval system developed by a group of students of the School of Information Studies for Africa, Addis Ababa University (Abebe et al 1992). The model is designed to incorporate records for the following entity types:

- -Documents/bibliographical records of various types such as books, reports, conference proceedings, analytics of monographs, analytics of serials);
- -Profiles of institutions, research projects, information systems and services, and experts.

For the sample record output from the database see app.8.

### 4.2.8 The Database Management Software Used to Design the Prototype Databases

In order to demonstrate some of the services and products that can be generated from computer databases of the entities discussed, the selection of a DBMS is crucial. The particular software selected for use in designing the prototype databases is the Micro CDS/ISIS (or MicroIsis) version 3.0+. MicroIsis is a generalized DBMS package designed for the management of machine-readable textual databases, i.e. to build, manipulate, maintain, and retrieve records from such databases.

MicroIsis is a DBMS software package developed by Unesco and distributed free of cost to non-profit organizations especially in developing countries. Since the release of the first version of the software in December 1985, some twenty thousand copies of it are reported to be in use in different countries of the world, in Europe and developing countries in particular [International Classification 1993]. Surveys by the Pan-African Development Information System (PADIS/United Nations Economic Commission for Africa) [PADIS 1989, 1991] indicate a significant increase in use of the software in Africa. And the situation is similar in other developing regions of the world.

Although Micro-Isis was initially intended and used for designing and developing bibliographic databases, it is now being used increasingly in developing also factual databases and Object-oriented databases [Neelameghan 1992c]. MicroIsis enables:

- defining of databases containing user selected fields and data elements:
- entering new records into a given database;

- modifying, correcting and deleting records in a database;
- automatic creation of fast access files, such as inverted files (index files) for any or all of the words or combination of them in any or all of the fields in each database applying eight different indexing techniques;
- retrieval of records from a database using simple or complex (including Boolean, adjacency and other operators) search expressions;
- displaying the list of terms in the index file facilitating selection of terms to formulate search expressions;
- displaying the number of hits for each component of the search expression;
- re-execution of earlier search expressions in the same or other databases during a search session;
- displaying/printing out of records from a database as per user defined formats;
- printing out an entire database or retrieve records
  . some or all the retrieved records and/or
  . indexes of a database;
- exchanging or merging of records of two or more databases that are in compatible formats (e.g. ISO 2709 format); and
- enhancing the software's capabilities through

programs written in CDS-ISIS Pascal language, for example, development, maintenance and use of controlled vocabularies, multiple databases search, retrieval and display, online public access catalogue, etc.

The systems restrictions currently in effect are:

| | |
|---|---|
| Maximum number of databases | Unlimited |
| Maximum number of records in a database | 16 million |
| Maximum record size | 8000 B |
| Maximum number of fields defined in the Field Definition Table (FDT), excluding repetitions of repeatable fields | 200 |
| Maximum number of lines in the Field Select Table (FST) | 200 |
| Maximum Field size | 8000 B |
| Maximum number of fields in a page of worksheet | 19 |
| Maximum number of pages in a worksheet | 20 |
| Maximum format work area | 8000 B+ |
| Maximum size of a display format | 8000 B* |
| Maximum number of stopwords in a stopword file | 799 |
| Maximum field size in a worksheet | 8000 B |
| Maximum number of characters in a search | |

| | |
|---|---|
| expression | 250 |
| Field tag number | 1 to 32,767 |
| Maximum length of sort keys | 256 B |
| Maximum number of literals | 132 B |
| Maximum HIT record size | 4000 B* |
| Maximum number of identifiers in an ISIS Pascal program (including all programs called by USES statement) | 10000+ |
| Maximum number of loaded programs | 10 |
| Maximum number of real constants | 200 |
| Maximum Pascal run-time stack | 2000+ |
| ISIS Pascal dynamic string area | 16932+ |

(* applicable to version 3.0)

(+ see Expanded Memory Manager below)

MicroIsis version 3.0+ supports multi-user local area network (LAN) that is, simultaneous access to a database by several users for data entry and searching. However, certain functions, such as master file backup/restore, inverted file updating and import and export of records operations may be performed by a user only if no other user is writing to the database at the same time. For ensuring this, appropriate 'locks' are provided. Similarly, the system will not allow the modification of a record which is at the same time being modified by another user. To operate in LAN mode, parameter 14 in the

SYSPAR.PAR file or parameter 0 of file DBN.PAR should be set to appropriate value (see below).

A facility is provided to redefine the graphic characters for boxes of type 1 (single line box) and of type 2 (double line box) by modifying parameters 11 and 12 respectively.

Parameter 13 enables Expanded Memory Support. The Expanded Memory Manager (EMM) is used to expand the amount of memory available to the software. The system restrictions affected by EMM are as follows:

| | Without EMM | With EMM |
|---|---|---|
| Maximum number of instructions in ISIS Pascal program including all programs called by the USES statement | 10000 | 16383 |
| ISIS Pascal Runtime stack | 2000 | 16000 |
| ISIS Pascal dynamic string area | 16932 | 49500 |
| Format work area | 8000 | 32767 |

A DOS command can be executed from any menu of MicroIsis by pressing f6 key.

New commands have been introduced in the print format specification; for example, NC(n) to move to a new column and NP(n) to skip to new page.

New indexing techniques (5,6,7,8) permit a prefix to each index term extracted by using the existing techniques 1,2,3 and 4 respectively. For example, if tag 24 is for Title field and TI= is to be prefixed to each word extracted from the title, specifying indexing technique 4 in the FST

```
24 4 "TI="v24
```

will prefix TI= only to the first word extracted from the title. On the other hand, if the specification in the FST is

```
24 8 '\TI=\',v24
```

then TI= will be prefixed to each word extracted from the title.

Using <PgUp> key in the Dictionary of Terms display (with option T in the Information Retrieval Services menu) backward paging upto fifty screen pages of the index file from the page from which the last term(s) is selected is now possible.

A new option H in the print menu permits the loading or conversion of a hit file into a master file. This facilitates the production of certain types of indexes, such as, the use of different subfields of the same repeatable field in different sort keys, which was not practicable with earlier versions.

Further, the capabilities of MicroIsis can be enhanced with programs written in CDS-ISIS pascal language. Some of the available programs useful in the present work include the following: Thes1.pas, Thes2.pas and Theshi.pas to interface MicroIsis databases vocabulary control tools such as thesauri (e.g. AGROVOC of FAO, MACROTHESAURUS of OECD, the environment Thesaurus UNEP, etc.) and SISA.PAS, VOCON.PAS, and DEA.PAS for indexing and on-line retrieval purposes.

The above features together with other facilities for database creation, maintainance and production of information services and products makes the software attractive for use in designing the TPARK, TFAUNA, TFLORA and Referral databases. The less volatile and qualitative nature of the records to be maintained in the databases also make the software more appropriate.

#### 4.2.8.1 The TPARK,TLORA,TFAUNA Databases

##### 4.2.8.1.1 *Introduction*

As there are several fields holding similar data in the TPARK, TFAUNA, and TFLORA databases, a single Field Definition Table is prepared, with three different online worksheets, a single FST for indexing purposes and a single display format. This has advantages in optimal use of computer resources, searching in different types of records simulataneously, without compromising on other capability of the system. As mentioned in section 4.2.7, the model selected for the referral database is an integrated one. For the database outputs, the display format, and the field definition table see also appendix 8.

## 4.3 PLANT GERMPLASM DATABASE IN USE

### 4.3.1 Introduction

Plant Genetic Resource Center/Ethiopia (PGRC/E) has a database already developed and currently in use. It provides services relevant for internal as well as external users. In view of this, the discussion in this section highlights the features of a typical genebank /based on the PGRC/E databases. The features considered are:

- -activities of a typical plant genebank
- -specific information needs and/report requirements of a genebank
- -types of information required in a genetic resources centre to maintain and distribute seed accessions
- -data to be maintained by a genebank
- -important descriptors for use by genebank managers, and
- -files and descriptors maintained at PGRC/E

These aspects are considered with the view to evaluating and then proposing recommendations on the current working of PGRC/E.

### 4.3.2 Genebank Activities

Organization of the various steps in a genebank process; culminating in a co-ordinated sequence of events and well-documented, stored germplasm is the essence of the genebank curator's work. Essentially this entails the acquisition, storage, and documentation of new material; the monitoring and maintenance of extant collections and the dissemination of information and germplasm to users (Astleys 1986).

The genebank curator carries out many tasks in order to properly conserve and distribute the germplasm. Data are generated in the course of these activities and the data must be stored and utilized in planning, implementing, and monitoring. The four core operations performed within a typical genebank are:

1. Banking: The introduction/incorporation of seed accessions into the seed store and the compilations of inventory lists;
2. Monitoring: Ensuring that accessions are maintained according to standards;
3. Regeneration: The production of a fresh stock of seeds from accessions maintained in store;

4. Distribution: The filling of requests for samples of seeds.

#### 4.3.2.1 Introduction of Germplasm

Germplasms enter the genebank from different sources and acquisition channals such as, field collecting missions, acquisition (by purchase), and donation. The sample will then be subjected to a series of processes in the genebank (verifying correctness of the collection information with the sample; test for acceptable level of moisture; test for cleanness from disease (quality), acceptable level of quantity for storage, and duplication of sample in the genebank). Depending upon the test results, appropriate actions, such as, registering the nature of the disease, disease eradication, short-term storage, or ignoring the sample are taken. Storage is made in two forms i.e. as base collection and active collection. Samples stored as base collection remain intact unless extraordinary events occur and make situations compelling. Samples stored as active collections are, however, to meet requests for samples by breeders, researchers, and other genebanks.

#### 4.3.2.2 Maintenance

The three inter-related activities involved in the maintenance of samples are storage, monitoring and regeneration. These naturally require data stored for management to use as an aid to decision making in running the genebank.

The storage of the accessions provides data important for management e.g. number and location of separate samples of the same accession, type of container used for each and information on where duplicate samples are stored in other genebanks. It may also be helpful to know where accessions are duplicated in active collections in order to redirect seed requests or to reintroduce accessions which have been lost.

Seed viability should be monitored during storage to detect decline in viability and to schedule regeneration of accessions. The period between monitoring tests depends on the normal storage characteristics of the species, the quality of the seeds at the start of the storage period and the storage conditions employed. The number of test results included in a data base should be limited to keep the data manageable. As a minimum the results of both the initial and most recent tests should be recorded and if further information is required for special cases it could be sought from the original paper data files.

When viability begins to decline or seed quantity falls below a critical level the accession is usually regenerated. A regeneration standard, i.e. the percentage germination at which regeneration is necessary, should be set for each crop using information about the usual longevity period and effects of deterioration on genetic change for that species. The IBPGR Advisory Committee on Seed Storage has recommended that a regeneration standard should be agreed for each species, although genebanks are expected to obtain advice from experts on individual crops in order to make decisions. A regeneration standard at 85% true viability has been taken as an acceptable level for the majority of species of crop plants (Hanson, Williams and Freund 1984).

The environment for the regeneration must be chosen with care to minimize selection procedures during the process and maximize quantity and quality of seeds obtained. The most suitable technique for a particular species will also depend on the breeding system and population characteristics of the original accession. Each time the accession is regenerated a new sample of that accession is considered to have been formed; it should not be mixed with other samples and a complete set of data specifically referring to it should be available.

4.3.2.3 Distribution

Seed samples are distributed to users only from active collections (i.e., not base collections). When accession is available only from a base collection, the accession is usually regenerated before supply to the user. Data regarding the accession numbers provided, quantity, recipient and purpose of the distribution is usually stored for reference in order to determine where and for what purpose the material is used and to allow statistical reports to be prepared about the operations of the genebank. It may also prove to be important to know where an accession has been distributed so that in case of loss the accession can be reintroduced into the genebank.

Information on the origin and characteristics of the accessions and technical data on germination procedure and regeneration should be extracted from the data base and accompany the germplasm. Feedback from the recipient regarding either the condition of the seeds or the characteristics of the accession should be entered into the database. These data should be stored in a way that relates them to the other data on the same accession.

#### 4.3.2.4 Characterization and Evaluation

Characterization and evaluation of the germplasm are important for the proper utilization of the germplasm by scientists and plant breeders. While these data are particularly important for the user and for the management and regeneration of the germplasm, they are not vital for day to day running of the seed store. The data are used for preparing lists of those accessions which have been or will be grown out, following assignment of priorities by the curator. They are also referred to before attempting regeneration, in order to select the most appropriate method and conditions.

### 4.3.3 Information Required with in Genetic Resources Centres to Maintain and Distribute Seed Accession

#### 4.3.3.1 Information on Accessions Required in all Genebank Core Operations

(1) Accession Identification

The accession identification number is required to link the seed accession in the genebank to all the information held on that accession. It is thus essential that a number is allocated as soon as the accession and accompanying information are received.

The identification of species must be verified in order to ensure that within the genebank suitable seed germination test procedures and seed regeneration environments are provided and that the accession is correctly identified on the seed list for distribution purposes, but verification should not delay the banking operations. In some cases, the identification of the accession may need to be altered at some time after the initial receipt of the accession.

(2) <u>Number of (true) Seeds</u>

The estimate of the number of seeds within the accession is a vital piece of management information and will determine:

(a) whether the accession can be accepted into long term storage without prior multiplication (if viability is acceptable);

(b) the distribution policy for the accession;

(c) the number of seeds available for monitoring tests;

(d) how much space is required for the accession within the long-term seed store; and

(e) the date of next regeneration.

The number of seeds will require constant updating to prevent the accession becoming depleted. The estimate is likely to be derived from the total weight of seeds divided by an estimate of mean seed weight adjusted by an estimate of purity. The rules of the International Seed Testing Association (ISTA) provide a reliable method for deriving an estimate of 1000 seed weight from which the mean seed weight can be calculated, but in addition good management would ensure that a check is made that the estimated number of seeds remaining is reasonable when accessions are monitored and/or a sample distributed.

(3) Accession location within the store

Locating accessions is essential for all core genebank operations. For various reasons some accessions will be depleted in size (e.g. through distribution) or removed (e.g. discarding duplications): thus empty spaces will occur within the store; and these should be filled to make optimum use of the space available.

(4) Viability

The viability of accessions, /that is, the proportion of true seeds in the accession which are estimated to be alive and capable of producing plants,/ is a key factor affecting genebank operations. The viability of the accession will determine whether the accession requires regeneration, whether it can be put on the seed list, the potential storage life of the accession and hence indirectly how frequently accession viability should be monitored. The estimate of accession viability will require periodic updating; it should show the result of the most recent accession viability monitoring test.

#### 4.3.3.2 Information on Accessions Derived During Their Incorporation into Collections

The objective of this operation is to incorporate each accession into the long term seed store as soon as possible in order to reduce to a minimum the loss in viability and reduction in potential seed longevity which can occur during the period preceding incorporation into the long-term store. Before considering what accession management information is required during this operation, it is necessary to determine a sequence of the component activities, for example, as shown in Table 4.1. The accession is placed in the drying room immediately upon receipt and should be entered into the long-term seed store as soon as possible thereafter. When all the information on accession quality is available, the accession is added to the seed list and becomes available for distribution.

Table 4.1. Sequence of component operations to incorporate accessions:

| ACTION | INFORMATION | PRECAUTIONS |
| --- | --- | --- |
| RECEIPT | Allocate serial number, Date of receipt. | Insect infestation? Seed treated chemically? Do seeds and documentation match? |
| VERIFICATION | Despatch all relevant collection information together with herbarium specimens to taxonomist. | |
| DRYING | Location in drying room. | Open container to allow seeds to dry, but prevent mixing of separate accessions |
| THRESHING | Cancel location in drying room, add date of threshing. | Keep discarded material for seed health analyses. |
| ESTIMATE MOISTURE CONTENT | Record moisture content. | If seeds too moist for long-term storage then return to drying room for further drying |
| CLEANING | Provide estimate of number of seeds within accession. | Keep discarded material for seed health analyses. |
| PURITY | Provide estimate of empty seed fraction, reduce estimate of total seed number. | If too many empty seeds then return for further cleaning. |
| PACKAGING | No. of containers, type of container, batch no. of containers. | |

| | | |
|---|---|---|
| STORAGE | Date of storage, location in store of all containers. | |
| ESTIMATE ACCESSION VIABILITY | Record all Details of the test(s), | Sample seeds at random, overcome seed dormancy in germination tests. |
| | Reduce estimate of total seed number by number of seeds removed to estimate viability. | |
| | Estimate regeneration interval, decide date of first monitoring test. | |
| ADD TO SEED LIST | Allocate accession number, indicate distribution policy, no. of seeds available for distribution and monitoring and minimum no. of seeds required for regeneration. | Do not add to seed list if insufficient seeds, insufficient viability verification of species not available. |
| DESPATCH SAMPLE FOR DUPLICATION | Record institute at which accession duplicated, despatch all information with duplicate sample. | duplicates existing accession or outside remit of the collection. |

#### 4.3.3.3 Information on Monitoring Accessions and the Long-Term Seed Store

The management of shelf-space within the store interacts with the management of individual accessions. The location of each accession (and if the accession is contained in several containers, the location of all containers) must be documented in such a way that this information is easy to retrieve. It is an important function of management to make full use of all storage space available. Consequently, it is necessary to know where the empty spaces occur on shelves in order that new accessions can be allocated a bank location until every location is occupied.

The items which require monitoring from time to time are: (1) the location(s) in the store; (2) the number of seeds; (3) the moisture content; and (4) the viability.

There are four topics concerning seed viability which must be covered at this point. Firstly, when monitoring accession viability during storage it is necessary to be able to refer back to the results of all previous tests of viability for this accession - and particularly those carried out initially - to ensure that the most suitable conditions for germination and breaking dormancy are provided within the monitoring test.

Secondly, it is necessary for the conditions and the results of this accession viability monitoring test to be recorded and for the previous estimate of accession viability to be overwritten with the current estimate.

Thirdly, this estimate has been derived for the purpose of making a decision as to whether or not the accession can be maintained in store until the next monitoring test date or whether the accession now requires regeneration.

Fourthly, the estimate of regeneration interval and the intended monitoring test date must be provided once the result of the initial accession viability test is known and before the accession is added to the seed list. The reason for this imperative is to avoid the possibility that accessions are added to the seed list with no allowance made by management to ensure their maintenance.

#### 4.3.3.4 Information on Accessions Required for and Derived During Regeneration/Multiplication

Accessions require regeneration as a result of low viability or insufficient number of seeds. Thus the information which triggers regeneration is either the estimate of viability or the estimate of the number of seeds remaining in store. The first action must be to indicate the temporary unavailability of the accession on the seed list. As a step, it is necessary to consider the possible alternatives to regeneration, since regeneration is a costly and risky procedure. Thus it is necessary to check if the accession has been duplicated within another genebank for safe keeping and, if so, to ask for a check on the status of that duplicate (thus the location of the institute in which the duplicate is stored is required on the accession management information file), and to check whether a fresh collection of the accession could be made more cheaply (by contacting the original collectors or suppliers, who also should be noted on the accession management information file).

#### 4.3.3.5 Information Required for Distribution on Accessions and on Customers

When a request is received for seed samples it is obvious that the name and address of the customer must be recorded, together with a list of accessions requested. A decision must then be made as to whether each request can be satisfied and, if so, how many seeds should be supplied. This depends largely upon the degree of genetic variation within the accession, and possibly accession viability. It is helpful for the accession management information file to note the distribution policy for each accession as in some cases - e.g. narcotics - the distribution ,may have to be restricted, and to specify how many seeds should be sampled to satisfy any one request. A permanent record of the accessions distributed to each customer is also suggested to avoid abuse of the collection through particular accessions being depleted as a result of repeated requests from one customer within a short period.

Sufficient information within the accession management information file should be distributed together with the sample from the accession to the customer, namely accession viability, the proportion of empty, dormant and hard seeds, and the suggested procedure for obtaining maximal germination together with the primary evaluation data and any information available on seed health and insect infestations. Finally the genebank may wish to request information gained during evaluation by the customer i.e. feedback information.

4.3.3.6 <u>Performance Reports</u>

An important function of genebank management is to monitor and report on the operation of the genebank. There are several obvious performance criteria which a genebank manager will record in annual reports of the operation of the genebank. These include:

- -Total number of accessions in the bank;
- -Total number of accessions available for distribution (with details for each species etc.);
- -Number of accessions deleted from the seed list in the past year;
- -Number of accessions added to the seed list in the past year; and
- -Number of samples distributed in the past year.

4.3.4 Data to be Maintained

In order to be able to provide the information discussed before, the data relating to the various aspects of the work of a genebank are kept in five files; namely

-passport and main data file

-evaluation data file

-summary data file

-genetic data file

-storage data file

Diagram showing the inter-relations of these data files is presented in fig.4.1.

4.3.4.1 Passport and main data file

This includes information relating to the identification of each accession in the genebank e.g. accession number, accession designation (name), botanical characteristics, origin etc.

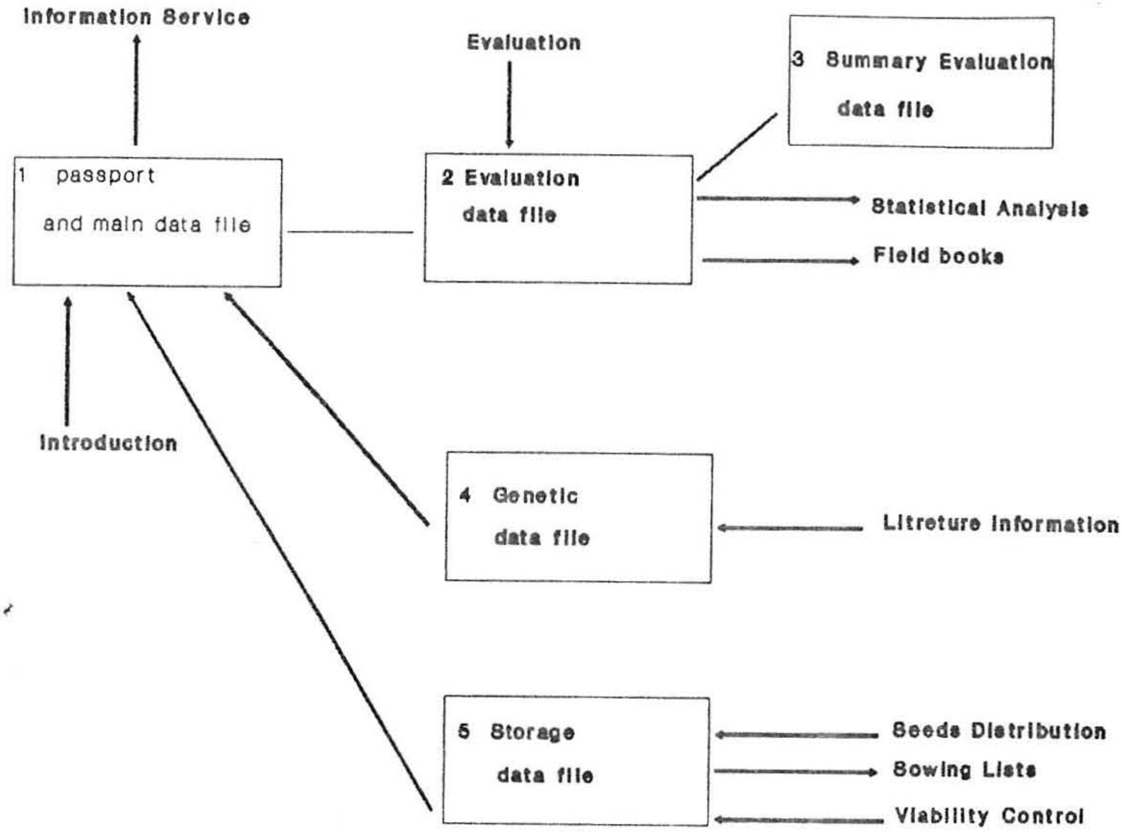
4.3.4.2 Evaluation data files

The files store the results of field and laboratory evaluation in a particular year.

4.3.4.3 Evaluation summary file

This stores summary evaluation data for all accessions of a particular crop from evaluations carried out up to the current year. This file is used to store the results of

Fig. 1 INTER-RELATION OF DATA FILES



statistical analysis of raw data maintained in the file mentioned in (4.3.4.2).

4.3.4.4 Genetic data file

This stores information concerning the pedigree and valid gene symbols for a particular accession. The main sources of this information are documents.

4.3.4.5 Storage data file

This contains all information about the location and storage characteristics of the accessions in the genebank, e.g. weight of seeds in sore, germination ability. If there are sub-samples of the same accession, due to large seed quantity, a list of all locations of samples are cross-referenced to this record. The location of the container in the store is given by the following parameters:

1) room number
2) chest number
3) shelf number
4) row number on the shelf
5) column number on the shelf

The organization of the files containing genetic resources information as presented above allows the use of the documentation system for preparation of several lists for genebank management, for example:

-Sowing lists for multiplication. These are prepared on the basis of quantity of seeds (less than a defined minimum) and the viability (less than a defined minimum for a particular crop). The system prints a list of accessions and their location in the store.

-Seed distribution lists. Receipt or distribution of accessions is noted in the documentation system with automatic correction of the quantity of seeds in the storage file.

-Field books. Once accessions have been selected for field experiments, the system prints a field book, including the list of accession names and numbers, their order in experimental plots for each replication and headings for recording observations at field.

### 4.3.5 Management Descriptors

From the above discussion it becomes evident that genebank managers require accurate, timely and relevant information on the quality and quantity of accession stored, storage spaces and storage technology, current holdings to run the genebank properly. This implies that information relevant for genebank managers be maintained. To be of value, the nature of the information should not be crop specific which would then be useful in the control and management of all plant germplasm. This section discusses the management descriptors that should be incorporated in order to meet information needs of genebank managers. The need for management descriptors has also been recognized by a working group (on barley) of the UNDP/IBPGR European Co-operative Programme for Conservation and Exchange of Crop Genetic Resources. Considering that accessions can differ in their requirements for successful maintenance and regeneration, it was recommended that appropriate management descriptors be developed (UNDP/IBPGR 1983).

The following list of descriptors has been agreed upon by the participants of the workshop after considerable discussion:

## ACCESSION DATA

1. ACCESSION NUMBER

   This number serves as a unique identifier for accessions and is assigned by the curator when the accession is entered into the genebank. Once assigned this number should never be reassigned to another accession in the collection. Even if an accession is lost, its accession number is not permitted for re-use

2. DATE OF COLLECTION

   Date of original collection, expressed numerically (in the format yyyy/mm/dd)

3. ACQUISITION DATE

   Date when the sample is received by the genebank, expressed numerically with format yyyy/mm/dd

4. PRINCIPAL ATTRIBUTE

   Main justification for preservation of the particular accession in the genebank. The states will be defined by individual curators

5. GENETIC STATUS OF SAMPLE

   The genetic basis of the material from which this accession was collected

6. LETHALITY/STERILITY PRESENT

Presence of special genes requiring attention during regeneration

7. DISTRIBUTION STATUS

Indicates the availability of seeds of this accession

1 Freely available

2 Limited distribution until regeneration completed

3 Time limit before distribution requested by donor

4 Part of special collection for which there is no agreement to make samples available

5 Other reasons specified in NOTES (descriptor 16)

8. DUPLICATION

Information about where this accession can be obtained

8.1 DUPLICATED IN ACTIVE COLLECTIONS

Name of Institutes

8.2 DUPLICATED IN BASE COLLECTIONS

Name of Institutes

## SAMPLE DATA

9. SERIAL NUMBER

Number used to identify samples of the accession number from different regeneration cycles. The states for this descriptor have to be exactly defined by curators depending on the organization of genebank

10. INITIAL DATE OF STORAGE

Date when this seed sample was placed in storage, expressed numerically in the format yyyy/mm/dd

11 LOCATION OF SEEDS WITHIN THE STORE

Indicates the exact location of each container of an accession within the seed store. The states for this descriptor have to be defined exactly by curators depending on the manner in which the seed store is organized

12 VIABILITY TESTING

Note: It is recommended that at an absolute minimum the results of the initial and most recent test be kept

12.1 DATE OF INITIAL SEED TESTING

Date when this seed sample was first tested, expressed numerically

12.2 INITIAL SEED VIABILITY

12.2.1 NUMBER OF SEEDS TESTED

12.2.2 NUMBER OF SEEDS GERMINATED

12.3 DATE OF MOST RECENT TEST

Date when this seed sample was last tested, expressed numerically

12.4 SEED VIABILITY FROM MOST RECENT TEST

The most recent estimate of seed viability, expressed numerically

12.4.1 NUMBER OF SEEDS TESTED

12.4.2 NUMBER OF SEEDS GERMINATED

12.5 DATE OF NEXT TEST

Date when this seed sample should next be tested, expressed numerically

12.6 REFERENCE TO COMPLETE VIABILITY TEST DATA

Reference to complete data in either paper or computer files for all seed testing about this accession

13 STORAGE CONTAINER

Code used to indicate the type of container used for this sample when various containers are used in the genebank. The state for this descriptor must be defined by the curator depending on the containers used.

14 SEED MOISTURE CONTENT

14.1 ESTIMATE OF SEED MOISTURE CONTENT

Percentage moisture content expressed

numerically on a wet weight basis from the results of determination by a standard method. (Usually this is measured only when seeds are first placed in store, but if change is suspected, e.g. due to leakage of containers, further determination may be necessary.)

14.2 REFERENCE TO MOISTURE CONTENT DETERMINATION DATA

Reference to complete test data on moisture content determination

15 QUANTITY OF SEEDS IN STORE

Approximate number or weight in grams of seeds in this sample

16 THOUSAND WEIGHT

Note: used for inter-conversion of seed number and seed weight

17 REGENERATION

17.1 NUMBER OF TIMES ACCESSION REGENERATED

Number of regeneration or multiplications of seeds of this sample since original collection or introduction

17.2 REFERENCE TO COMPLETE DATA

Location of complete data referring to regeneration of this accession

17.3 REGENERATION YEAR

Year when presence of principle attribute last checked

17.4 PRINCIPAL ATTRIBUTE CHECK

A check of whether the main character(s) for which the accession is preserved were maintained during regeneration

18 NOTES

Any specific information regarding maintenance, germination, regeneration behaviour or distribution of this accession

### 4.3.6 Organization of Documentation Division at PGRC/E

#### 4.3.6.1 Introduction

An overviews PGRC/E's activities, existing information facilities, information users and their needs, germplasm information sources and services has been presented in chapter two and chapter three. In this section, therefore, discussion is limited to the activities of the Documentation Division (its component units and their functions) and the files maintained by the division to fulfil internal and external needs for information. It will be useful to recall some of the main features of PGRC/E mentioned earlier.

4.3.6.2 The Documentation Division

The Documentation Division has the following four component units:

1. Germplasm Accessioning and Data Acquisition (GA)
2. Data Compilation and Preparation (DCP)
3. Data Entry and Correction (DEC)
4. Data Processing, Retrieval and Research (Data Management) (DM)

In the Germplasm Accessioning (GA) Unit newly acquired germplasm is accessioned in the master book; a unique accession number is given to each germplasm sample, and the germplasm is forwarded to the concerned conservation unit. A form is in use to facilitate proper information flow between the units involved in the process. The various sections of the Center also use different forms to hand over data to the Unit.

The main task of the Data Compilation and Preparation (DCP) Unit is the collection and compilation of information, mainly passport data, from all possible sources. One problem identified in this connection is the existence of many collections donated with little documentation/information. For facilitate data entry into the computer, a form consisting of all passport descriptors is prepared. During compilation and preparation, data are converted, added, deleted, or combined depending upon the particular situations encountered. For smooth exchange of information and ensuring data standardization among sections of Center, the other sections also use the format used by the Documentation Division.

The basic activity of the Data Entry and Correction (DEC) Unit is to enter data into the computer using dBASE+ software. Before the data are stored in the database, printouts are generated and sent to the sections from which the data originated for verification such as characterization, evaluation, seed processing, and testing data. For crop and locality references the division has recently developed a program to detect incorrect data entries.

Finally, the Data Management Unit is responsible for general management of the database which includes all processing and retrieval activities as well as provision of data requested by plant breeders and other users of germplasm. It also assists research operations and produces seed lists and catalogues. The library and the photographic laboratory also belong to this Unit.

4.3.6.3 Files Maintained by the Documentation Division

The various files in use at present in the PGRC/E Documentation Division are as follows:

| FILE NAME | NO.OF FILES | TYPE DATA | NO.OF DESCR. | NO.OF RECORDS |
|---|---|---|---|---|
| PGRCE | 1 | Passport | 29 | 32000 |
| SEED:STR | 1 | Seed storage and Testing | 23 | 27755 |
| SEED:CHR | 30 | Characterization & evaluation | crop speci. 9-31 | 14110 |
| PGRC:COLN | 1 | Summary of PGRC/E holdings | 6 | 75 |
| SEED:REF | 1 | Crop Reference | 5 | 119 |
| LOC:REF | 1 | Locality Refer. | 3 | 552 |
| SEED:DES | 1 | Seed Despatch | 11 | 41 |
| SEED:REC | 1 | Seed Acquisition | 12 | 28 |

4.3.6.4 Descriptors (Field Names)

4.3.6.4.1 *Descriptors of the PGRCE file*

1. ACC:NUM = Accession number
2. CROP NAME= Crop name ( scientific or common english name)
3. SPECIES = Species
4. GENUS = Genus
5. FAMILY = Family (the family to which a given crop germplasm belongs)
6. LOC:NAME = Local name

   Local name of the cultivar. Include in brackets the language eg. teff (Amharic).
7. COUNT:ORIG = Country of Origin
8. ADM:REG = Administration region/Province
9. AWRAJA = Awraja/District
10. WEREDA= Wereda/Sub-district
11. LOCALITY

    The village or farmer association from where the cultivar is brought
12. LONG:LAT = Longitude - latitude locater

    Longitude latitude measure of the village as it is read from a map
13. ALTITUDE

14.COLL:INST = Collecting Institute

Mention the particular institute which collected the accession

15.COLLECTOR

The team or individual who collected the cultivar together with the coordinator number

16.COLL:DATE = Collection date (year/month/day)

17.SOUR:COLL = Source of collection

1=Field; 2=Backyard; 3=Farm Store/Threshing place; 4=Market;5=Agricultural Institute; 6=Natural Vegetation; 7=Others (specify)

18. MATERIAL

1=Seed; 2=Spikes; 3=Pods; 4=Others (specify)

19.DON:NUM = Donor number

20.COLL:NUM= Collection number

21.GEN:STAT=Genetic status

1=wild; 2=weed; 3=primitive cultivar/landrace 4=breeders line; 5=advanced cultivar

22.TOPOGRAPHY

1=swamp; 2=flood plain; 3=plain level; 4=undulating; 5=hilly; 6=hilly dissected; 7=steeply dissected; 8=maintainor; 9=others (specify)

23.SOIL:TEXT=Soil texture

1=sand; 2=sandy loam; 3=loam; 4=clay loam 5=clay; 6=silt; 7=high organic

24.SOIL:COL=Soil colour

1=black; 2=brown; 3=red; 4=orange; 5=yellow

6=others (specify)

25.DRAIN.=Drainage

1=poor; 2=moderate; 3=well drained; 4=excessive

26.SOIL PH

27.SAM:TYPE=Sample Type

1=single plant; 2=pure line/clone;

3=population/mixture; 4=other (specify)

28.SOW:MONT=Sowing Month

The month expressed numerically; and include in brackets whether it is in the early/middle/late of the month. Use gregorian calendar.

29.HAR:MONT=Harvesting month

4.3.6.4.2 *Descriptors of the SEED:CHR file*

1.ACC:NUM=Accession number

Identification number given by PGRC/E

2.REF:NUM=Reference number

Former accession number of selected component

3.DAY:FLR10=Day to 10% flowering

Counted as number of days from sowing to 10% of plants in flower

4.DAY:FLR50=Day to 50% flowering

Counted as number of days from sowing to 50% of plants in flower

5.DAY:FLR90=Day to 90% flowering

Counted as number of days from sowing to 90% of plants in flower

6.DAY:MAT50=Days to 50% maturity

Counted as number of days from sowing to 50% of the pods per plant are completely dry and show no more green colour

7.STEM:CLR=Stem colour

Visual measurement taken during early vegetative state at the middle part of the plant (L=light M=medium D=dark G=green P=slight purple PP=intensive purple)

8.LEAF:CLR=Leaf colour

Visual measurement taken during early vegetation state at the middle part of the plant, eg. LGP (light green with purple)

9.LEAF:IDEN=Leaf identification

Visual measurement taken during flowering at the middle part of the plant. Symbols to be used are (3=almost no lobes; 5=lobed leaf; and 7=deeply lobed)

10. DIS:STRESS=Disease stress conditions

Special trait the accession possesses to resist diseases

11.PLT:HEIGHT=Plant height

Mean of the measurement of five plants height at different places in the plot in cm.

12.NO:PRIM=Primary branches

Mean of the counting at five plants

13.NO:SECN=Secondary branches

Mean of the counting at five plants

14.NO:POD:PL=Pods per plant

Mean of the counting at five plants. Tag the plants for laboratory characterization

15.LODGING

Visual measurement of the susceptibility to lodging taken at maturity, comparable to a percentage scale. The symbols to use are

1=almost no 3=slight 5=intermediate 7=heavy 9=very heavy

16.STEM:DIAM=Stem diameter

Mean of three measurements in mm. per plot after harvest

17.SYNCHR:MAT=Synchrony of maturity

Visual measurement of the ripening of the pods with in the single plant. Symbols to be used are (1=synchronous 3=intermediate 5=non synchronous)

18.ANGL:BR=Angle of branching

Visual measurement taken during flowering at the middle part of the plant. Symbols to be used are

(1=very erect 3=intermediate 5=right angle or more)

19.SHAT:PERC=Shattering percent

Estimation of the percentage of seeds lost due to shattering

20.PLOT:UNIFO=Plot uniformity

Visual measurement during flowering stage of the phenotypical appearance. Symbols to be used are (SL=single line(pure) ABC=three components)

21.NUM:SEED:POD=Number of seed/pod

Counted and recorded as an average on five randomly selected plants at maturity stage

22.LEAF:HAIR=Leaf hairiness

Presence and absence of hairs on the upper and lower parts of the leaf, at three weeks after sowing

23.ANTHO:PIG=Anthocyanin pigment

Presence or absence of anthocyanin pigmentation on the vegetative and floral organs

24.SPIK:DEN=Spike density

Number of spikelets counted in 10cm internodes of the rachis in the central part of the spike. Symbols to be used are 3=lax (60-70mm) 5=intermediate (35-60mm) 7=dense (20-35mm)

25.SPIK:LEN=Spike length

Length in cm from end of upper inter-node of stem to top

26.SPIK:SPIK=Spikelets per spike

The total number of spikelets per spike

27.SPIK:WID=Spike width

Measured in mm. in the middle part between the borders of profile

28.TSW

Thousand Seed/Grain Weight

29.KERN:LEN=Kernel length

Length of kernel in mm. between two pointed ends

30.KERN:WID=Kernel width

Width in mm. at the middle point

31.KERN:COL=Kernel colour

Colour of the kernel (1=white; 2=red; 3=purple)

Some of these descriptors may only occur in any one record.

4.3.6.4.3 *Descriptors for SEED:STR file*

1.CROP NAME

2.ACC:NUM=Accession number

3.STRG:DATE=Storage date

4.COMP:NUM=Compartment number

5.BOX SIZE ("A"=30*24cm "B"=30*12cm "C"=45*24cm "D"=45*12cm)

6.BOX:NUM=Box number

7.DATE:INT:TEST=Date of seed testing

8.VIAB:TEST=Viability test

Initial and the most recent test result

9.NUM:SEED:USEDP=Number of seeds used for the test previously

During the first and the most recent test period

10.NUM:SEED:GERP=Number of seeds germinated previously

Initial and the most recent test result count

11.NUM:USEDC=Number of seed used for the current test

12.GEN:COM=Genetic composition

Homogeneous/heterogeneous

13.BATCH:NUM=Batch number

Serial number used to identify samples of the accession number from different regeneration cycles

14.NUM:GER=Number of seeds germinated

From count of the current test result

15.VIAB:PERC=Viability percentage

From the current test result

16.NEX:DATE=Next test date

17.SEED:MOIST=Seed moisture

Seed moisture content determined after drying

18.METH:USED= Test method used

19.DRY:COND=Drying condition

Temperature and relative humidity

20.TOT:NUM:GER=Accumulated total number of seeds germinated

21.TIME:GEN=Number of times accession regenerated

22.NUM:SEED:STOR=Number of seeds in store (same as the sample type)

23.REMARKS

4.3.6.4.4 *Descriptors of PGRCCOLN file*

1.SPECIES

2.PGRCCOLN=PGRC Collection

3.OTHERINST=Other institution collection

4.DONATED

5.REPATRIATE

6.TOTALC=Total collection

4.3.6.4.5 *Descriptors of SEED:REF file*

1.CROP NAME=Common English name

2.LOC:NAME=Local name (language)

3.SPECIES

4.GENUS

5.CROP TYPE

Cereal/beverage/fibre/pulses/tuber/oilcrop/spice/vegetable/fruit/browse

4.3.6.4.6 *Descriptors of LOC:REF file*

1.ADM:REG=Administrative region/province

2.AWRAJA=DISTRICT

3.WEREDA=SUB-DISTRICT

4.3.6.4.7 *Descriptors of SEED:DES file*

1.CROP TYPE

2.ACC:NUM=Accession number

3.AMT:REQ=Total number of seeds/amount in grams requested

4.SOURCE:Source of collection

From active collection/base collection/short term collection/ or Excess

5.DATE:DES=Date of despatch

6.NUM:TOT:SAM=Number of total sample

7.GIVENTO

Full details of the individual/institution address

8.PURPOSE

For multiplication/characterization/research/ exchange/regeneration/duplication collection for safety

9.REG:SITE=Regeneration site

Data about the appropriate site for regeneration and important test results

10.FEEDBACK

Response of germplasm users

11.NOTE

4.3.6.4.8 *Descriptors of SEED:REC file*

1.CROP TYPE

2.SOURCE

Where the accession came from such as collection/ multiplication/ regeneration/ exchange/ donation/ repatriation/ breeders material/ population split

3.ACC:NUM=Accession number

4.REF:NUM=Reference number

Former accession number of the selected component

5. SAMPLE STATUS (YES/NO)

5.1 FUL:MATU=Full maturity

5.2 MECH:DAM=Mechanical damage

5.3 SHRIE=Shrivelled

5.4 PES:DAM=Pest damage

5.5 FUMIG=Fumigated

5.6 HOMO:Homogeneous

5.7 SAM:WEIG=Sample weight (gms.)

6.REMARK

# CHAPTER FIVE

# IMPLEMENTATION STRATEGY

## 5.0 SCOPE

This applied research study has as its goal to address practical problems. Therefore, biodiversity related institutions and government authorities can benefit from implementing the proposed system. This chapter discusses general considerations and activities involved in system development and implementation.

## 5.1 GENERAL CONSIDERATIONS

### 5.1.1 Centralized Versus Decentralized Approach

All participating institutions should preferably adopt a common methodology for data entry, data storage and reporting. It implies that all the participants use the same or compatible terminology so as to ensure efficient and effective communication among them in respect of system design and networking.

This commonality can be achieved by one of two means. The first is by storing data at one site only. In this way, all the data must be entered in the same format and stored in the same format. Data can then be retrieved using a single search language. The second is to have databases at several locations but to force each one of them to adopt the same approach in data entry and storage. This does not necessary imply use of the same software, but it would certainly be advisable to do so. The second method would need to ensure transportability of data between the institutions and to avoid duplication of data.

#### 5.1.1.1 The Centralized Approach

ADVANTAGE

- avoids duplication of hardware and computer personnel
- guarantees a common approach to data storage and to what information is stored.

DISADVANTAGE

- a central site storing all data may require a much larger computer and/or disk space than would be required if the data were decentralized. Thus the final hardware cost may in fact be greater than it would be in a decentralized approach. If new tasks cannot be assigned to existing staff, it may also need some more people to maintain it.

-The site might be remote to at least one of the participating institutions. This may cause unnecessary delays in getting information to and from the institution and so lead to reduction in the use of the facility. It can also involve large amount of expenditure for participating members to get hooked to the central reservoir.

-It may promote feelings of impersonality. Some institutions may not feel part of the project and so lose incentive to participate.

-In the event of major catastrophe, all information could be lost in one blow.

5.1.1.2 Decentralized Approach

ADVANTAGE

-Only need hardware to service the needs of each participating institutions. This may mean the difference between an expensive mini and a cheap micro. It may also mean not having to buy any hardware, since many of the institutions surveyed already have existing hardware that ran different software.

-A feeling of active participation is more likely to be achieved among the participating institutions if each has its own computing facilities.

-More immediate access to data will be possible.

-A major catastrophe in any one institution would not affect data available in the other institutions.

DISADVANTAGES

-Duplication of hardware among the institutions may increase the overall cost of the project. This would depend very much on the storage requirements of each of the institutions. Duplication of software is generally not of such importance i.e. repeats of software are usually cheaper than repeats of hardware.

-Unless the same software is forced on each of the institutions, there is a danger of losing commonality in the content of information stored and the way it is stored. This could inhibit ease of transfer of data between institutions, apart from moving away from one of the original aims of the project.

-There is the risk of duplication of data

-Each site requires personnel who understand the intricacies of the data being entered and the software system used for data entry and retrieval. This can be a large overhead if the person(s) is(are) dedicated to this job. Where there are existing personnel taking on extra duties at no extra cost, obviously this is not a problem; but the survey did not indicate this situation.

Given those two situations, the researcher recommends the first approach because it is consistent to the goal of designing the information system. These are (1) to avoid unnecessary wastage of time and resources in doing the same work already performed by other related institution (2) to serve as an instrument for the co-ordination and integration of biodiversity related institutions by creating a conducive atmosphere such as facilitating data exchange, encouraging the maintenance of common formats and compatible machines and software; and (3) to ensure and promote efficient and effective provision of complete, timely, relevant and accurate information on biodiversity components and topics which is hardly possible to find at one institution.

On the other hand, cost of terminals has gone down these days and can not be something unjustifiable compared to the benefits that can be derived from maintaining a central point.

### 5.1.2 Choice of Software

Software may either be bought as an off-the-shelf product, provided that it is possible to get a hardware which matches, or a new package may have to be developed. There are arguments for and against both these approaches. These are detailed below.

#### 5.1.2.1 Off-the Shelf Packages

ADVANTAGE

- These packages are generally produced for a large market and so development costs can be spread over many potential installations rather than just one; they are, therefore, cheaper than packages developed for specific purpose.
- They are intentionally written as a general purpose tool and so suit a variety of applications.
- They generally have easy to use report writing facilities that enable different report formats to be generated.
- Many allow the database to be restructured without modification to the software.
- Most packages have an interface to another commonly used high level language to allow further tailoring of the

system to suit particular needs.

DISADVANTAGES

-The packages available may often do more than what may be needed for a particular application. In this respect, one may end up paying more for the software than you would be the case if a customized solution were to be developed.

-Because packages are designed for general purpose use, they may run slower than a customized package would. This depends very much on the language used for comparison, machine usage, type of application, etc.

-It takes up more computer memory.

-Software support is often harder to achieve than with in-house written software. If the package is purchased and then found unsuitable there is very often little that one can do than bearing the loss and try another solution. The only people who can modify the package are the original suppliers. Even if they are prepared to make modifications, those changes may be substantially higher than in-house costs.

5.1.2.2 Customized/In-house Developed Software

ADVANTAGE

-Software written in house takes up minimum amount of memory, runs faster, and is easy to use. It does specific functions and it does them well.

-If the software is written in-house (as opposed to being contracted to some one normally responsible to the "company"), modifications can generally be made fairly quickly by some one proficient with the system.

-Applications which have not been satisfied by off-the-shelf software can be made available (adapted).

DISADVANTAGE

-Development costs are high where the software can only be used for one application.

-Skilled personnel are required to maintain the software. Apart from logical errors in the programme itself, problems in the initial design may soon become apparent. Lack of generality early in development can become a very serious and costly problem in later stages.

The second approach is not tenable for the specific application in mind i.e. Database Management Software (DBMS). DBMS is a system software which is composed of relevant facilities to create databases. This software is general and sophisticated in that it is hardly possible to develop in house. Even if it is attempted and happened to be successful, it would not be feasible in terms of cost outlay as it involves large amount of expenditure to be absorbed by a single package.

### 5.1.3 Sizing the Database

Attribute lists for all the entities involved have been detailed in the previous chapter. From the sample record generated for each one of the entities, again, an estimate of the record size is possible. The volume of records may also be estimated from both the survey findings and through informed guess. Thus, the total total size of the database is computed by multiplying the indicated number of records for each data base by the space required for a single record of the same databases (see table 5.1). In this connection, however, it is essential to note that the estimate cannot be exact. The purpose here is just to avoid the risk of having devices either one of too small or too large storage capacity which results inefficient use of storage space. From table 5.1 we can see that the overall size of the databases for all the entities is huge i.e. about 462.35MB.

TABLE 5.1 ESTIMATES OF POTENTIAL SIZE OF DATABASE IF ALL RECORDS WERE FIXED LENGTH AND NO GROWTH FACTORS HAVE BEEN APPLIED

| Database | Storage space requirement for a record (a) | Expected no. of record (b) | Total (a * b) |
|---|---|---|---|
| TPARK | 6000 CHAR. | 25 | 0.15MB |
| TFAUNA | 6000 CHAR. | 10000 | 6 MB |
| TFLORA | 5500 CHAR. | 30000 | 165 MB |
| TGPLASM | 8000 CHAR. | 32000 | 256 MB |
| TBIBLIO | 1000 CHAR. | 35000 | 35 MB |
| TINSTIT | 1500 CHAR. | 30 | 0.05MB |
| TEXPERT | 1500 CHAR. | 100 | 0.15MB |
| SUM TOTAL | ................... | ............ | 462.35MB |

### 5.1.4 Software Recommendations and Suggested Development Approach

#### 5.1.4.1 Software Recommendations

It is not the researcher's intention at this stage to propose a specific package, but merely to indicate the options available. A detailed investigation still remains to be done to fully and exactly define the requirements of the proposed system before a final selection can be made.

A few features of the databases discussed below rule out several of the cheaper packages include: The system should be capable of

- -storing and manipulating records of variable length.
- -being portable, that is, run on more than one computer should the initial computer prove to be not adequate.
- -supporting backup and recovery facilities.

An accurate costing of the package is not also possible at this stage. A further briefing with developers and users of the system is required to discuss finer details to ensure that any package that is purchased can accommodate all needs. Details of validations, extraction methods, some internal values of attributes, report formats, screen designs are just a few of the matters to be clarified to guarantee that all users of the system have the same perspective of what it can do for them. It is desirable that users meet prior to calling in an outside consultant or software supplier to agree on as many of these areas as possible. This will not only minimize development time but considerably reduce the cost.

5.1.4.2 Suggested Development Approach

If the decision to develop the databases has been made, the following steps should be taken:

- -determine the content of the databases as fully as possible; this has been partially done already.
- -determine the length and format of all data items; this includes deciding which fields will be repeating (this has also been attempted but shall be revised and refined).
- -determine what validation checks can be done as data are entered into the database or are modified.
- -determine in what order data should be entered: the data most likely to occur in every source document should be made to be entered first.
- -divide data into logical groups; menus can be used to direct the user to entry or modification of these data.
- -determine screen layouts for data entry to make the process as simple as possible. The operator should not have to resort to memory or large manuals to determine what to do next. This may be influenced to some extent by how the data are currently recorded on paper. Screens should match data preparation sheets.
- -determine what and how data are to be extracted.

- determine whether the data made available from requests to be displayed on the screen, on a lineprinter or both.
- determine the format of any reports required.
- provide reasonable estimates of the number of records likely to be processed.
- obtain agreement among users on the required features.

Once the system has been well defined and understood by all involved, the system can be either put up for tender or a systematic search can be made of available software packages. Either approach will involve a very close evaluation of several systems. The potential system must:

- meet all needs as determined above
- be readily maintainable either by the supplier or a local expert to cover those inevitable forgotten items or inconveniences
- be economical in disc space
- be simple to use
- be within budget limits
- be capable of meeting future growth requirements
- be preferably transportable to several computers.

### 5.1.5 Hardware Recommendations

From estimates provided and detailed in Table 5.1, the total figure for disc requirements for all entity types involved has been derived. The interpretation of the table is that if data from all estimated relevant source documents known to date were entered into a computer system the data would occupy less than 500MB. To this must be added some allowance for system overheads; but as the figures already provide for overheads a 500MB hard disk space will be adequate to begin with. The growth rate of the databases is difficult to estimate as time series data were not collected. However, from consulting expert staff, it would seem reasonable to apply a growth rate of at least 10% annually. This implies that every year disc requirements would be approximately 500, 550, 605, 666,733MB assuming that the system to be designed should meet requirements for the next five years (see table 5.2). Thus in five years time the total disk requirements would be about 733MB.

TABLE 5.2 DETERMINATION OF STORAGE REQUIREMENT OF THE DATABASES DISCUSSED FOR FIVE YEARS TIME

| year | disk space requirement beginning of year | growth at 10% | total disc space requirement end of year |
|---|---|---|---|
| 1 | ---- | ---- | 500MB |
| 2 | 500MB | 50MB | 550MB |
| 3 | 550MB | 55MB | 605MB |
| 4 | 605MB | 61MB | 666MB |
| 5 | 666MB | 67MB | 733MB |

The data entry has to be made efficient. Moreover, tasks may have to be performed simultaneously and researchers and decision makers normally can tolerate a delay rate of a week and a day respectively. Working on the above premises, it is recommended that a multi-user terminal system with two reasonably fast printers of good print quality be provided for. In a multi-user system different users can simultaneously use the system.

For details about the recommended configuration type, however, the body in charge of developing the system (developers) shall prepare bid documents/request for proposal and evaluate. In the mean time, getting consultant's assistance would be advisable.

5.1.6 Considerations in Procuring the System

5.1.6.1 Evaluating the System

- system's life time
- reliability (performance of the entire system as well as that of the components)
- expandability of the system
- system's documentation (evaluating for its completeness and understandability at all levels - programming, user manual, and hardware).

5.1.6.2 Vendor Analysis

Since computers are available from numerous sources, the body in charge of procuring the system needs to consider vendor characteristics that can affect future satisfaction with the system. Important considerations include:

- vendor stability and expense, and
- maintenance support

5.1.6.3 Contract with the Hardware and Software Vendor

It is the only reasonable assurance that the product will perform as described and the only protection if it does not. The contract should specify in detail a product description, acceptance criteria, the test period, payment terms and maintenance agreements.

#### 5.1.6.4 Cost Items

Cost components such as site preparation costs (if there is no place to accommodate in any of the participating institutions), system costs (purchase costs, ongoing costs, staff costs), and data transfer costs need to be taken into accounts. In respect to data transfer, for data of either cassettes or floppy disks, the system at each institution must have the appropriate peripherals to read them.

## 5.2 IMPLEMENTATION ACTIVITIES

### 5.2.1 File Conversion

The costs involved with conversion vary almost directly with the number of manual records held for wildlife species, and conservation areas and number of reference and referral sources to be incorporated in the databases together with the length of the record (in characters). Before conversion, future anticipated needs should be considered.

In our case the situation is such that some of the existing data/files are in card form, some in document form, some others are in machine readable form. All should, however, be available in machine readable form. This requires advance consideration and hence the following.

#### 5.2.1.1. Method

With regard to file conversion we have two alternative methods to consider, namely, one time conversion (full conversion) and 'as required' conversion. Applying one time conversion in anticipation of a full-scale live operation would involve interruptions of regular work.

However, it has the advantage of economy of time. In 'as required' conversion, records are converted to the new system only as and when required by the new system in operation.

Of the two alternatives, the later approach is recommended, for it is not feasible to convert all records at one shot and there is no serious time limitation.

Whatever methods is chosen, it is best to document the various procedures in a conversion procedure manual. This manual can be used for training and as a reference manual for the personnel involved in the conversion process.

5.2.1.2 <u>Major Activities</u>

The first activity that the body in charge of developing (developers) should complete when undertaking a conversion project is to extensively weed out duplicate and other unnecessary records. This will reduce the number of records that must be converted and lower the number of items that must be handled, which will result in a less expensive and more timely completion of the project. Additional activities in the conversion process may include the time and personnel needed to remove each item from the shelf. Similarly, time and personnel will be needed to register or input data about the entities to be incorporated to the system. In brief, the tasks of file conversion may involve the following activities:

- -Identifying, organizing, and weeding the required manual document
- -Manual description of these data to the requirements of the newly developed system
- -Checking of the manually transcribed data
- -Data entry
- -Proof listing
- -proof reading and conversion
- -Entry of collected data
- -Computer related activities to proof listing procedures and file organization

5.2.1.3. Required Equipment/Supplies

Job aids such as procedure manuals, user guides and handbooks, booklets of codes, tables, menus; workstation equipment (such as filing equipments, waste bins, furniture); input and output forms and documents are among the required materials that should be provided. Further, encoding machines required for data conversion, diskettes for the data and sufficient computer time to sort. merge and organize the various source and formatted files, and microfiche readers are among those which should be made available. They can either be obtained on rent from commercial agencies or be purchased.

5.2.1.4 Control Systems

In addition to the already existing procedures, there should also be methods by which individuals are made responsible for work and audit controls. Accordingly, daily entries must be counted and assembled into classes for review by supervisors and there shall be record of totals of data coming in and going out for control purposes.

5.2.2 Installation

5.2.2.1 Environmental Concerns

The selection of the room and layout of computer equipment requires careful consideration. In addition to space for initial and future equipment and maintenance access, adequate space must be provided for operating personnel and for storage of spare parts, testing equipments, forms, paper, and other data processing supplies.

Electrical requirements should also be considered as per the specification of the vendor who supplies the hardware and the software. Further, dust protection devices for the diskettes and air conditioning for both the operating personnel and for the computing equipments (the computer, disk drives and printer) may also be necessary.

5.2.2.2. Security

Here the concern should be with regard to physical security (building constructed of fire proof materials; fire protection methods and devices, physical access control by locking doors, main entrance and windows, and the like). The hardware and software security requirements are also essential though they should be the concern of the vendor and should be specified in the vendor selection.

Once the above considerations are duly taken care of, the next task is installation of the hardware and the software, which is also the responsibility of the vendor and the institution's designated staff. However, upon completion this should be checked and approved by the walkthrough committee.

### 5.2.3 System Testing

Testing should be considered from three angles;namely: functional testing; performance testing; and quality testing.

#### 5.2.3.1 Functional Testing

The purpose should be to discover functional faults, if any. The recommended procedures for this are careful selection of cases and inspection. Programming personnel and users should hypothesise different views of vulnerability of the system to different types of errors.

#### 5.2.3.2 Performance Testing

Here the aim is to find out how well the system meets the system's requirements and other measure of effectiveness and design aims such as execution time, response time, average time to process a given type of transaction, etc. To this end, therefore, performance parameters (measures of effectiveness and efficiency) should be identified.

5.2.3.3 Quality Assurance

Quality here refers to excellence or fitness of the system to satisfy the desired goals. This is, again, confirmed by developing first quality parameters and seeing to what extent they are satisfied by the new system. Hence, the need for identifying the essential quality parameters.

Generally, a walkthrough committee of higher caliber personnel (composed of members from the participating institutions) is recommended to organize the testing and review the test case results.

5.2.4 Acceptance Test

Once the new system is tested and corrected for any erroneous findings in the course of the test, the next step would be to conduct acceptance testing. This is the last chance to verify that the system meets the requirements of the system to be developed, before completely relying upon it. Acceptance test should take place during the initial operational period.

Acceptance test may be performed in one of three ways, namely, One-time acceptance test; Parallel running acceptance test: and Pilot operation acceptance test. From these alternatives, one time acceptance test is recommended, to be later confirmed by a pilot operation.

### 5.2.5 Maintenance

Maintenance refers to two aspects: first when some part becomes out of line and requires repairs and second when the system fails to operate at a steady state and this requires some change (adjustment). For both the above cases, the recommended action is to have maintenance contract with local computer dealers. Note, however, that maintenance involves post implementation evaluation of the system by users or/and external bodies other than those who participated in the implementation and documentation for updating the system according to the changes made.

### 5.2.6 Personnel Requirement and Training

#### 5.2.6.1 Requirements

The system requires at the minimum two experts to analyze, extract and verify data items from the original documents in a form appropriate for data entry: two search assistants; one system analyst; two programmers; and four data entry clerks.

#### 5.2.6.2 Selection

The selection of personnel capable of effectively performing all the required function has much to do with the success of the project. For selection, appropriate criteria of qualification, experience, etc. should be adopted. Among the criteria, experience and qualification in biodiversity and related areas and aptitude test performance are to be given relatively more weight in addition to the relevant knowledge and skill in computer and/or information science.

#### 5.2.6.3 Training

The training that the staff of the developing institutions receives is crucial to the success of the system. Some of the facts to be to be considered here are:

- Training sessions are better conducted on a continual basis rather than having a single training session, since it will allow staff to experience and experiment with the system so that they can formulate questions and become comfortable with the system.

-Structured training sessions for all staff members concerned is more effective than hierarchical structured training, with supervisors trained first and then asked to train their staff.

-Training shall be provided by the vendor at least for selected personnel who are responsible for the operation of the system and who will then train other staff.

-Training programs should include material on the operation of the terminals (disk operating system and others) in addition to the systems basic application (the selected DBMS).

-Biodiversity information users should be oriented to the features of the new system in order to alleviate any anxieties concerning the new system.

### 5.2.7 Project Management

For achieving the anticipated benefits from this project, the establishment of a body for monitoring the implementation is suggested. The body, which we may call steering committee, should consist of permanent and interim members from all the participating institutions.

# CHAPTER SIX

## SUMMARY AND RECOMMENDATIONS

### 6.1 SUMMARY

Biodiversity is the totality of diversity in genes, species, and ecosystems of a region. Genetic diversity refers to the variation of genes within species. This covers distinct population of the same species or genetic variation within a population. Species diversity refers to the variety of species with in a region. "Taxonomic diversity" and/or the number of species in a region -its species "richness"- are/is used to measure species diversity in a given region. Ecosystem diversity is the diversity among systems in a given area (often at national or regional level).

The sheer variety of biological resources has enormous value. From both wild and domesticated components of biodiversity, humanity derives all of its food and many medicines and industrial products. Biotic resources also serve recreation and tourism. Besides these direct values and benefits, biodiversity provides priceless ecological services (in protecting watersheds, cycling nutrients, combating erosion, enriching soil, regulating water flow, trapping sediments, mitigating pollution, and controlling pest populations).

The unknown potential of genes, species, and ecosystems diversity represents a never ending biological frontier of inestimatable but certainly of high value. A diverse array of genes, species, and ecosystems is a resource that can be tapped as human needs and demands change. The many values of biodiversity and its importance for development suggest the need to conserve biodiversity.

The degradation of natural ecosystems and habitats, and the loss of their characteristic species diversity, are occurring in nearly every part of the globe as human population and their system expand. Today, the rate and scale of environmental changes brought about by human activities have increased to the point where a great species may not have sufficient time or space in which to migrate or adapt.

Our information about and understanding of the Earth's biological diversity has significant gaps which should be filled promptly through intensive and extensive researches. This lack of information hampers the ability to comprehend the magnitude of the loss of biodiversity, prevent further losses, and formulate sustainable alternatives to resource depletion. Loss of biodiversity is a problem; conserving biodiversity is the science to understand the problem and propose solution; and efficient information management, dissemination and environmental education is the means of getting solutions implemented.

There is a continuing need for research on biodiversity that improve our knowledge base and our management capacities, and leads to the development of new ways for people to live with and not at the expense of their biological resources. Biodiversity conservation research has three aspects; namely the socio-economic, the cultural and the biological aspect.

The overall objectives of the socio-economic research agenda are to identify socio-economic factors leading to the loss of biodiversity with in a country; to determine the role of international economic institutions and trends that support this depletion; to elucidate the principles operant in cases of successful development and conservation; and to develop and test economically viable mechanisms for slowing resources depletion and stimulating conservation.

The fact that biological diversity has been also lost as a result of social (cultural) processes, and will ultimately be conserved only through adjustments in these processes makes it necessary for carrying out conservation research in a cultural context. Finally, the biological ecological aspect of conservation research has objectives to gain a better and more complete sense of "what is out there"; how to protect and use it in a sustainable manner, and how to restore it. Improving the ability to gather, organise, communicate, and apply this basic biological information/knowledge also falls under biological conservation research.

To enhance the availability and application of scientific information for the purpose of managing and conserving biological diversity, research on developing computer databases and inventories, setting up and strengthening information networks, the use of remote sensing and geographic information systems for agro-ecosystem monitoring is very helpful.

As conservation faces greater competition for resources, the need for coordination and shared information to prevent duplication of effort becomes paramount. To select and design new reserves, efficiently manage and monitor existing reserves, take advantage of opportunities for sustainable land use and restoration, and coordinate ex-situ conservation efforts, researchers and administrators must have access to information on the classification, distribution, characteristics, status, conservation research in a cultural context. Finally, the biological ecological aspect of conservation research has objectives to gain a better and more complete sense of "what is out there"; how to protect and use it in a sustainable manner, and how to restore it. Improving the ability to gather, organise, communicate, and apply this basic biological information/knowledge also falls under biological conservation research.

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The data from remote sensing techniques, coupled with the wide range of capabilities of GIS to manage attribute and graphic data, offer unprecedented opportunities to assess and monitor ecosystem processes.

As the need for scientific information on biological diversity grows, and as the volume and quality of information increase, scientific networks must keep pace. The effectiveness of all scientists depends in large part on their access to professional colleagues and to information in their field.

Ethiopia, with extensive and unique highlands together with their isolation by the rift valley, has world importance for the diversity of its domesticated and wild floral and faunal genetic variety and species. The endemic fauna and flora of Ethiopia include 28 out of 861 bird species, 31 out of 277 terrestrial mammal species, 9 out of 201 reptiles, 24 out of 63 amphibian species, 4 out of 150 fresh water species 7 out of 324 butterflies, and at least 1150 out of 6000 plants. Research into the wild fauna and flora is relatively recent and as a result the flora and fauna of Ethiopia are not yet completely known in numbers and classification. Wildlife conservation initially focused on the larger fauna with the conservation of flora and small fauna associated incidentally. About 32,000 km.sq. or 2.7% of the country is under strict protection (i.e. national parks and sanctuaries), although only two of the nine national parks are gazetted.

Though protection of wildlife was given proper attention by the government, results have not been upto expectation for various reasons among which the unsustainable high rate of human population growth and natural resource consumption, the steadily narrowing spectrum of traded products from agriculture, forestry, and fisheries, economic systems and policies that fail to value the environment and its resources, inequality in the ownership, management and flow of benefits from both the use and conservation of biological resources, deficiencies in knowledge of natural ecosystems and their innumerable components and its proper application, legal and institutional systems that promote unsustainable exploitation, drought, economic systems and policies that fail to value the environment and its resources, and failure to sensitize the public about the values of ecosystems and wildlife, failure to develop an alternate source of fuel, inefficient exploitation of wildlife products, and absence of efficient and effective information support system are the major ones.

The wide range of agro-climatic conditions and the Ethiopian farmers' traditional method of conserving and utilizing germplasm have contributed to the existence of crop genetic diversity in the country. This is at present subject to serious genetic erosion and losses due to various reasons among which displacement of indigenous landraces by exotic ones, predominance of genetically uniform crop varieties and developments in agriculture are major ones.

Resource planners and policy makers, conservation administrators and decision makers, researchers, academics, environmental engineers, international development agencies, local healers and pharmaceutical companies, agencies and people concerned with nutrition, tourism agencies and tourists, extension workers and farmers, people interested on forage, ministry of information, international conservation organizations and genetic resource centers, information service centers and information people, and the general public are the main potential users of biodiversity information. In characteristic users range from highly educated (in biodiversity field as well as outside it) to the illiterate. In their information seeking behaviour, again, some require detailed data on a regular basis and some others less detailed data very occasionally.

Existing biodiversity sources (published and unpublished documents) are adequate but they are dispersed or not properly organized, and as a result users have problems of access to them. Except at PGRC/E where services are relatively better, others have less efficient and effective services. In general, however, the survey has indicated the following problem situations prevailing in all the institutions: lack of trained personnel, little professional incentive to employees in charge of documentation and information centers, lack of finance, lack of the required software, standardization problems among systems in use by the institutions surveyed, inhibiting policies, and lack of perception or awareness of the importance for improved information system by the management and the community.

On the otherhand, the survey revealed that almost all the institutions surveyed have at least the basic information facilities such as computer and essential accessories which is promising to set up information networks and data exchange. At present, however, though they are performing related works, the institutions surveyed are not coordinated among themselves. Due to this there is duplication of work and resultant wastage of resources, time and effort.

The main purpose of a computerized information system is to make information available to the users according to their needs. An important aspect of systems design involves establishing database(s) which consists of three phases i.e. assessing the feasibility of the system; designing the database; and organizing access to the information system.

Careful database design is essential for a variety of reasons including data redundancy, application performance, data independence, data security, and ease of programming. The two most common database design methodologies include normalization and data structuring and the entity-relationship methods.

Database design using the entity relationship model lists the entity types involved and the relationship among them. An entity is an object, real or imaginary, which can be thought of as having a distinct and identifiable existence. Entities are described according to their attributes. An attribute is any property or characteristic of an entity which, individually or in combination with other attributes, provides description or view of the entity tailored to a particular environment. The entity types identified during the survey are Conservation Area(National park), Wild-animal species (fauna), Trees and Shrubs (Flora), and reference and referral services.

The software selected to design the prototype is MicroIsis. MicroIsis is a generalized system designed for the management of machine readable textual databases i.e to build, manipulate, maintain, and retrieve records from such databases. It is a DBMS software which is distributed free of cost to non-profit organizations; supports multi-user local area network (LAN) applications; has growing number of users in Africa and different parts of the world; is used for developing bibliographic, factual, and object-oriented databases, and has advanced programming facility to write CDS/ISIS pascal interface programs.

## 6.2 RECOMMENDATIONS

### 6.2.1 Introduction

Irreplaceable genes, species, and ecosystems are disappearing at an unprecedented rate. Immediate action is needed to defend these threatened living resources; to reform the policies that lead to/invite such losses; to conduct inventory and study of resource use in key ecosystems and regions; to monitor changing and impeding threats; to mobilize funding; and to support national and grassroots conservation initiatives.

For these actions to be executed there should be executing body. However, in Ethiopia there is as yet no such body officially designated as biodiversity center and neither does exist any biodiversity conservation strategy formulated and in use. Given this situation, it is hardly possible that any effort made towards conserving and managing biodiversity be successful/effective. In view of the facts mentioned above and also revealed from survey analysis and literatures review, it is recommended that

1. A national biodiversity conservation strategy be drawn up and a national biodiversity center be officially designated and made operational.
2. A national biodiversity information and monitoring system be designed and developed. The present work can serve as a basis for these actions to be initiated.

Until biodiversity conservation becomes a stated national policy goal, investments will not be targeted to developing the national human, technological, and institutional capacity required to save, study, and use sustainabe biodiversity. Nor will the appropriate policy environment be established.

On the other hand, in the context of proposed conventions or agreements on biodiversity, forests, climate change which Ethiopia has ratified, and the increasing importance of biodiversity conservation as a criterion for development assistance, it is essential that biodiversity conservation be incorporated into the national policies and planning to define and articulate national as well as international biodiversity interests.

Various planning mechanisms can be used to promote and integrate biodiversity conservation in development. These include: National conservation strategy, forest action plans, environmental action plans, or national biodiversity action plans. The latter approach is recommended. The rationale for this are two: Firstly, as has been discussed biodiversity loss in Ethiopia is so serious that it should get particular attention and secondly as an agrarian and pastoral society, the life of many Ethiopians depend upon biodiversity; if biodiversity be well cared for, the living conditions of the citizens would soon change. This becomes possible when biodiversity issues are given special attention and separately treated. In this respect, the following national biodiversity conservation strategy is proposed.

### 6.2.2 Proposal for the National Conservation Strategy

#### 6.2.2.1 Scope

As the goal of biodiversity conservation i.e. supporting sustainable development by protecting and using biological resources in ways that do not diminish the country's variety of genes and species or destroy important habitats and ecosystems, is so broad, any biodiversity conservation strategy must also have a broad scope. It has to ensure and/or promote at least the achievement of three goal components, namely, saving biodiversity, studying it, and using it sustainably and equitably.

Saving biodiversity means taking steps to protect genes, species, habitats, and ecosystems. The best way to maintain species is to maintain their habitats. Saving biodiversity therefore often involves efforts to prevent the degradation of key natural ecosystems and to manage and protect them effectively. However, measures to maintain diversity on land and in water that have already been disturbed, restore lost species to their former habitats, and preserve species in genebanks, zoos, botanic gardens, and other off-site (ex-situ) facilities must also come under this strategy.

Studying biodiversity means documenting its composition, distribution, structure, function; understanding the roles and functions of genes, species, and ecosystems; grasping the complex links between modified and natural systems, and using this understanding to support sustainable development. It also means building awareness of biodiversity's values, providing opportunities for people to appreciate nature's variety, integrating biodiversity issues into educational curricula, and ensuring that the public has access to information on biodiversity, especially on developments that will influence local situations.

Using biodiversity sustainably and equitably means husbanding biological resources so that they last indefinitely, making sure that biodiversity is used to improve the condition, and seeing that these resources are shared equitably.

The national biodiversity conservation strategy must therefore encompass concern for at least these three conservation goal components.

6.2.2.2 Key Strategic Objectives to be Adopted

The National Biodiversity Conservation Strategy needs to have key strategic objectives/development frame work to be achieved ultimately. Instrumental to achieving these key strategic objectives, again, there are other subordinate objectives with corresponding actions and investment programs (if possible). In view of this, the following objectives are recommended to be adopted.

It is assumed that government, through its policy intervention, can create the incentives that facilitate or constrain local action where biodiversity is ultimately conserved. The secondary objectives and corresponding actions recommended include the following: (Note: Indented items are recommended actions to achieve the subordinate objective to which they belong).

Sub-objectives and corresponding actions

1. Reforming existing public policies that invite the waste or misuse of biodiversity. (Appropriate actions to achieve this shall include):
   - Abandon forestry policies that encourage resource degradation and the conversion of forest ecosystems to other less valuable uses.
   - Reform policies that hasten loss of biodiversity in freshwater ecosystems.

2. Adopting new public policies and accounting methods that promote conservation and equitable use of biodiversity
   - Assert national sovereignty over genetic resources and regulate their collection.
   - Strictly regulate the transfer of species and genetic resources and their release into the wild.

-Establish incentives for effective and equitable private sector plant breeding and research.

-Modify national income accounts to make them reflect the economic loss that results when biological resources are degraded and biodiversity is lost.

3. Reducing demand for biological resources

-Provide universal access to family planning services and increase funding to support their adoption.

-Reduce resource consumption through recycling and conservation.

-Audit the consumption of biological resources to raise awareness of the balance between local consumption and production.

6.2.2.2.2 *Adopt an International Policy Environment that supports National Biodiversity Conservation*

The impacts of ecosystem and habitat degradation reach beyond national boundaries. Climate regimes, river flows, sediment deposition patterns, and migratory species are all affected. The interconnections in the world environment mean that biodiversity loss in one area is liable to be felt widely. As the whole world shares crop plants, medicinal plants, and other living resources and due to the increasing interlinkage of the global economy, these interconnections are the stronger.

<u>Sub-objectives and corresponding actions</u>

1. Integrate biodiversity conservation into the national economic policy
   - Develop a principle and policy of "national ecological security" to ensure that international trade policies do not intensify biodiversity loss.
   - Facilitate the exchange and development of technologies for conserving and using biodiversity sustainably.
   - Ensure that the country is free to decide whether to adopt intellectual property rights protection for genetic resources and how strong that protection should be.

2. Strengthen the national legal framework for conservation to complement the Convention on Biological Diversity.
   - Strengthen the effectiveness of existing national convention and treaties covering the conservation of ecosystems, species, and genes.

3. Making the development assistance process a force for biodiversity conservation

   - Incorporate biodiversity values into the criteria for choosing, designing, and evaluating development assistance loans and projects, and for assessing the country's economic performance.
   - Open the development assistance process the design, implementation, and evaluation of projects and the policies that guide them to public scrutiny, participation, and accountability.

4. Increasing funding for biodiversity conservation, and develop innovative, decentralized, and accountable ways to raise funds and spend them effectively.

   - Involve governments, multilateral development agencies, and non-government organizations jointly in establishing new biodiversity conservation funding sources and mechanisms.
   - Promote the use of trust funds or endowments for biodiversity conservation.
   - Develop mechanisms to fund grassroots organizations and initiatives.

### 6.2.2.2.3 *Creating Conditions and Incentives for Local Biodiversity Conservation*

Local communities simply have no economic incentives to conserve biodiversity. In these communities, the key to successful conservation is making sure that they share the benefits fairly and do not shoulder a disproportionate share of the costs.

Sub-objectives and corresponding actions:

1. Correcting imbalances in the control of land and resources that cause biodiversity loss and develop new resource management partnerships between government and local communities,
   - Reduce pressure on fragile ecosystems and wildlands by using land already under cultivation more efficiently and equitably.
   - Increase incentives for local stewardship of public lands and waters.
   - Recognise the culture, knowledge, and desire of indigenous people and support their efforts to maintain traditional practices and adapt them to modern pressures and conditions.
   - Compensate individuals and local communities who own or depend on lands or resources taken for public purposes.

2. Expanding and encouraging the sustainable use of products and services from the wild for local benefits

   -Recognise and quantify the local economic value of wildproducts in development and land use planning

   -Encourage local communities to explore opportunities for developing a larger market share for wild products harvested sustainably.

   -Increase the local benefits of tourism in natural areas -"ecotourism"- ensure that tourism development does not result in biodiversity loss or cultural conflict.

   -Strengthen local capacity for maintaining and benefiting from crop and varietal diversity.

   -Develop the role of traditional medicines and ensure their appropriate and sustainable use.

3. Ensuring that those who possess local knowledge related to genetic resources benefit appropriately when it is used

   -Promote recognition of the value of local knowledge and genetic resources and affirm local peoples' rights.

   -Base the collection of genetic resources on contractual or other agreements ensuring equitable returns to local people/community.

6.2.2.2.4 *Managing Biodiversity throughout the Human Environment*

Clearly, the success of biodiversity conservation will depend upon how well the overall landscape is managed to minimize biodiversity loss. Human needs and activities must be reconciled with the maintenance of biodiversity, and protected areas must be integrated into natural and modified surroundings. Farms, forests, grazing areas, fisheries, and villages belong on the same planning grid as land restoration projects, protected areas, and species conservation efforts. The scale of such efforts must be tailored to both ecological processes and the needs and perception of local communities. This integrative approach is here termed bioregional management. A bioregion is a land and water territory whose limits are defined not by political boundaries, but by the geographical limits of human communities and ecological systems.

Sub-objectives and corresponding actions:

1. Creating the institutional conditions for bioregional conservation and development
   - Develop new methods and mechanisms at the bioregional level for dialogue, planning, and conflict resolution.

-Give weak and disenfranchised groups the means to influence how the bioregion's resources should be managed and distributed (encourage their participation).

-Establish intersectoral and interagency task forces to facilitate bioregional planning and action.

-Establish bioregional information centers to heighten public awareness and support biodiversity conservation

2. Supporting biodiversity conservation initiatives in the private sector

   -Establish tax incentives for conservation

   -Support the establishment of private biodiversity conservation trusts.

3. Incorporating biodiversity conservation into the management of biological resources.

   -Incorporate biodiversity conservation practices into the management of all forests.

   -Promote agricultural practices that conserve biodiversity

   -Restore degraded lands in ways that enhance their productivity and biodiversity.

6.2.2.2.5 *Strengthening Protected Areas*

Every effort has to be made to preserve, conserve, and manage biodiversity. Protected areas, from large wilderness reserves to small sites for particular species, and reserves for controlled uses, will all be part of this process. Such systems of protected areas must be managed to take account of a range of ecological and human-induced changes.

Sub objectives and corresponding actions:

1. Identifying national and international processes for strengthening protected areas and enhancing their role in biodiversity conservation.
   - -Conduct national reviews of protected area systems.
   - -Prepare immediate and long-term action to establish and strengthen protected areas.
   - -Undertake a national assessment of present and future protected area needs.
   - -Promote international cooperation on protected area management

2. Ensuring sustainability of protected areas and their contribution to biodiversity conservation
   - -Broader participation in the design of protected

area management plans and expand the range of issues addressed by those plans.

- Expand the management objectives of the protected areas to include the full scope of biodiversity conservation.
- Enhance the ecological and social value of protected areas through land purchase and zoning outside the protected area and by providing financial incentives for conservation on adjacent private lands.
- Enhance the ecological and social value of protected areas by increasing the benefits to people in and around them.
- Restore degraded lands within protected areas and in adjacent lands and corridors.

6.2.2.2.6 *Conserving Species, Populations, and Genetic Diversity*

By almost any reckoning, the most effective and efficient mechanism for conserving biodiversity is to prevent the destruction or degradation of habitat. For conserving the diversity of landscapes and ecosystems, there is no alternative. But a particular species or population may become a conservation target for various reasons such as unique threats from overexploitation, pollution, or introduced predators or competitors. During this time to conserve individual species, populations, and genes, habitat protection will have to be complemented by a wide array of other techniques. The options range from species-management programs in the wild to off-site protection in botanic gardens, zoos, genebanks, and aquaria. Plants and animals conserved in botanic gardens and zoos can be used to restore degraded lands, reintroduce species into the wild, and restock depleted populations. Finally, zoos, botanic gardens, aquaria, and other such facilities can give the public a window on the natural environment and expand opportunities for basic and applied research.

Sub-objectives and corresponding actions:

1. Strengthening capacity to conserve species, populations, and genetic diversity in natural habitats
   - Integrate the conservation of species, population, and genetic resources into regional management and protected area reviews.
   - Use flag slip (a list for species of significance at national and international levels including the status and conservation needs) species to increase support for conservation.
   - Improve and expand legal mechanisms to protect species.

2. Strengthening the capacity of off-site conservation facilities to conserve biodiversity, educating the public, and contributing to sustainable development

- Strengthen crop and livestock genetic resource conservation, and implement the national initiative for security and sustainable use of plant genetic resources.

- Develop the nation's collections of cultures of micro-organisms as an ex-situ (fungi, protozoa, and viruses).

- Fill major gaps in the protection of plant genetic resource (such as, forest trees, medicinal plants, ornamental and "minor" crops of local or regional importance)

- Develop the Plant Genetic Resource Centre/Ethiopia as a major and comprehensive off-site network for conserving plant resources (by encouraging to set up also botanic gardens).
- Strengthen the conservation role of zoological parks.
- Strengthen the role of public aquaria in the conservation of biodiversity.

-Strengthen collaboration among off-site and on site conservation institutions, partly to enlarge the role of off-site facilities in species reintroduction, habitat restoration, and habitat rehabilitation. Indeed, institutions concerned with the conservation of biological diversity must come under one common co-ordinating authority.

#### 6.2.2.2.7 *Expanding Human Capacity to Conserve Biodiversity*

Research, training, and information management help expand the human capacity to conserve genes, species, and ecosystems. But even more important is expanding people's awareness of biodiversity and appreciation of its significance. As the German philosopher Goethe observed "Every man is given only enough strength to complete those assignments of whose importance he is fully convinced." Conservation can succeed only if people understand biodiversity distribution and value, see how it figures in their own lives and aspirations, and know how to manage bioregions to meet human needs without damage. "A greening of the human mind must precede the greening of our Earth. A green mind is one that cares, saves, and shares." by M.S. Swaminathan, former president of IUCN.

Sub-objectives and corresponding actions:

1. Increasing appreciation and awareness of biodiversity's values and importance.

   - Build awareness of the importance and values of biodiversity into popular culture.
   - Use the formal education system to increase awareness about biodiversity and the need for its conservation.
   - Integrate biodiversity concerns into education outside of the classroom.

2. Helping institutions disseminate the information needed to conserve biodiversity and mobilizing its benefits.

   - Establish or strengthen national and regional institutions providing information on the conservation and potential values of biodiversity. From the survey, it becomes evident that PGRC/E stands by far better than all the others in respect to information management, trained staff, information facilities, and information services. Therefore this centre would serve as the National biodiversity information Centre. This will facilitate and make less expensive the implementation/development of the prototype information support system for biodiversity studies in Ethiopia. The only adjustment required is to widen its scope from confining itself with domestic germplasm to other components of biodiversity such as wild plants, forest trees, medicinal plants, forages, microbial, and wild animals. This is, again, consistent to the proposal made by the Transitional Government that PGRC/E serves as national biodiversity center.

-Undertake national biodiversity inventories and produce periodic national biodiversity assessments.

-Establish links to the global biodiversity information network to speed up the flow of data for local, regional, national and global assessments.

3. Promoting basic and applied Research on biodiversity conservation

-Systematically assess national biodiversity research priorities.

-Promote basic and applied natural sciences such as research on biodiversity conservation.

-Strengthen social science research on the connection between biodiversity and social processes.

-Strengthen research on ethical, cultural, and religious concerns related to conserving biodiversity.

4. Developing human resources capacity for biodiversity conservation. Increased funding, internal conventions, and expanded protected area systems all will be ineffective unless the pool of trained human talent for biodiversity conservation expands rapidly. Committed and skilled people are key to the success of the actions called for in this strategy

-Increased support for training biodiversity professionals.

-Revise career incentives provided by governments to increase the attractiveness of works in the field.

-Strengthen influence and capacity of non-governmental conservation and development organizations to promote biodiversity conservation.

### 6.2.3 National Biodiversity Information and Monitoring System (NBIMS)

#### 6.2.3.1 Purpose and Objective of NBIMS

Just as efficient and effective flow of biodiversity information strengthens protected areas, off-site facilities, research and development centers, and the people who need and depend upon biological resources for their livelihood, a lack of relevant and accessible information impedes biodiversity conservation. Users often fail to get information at all; and at times find themselves stuck with large amount of data, maps, and tables that they cannot use. Resolving these barriers requires attention to three basic issues.

First is structural ignorance i.e ignorance caused by poor access to existing information. The people who most need information on biodiversity often have no access to costly, unpublished, or classified publications. They also find terminology used on reports obscure, and the bureaucratic procedures for obtaining them imposing. On the other hand, universities and government agencies do not often let people know what information they have. Many of these barriers exist because (1) adequate finance is not allocated to acquire published and unpublished sources and journals, (2) of lack of trained personnel (3) of the absence of conducive environment (users and management do not recognise value of information).

Second, information obtained often does not meet user's needs. This is mainly due to lack of trained personnel who must systematically survey the user communities to determine what is needed and how best to present it and act upon accordingly. Finally, much information is not scientifically credible. This can also be avoided if experts are made to screen documents for data entry at first and due care is paid in processing it further.

For problems mentioned above as well as others, the recommended solution is to establish a national biodiversity information and monitoring system. Its objective shall be to ensure and promote the free flow and utilization of biodiversity information to current and prospective users.

6.2.3.2 Subject Scope of the System

As a national system, it should take into account the needs of wide range of users (as mentioned in chapter three). Information of interest to the system include both published and unpublished documents (books, articles in periodicals, legal documents, reports, thesis, machine-readable media, maps, tables, etc.) and also factual (numerical and statistical data), and object-oriented databases on biodiversity/biological resources and related areas.

6.2.3.3 Structure of the System

As mentioned in chapter five (implementation strategy), the system is to be organized as a centralized system to which participating members shall be linked. The central system (focal point) encourages the participating members to provide it with input data and in return outputs of the system should be made accessible to all participating institutions and to other target users. In the mean time, protocols are needed for exchanging information between the focal point and other participating members. This should be prepared by a central co-ordinating body of representatives of all participating institutions. Once participating institutions own uniform computer protocols and definition of fields, etc then, the centralized system can be converted to a full network system after which each node using a modem and a data communication software can access at any time other nodes for information.

6.2.3.4 Proposed Functions of the System

1. Coordinating collections and documentation

Biodiversity data and specimens of the nation's species are currently scattered (among different university departments and government institutions). The proposed system shall perform this activity centrally. Financial, human, material, equipment and other resources required to co-ordinate collection efforts should be provided. This system shall serve as an official repository of biodiversity specimens and biodiversity information source. Thus, the system shall store data from all collections within the country, and develop complementary collecting policies with other collections. It will receive/search various sources (publications, reports, thesis, proceedings, monographs); screen them; extract data from appropiate ones (review, extract data, collect information), prepare data (source data sheets/worksheets), and enter data into the computer system.

2. Designing and developing databases

Prototypes have been described in chapter four.

Similarly, database shall be developed for other components such as microbial, water species, etc. Moreover, databases should be strengthened through the application of GIS to present data in geographic formats in such a way that it can easily be integrated with other natural resources, demographic and socio-economic information.

3. Inventory

This is related to housing additional collections (specimens), labelling, monitoring, and producing inventory lists.

4. Providing information for policy needs

System should support the formulation of national, regional, and local policies for development and resource management by making policy-relevant information available. Annual reports on the nations biodiversity and biological resources, endangered species population trends, plants and animals of potential economic value, as well as maps on land use and the location of important endemic or threatened species would help government administrators, community groups, and non-government organizations make rational land or resource management and conservation decisions.

5. Disseminating Information

The national center besides providing services such as SDI, current awareness, on-line database searches, information analysis and synthesis should serve as a clearing house for biodiversity information.

6. Networking

Networking among the biodiversity - related institutions is very critical. As the institutions at present have no clear demarcating line of tasks there is duplication of work that implies wastage of resources, time and effort. This can be minimized by setting up network among institutions. Networks must first be set up for the institutions surveyed and later on form links to other national and international networks. In this regard, the system should further ensure consistency and uniformity of input at decentralized level by distributing the appropriate manuals, rules, conventions, standards, formats, etc.

7. Reprography function

8. Training

6.2.3.5 Target Users of the System

Institutions and people identified as users of biodiversity information in chapter three shall virtually constitute the target user group. In the event this becomes difficult (at the beginning), priority concern should be given to fulfilling the requirements of participating institutions and planners and policy makers.

6.2.3.6 Outputs/Products of the System

1. Publications

National biodiversity status report shall be produced periodically (e.g. biennial) and distributed to members and other users on request. The report shall also be available in machine readable format for institutions with appropriate computer facilities.

2. On-line Database Search (on plants, national parks, wild-animals, germplasms, forages, and referral and reference services).
3. Abstracts
4. Reprography services
5. Translation services to disseminate especially project documents to local people influenced by the project in the local language.

6. Production of labels and inventory lists; red-data lists of threatened species; reports on the status of specific ecosystems; and other reports on request, from the database.
7. Providing training services to the staff of participating institutions.

### 6.2.4 Implementing the Strategy

National governments must take the lead to set the proposed policy framework, by allocating resources and integrating biodiversity into the national and sectoral planning processes. Regional biodiversity plans are also needed. Community-level organizations and activities represent the front lines in making biodiversity conservation equitable and effective. Other influential bodies include non-governmental organizations, indigenous communities, private business, education and training bodies, researchers, and information disseminators.

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# APPENDIX II

## The Birds of Ethiopia

| Scientific Name | Determinator | English Name | Status |
|---|---|---|---|
| Order Struthioniformes | | | |
| Family Struthionidae - Ostrich | | | |
| *Struthio camelus* | Linn. | Ostrich | |
| Order Podicipediformes | | | |
| Family Podicipedidae - Grebes | | | |
| *Tachybaptus ruficollis* | (Pallas). | Little Grebe | |
| *Podiceps cristatus* | Linn. | Great-crested Grebe | |
| *Podiceps nigricollis* | Brehm. | Black-necked Grebe | |
| Order Procellariiformes | | | |
| Family Procellariidae - Shearwaters | | | |
| *Puffinus lherminieri* | Lesson | Persian Gulf Shearwater | |
| Order Pelecaniformes | | | |
| Family Phaethontidae - Tropicbirds | | | |
| *Phaethon aethereus* | Linn. | Red-billed Tropicbird | |
| Family Sulidae - Boobies | | | |
| *Sula dactylatra* | Lesson. | Masked Booby | |
| *Sula leucogaster* | (Boddaert). | Brown Booby | |
| Family Phalacrocoracidae - Cormorants | | | |
| *Phalacrocorax carbo* | (Linn.). | Cormorant | |
| *Phalacrocorax nigrogularis* | Ogilvie-Grant & Forbes. | Socotran Cormorant | |
| *Phalacrocorax africanus* | Gmelin. | Long-tailed Cormorant | |
| Family Anhingidae - Darters | | | |
| *Anhinga rufa* | (Daudin). | African Darter | |
| Family Pelecanidae - Pelicans | | | |
| *Pelecanus onocrotalus* | Linn. | Great White Pelican | |
| *Pelecanus rufescens* | Gmelin. | Pink-backed Pelican | |
| Family Fregatidae - Frigate-birds | | | |
| *Fregata ariel* | (Gray). | Lesser Frigate-bird | |
| Order Ciconiiformes | | | |
| Family Ardeidae - Herons, Bitterns, Egrets | | | |
| *Botaurus stellaris* | (Linn.). | Bittern | |
| *Ixobrychus minutus* | (Linn.). | Little Bittern | |
| *Ixobrychus sturmii* | (Wagler). | African Dwarf Bittern | |
| *Nycticorax nycticorax* | (Linn.). | Night Heron | |
| *Nycticorax leuconotus* | (Wagler). | White-backed Night Heron | |
| *Butorides striatus* | (Linn.). | Green-backed Heron | |
| *Ardeola ralloides* | (Scopoli). | Squacco Heron | |
| *Bubulcus ibis* | (Linn.). | Cattle Egret | |
| *Egretta ardesiaca* | (Wagler). | Black Heron | |
| *Egretta gularis* | (Bosc) | Reef Heron | |
| *Egretta garzetta* | (Linn.). | Little Egret | |
| *Egretta intermedia* | (Wagler). | Yellow-billed Egret | |
| *Egretta alba* | (Linn.). | Great White Egret | |
| *Ardea cinerea* | Linn. | Grey Heron | |
| *Ardea melanocephala* | Vigors & Children. | Black-headed Heron | |
| *Ardea goliath* | Cretzschmar. | Goliath Heron | |
| *Ardea purpurea* | Linn. | Purple Heron | |
| Family Balaenicipitidae - Whale-headed Stork | | | |
| *Balaeniceps rex* | Gould. | Whale-headed Stork | T |

Source: Jesse C. Hillman

| Scientific Name | Determinator | English Name | Status |
|---|---|---|---|
| Family Ciconiidae - Storks | | | |
| *Mycteria ibis* | (Linn.). | Yellow-billed Stork | |
| *Ciconia nigra* | (Linn.). | Black Stork | |
| *Ciconia abdimii* | (Lichtenstein). | Abdim's Stork | |
| *Ciconia episcopus* | (Boddaert). | Woolly-necked Stork | |
| *Ciconia ciconia* | (Linn.). | White Stork | |
| *Ephippiorhynchus senegalensis* | (Shaw). | Saddle-billed Stork | |
| *Anastomus lamelligerus* | Temminck. | Open-bill Stork | |
| *Leptoptilos crumeniferus* | (Lesson). | Marabou | |
| Family Threskiornithidae - Ibises, Spoonbills | | | |
| *Plegadis falcinellus* | (Linn.). | Glossy Ibis | |
| *Bostrychia carunculata* | (Rüppell). | Wattled Ibis | E |
| *Bostrychia hagedash* | (Latham). | Hadada Ibis | |
| *Geronticus eremita* | (Linn.). | Waldrapp | T |
| *Threskiornis aethiopicus* | (Latham). | Sacred Ibis | |
| *Platalea alba* | Scopoli. | African Spoonbill | |
| *Platalea leucorodia* | Linn. | Spoonbill | |
| Order Phoenicopteriformes | | | |
| Family Phoenicopteridae - Flamingoes | | | |
| *Phoenicopterus ruber* | Linn. | Greater Flamingo | |
| *Phoenicopterus minor* | (Geoffroy). | Lesser Flamingo | |
| Order Anseriformes | | | |
| Family Anatidae - Ducks, Geese | | | |
| *Dendrocygna bicolor* | (Viellot). | Fulvous Tree Duck | |
| *Dendrocygna viduata* | (Linn.). | White-faced Tree Duck | |
| *Cyanochen cyanoptera* | (Rüppell). | Blue-winged Goose | E |
| *Alopochen aegyptiacus* | (Linn.). | Egyptian Goose | |
| *Tadorna ferruginea* | (Pallas). | Ruddy Shelduck | |
| *Plectropterus gambensis* | (Linn.). | Spur-winged Goose | |
| *Sarkidiornis melanota* | (Pennant). | Knob-billed Goose | |
| *Nettapus auritus* | (Boddaert). | Pygmy Goose | |
| *Anas sparsa* | Eyton. | Black Duck | |
| *Anas penelope* | Linn. | Wigeon | |
| *Anas strepera* | Linn. | Gadwall | |
| *Anas crecca* | Linn. | Common Teal | |
| *Anas capensis* | Gmelin. | Cape Wigeon | |
| *Anas undulata* | Dubois. | Yellow-billed Duck | |
| *Anas platyrhynchos* | Linn. | Mallard | |
| *Anas acuta* | Linn. | Pintail | |
| *Anas erythrorhyncha* | Gmelin. | Red-billed Duck | |
| *Anas hottentota* | Eyton. | Hottentot Teal | |
| *Anas querquedula* | Linn. | Garganey | |
| *Anas clypeata* | Linn. | Shoveler | |
| *Anas smithii* | Hartert. | Cape Shoveler | |
| *Netta erythrophthalma* | (Wied). | African Pochard | |
| *Aythya ferina* | Linn. | Pochard | |
| *Aythya nyroca* | (Güldenstädt). | White-eyed Pochard | |
| *Aythya fuligula* | (Linn.). | Tufted Duck | |
| *Oxyura maccoa* | (Eyton). | Maccoa Duck | |
| *Thalassornis leuconotus* | Eyton. | White-backed Duck | |

| Scientific Name | Determinator | English Name | Status |
|---|---|---|---|
| Order Accipitriformes | | | |
| Family Accipitridae - Hawks, Vultures, Eagles | | | |
| *Aviceda cuculoides* | Swainson. | African Cuckoo-hawk | |
| *Pernis apivorus* | (Linn.). | Honey Buzzard | |
| *Machaerhamphus alcinus* | Westerman | Bat Hawk | |
| *Elanus caeruleus* | (Desfontaines). | Black-shouldered Kite | |
| *Chelictinia riocourii* | (Viellot) | Swallow-tailed Kite | |
| *Milvus migrans* | (Boddaert). | Black Kite | |
| *Haliaeetus vocifer* | (Daudin). | African Fish Eagle | |
| *Gypaetus barbatus* | (Linn.). | Lammergeier | |
| *Neophron percnopterus* | (Linn.). | Egyptian Vulture | |
| *Necrosyrtes monachus* | (Temminck). | Hooded Vulture | |
| *Gyps africanus* | Salvadori. | African White-backed Vulture | |
| *Gyps fulvus* | (Hablizl). | Griffon Vulture | |
| *Gyps rueppellii* | (Brehm). | Rüppell's Griffon | |
| *Torgos tracheliotus* | (Forster). | Lappet-faced Vulture | |
| *Trigonoceps occipitalis* | (Burchell). | White-headed Vulture | |
| *Circaetus gallicus* | (Gmelin). | European Short-toed Eagle | |
| *Circaetus pectoralis* | Smith | Black-chested Snake-eagle | |
| *Circaetus cinereus* | Viellot | Brown Snake-eagle | |
| *Circaetus cinerascens* | von Müller. | Smaller Banded Snake-eagle | |
| *Terathopius ecaudatus* | (Daudin). | Bateleur | |
| *Polyboroides typus* | Smith. | African Harrier Hawk | |
| *Circus aeruginosus* | (Linn.). | Marsh Harrier | |
| *Circus ranivorus* | (Daudin) | African Marsh Harrier | |
| *Circus macrourus* | (Gmelin). | Pallid Harrier | |
| *Circus pygargus* | (Linn.). | Montagu's Harrier | |
| *Melierax metabates* | Heuglin. | Dark Chanting Goshawk | |
| *Melierax canorus* | (Rislachi). | Pale Chanting Goshawk | |
| *Melierax gabar* | (Daudin). | Gabar Goshawk | |
| *Accipiter melanoleucus* | Smith. | Great Sparrow-hawk | |
| *Accipiter ovampensis* | Gurney. | Ovampo Sparrow-hawk | |
| *Accipiter nisus* | (Linn.). | European Sparrow-hawk | |
| *Accipiter rufiventris* | Smith. | Rufous-breasted Sparrow-hawk | |
| *Accipiter minullus* | (Daudin). | African Little Sparrow-hawk | |
| *Accipiter tachiro* | (Daudin). | African Goshawk | |
| *Accipiter badius* | (Gmelin). | Shikra | |
| *Accipiter brevipes* | (Severtsov) | Levant Sparrow-hawk | |
| *Butastur rufipennis* | (Sundevall). | Grasshopper Buzzard | |
| *Kaupifalco monogrammicus* | (Temminck). | Lizard Buzzard | |
| *Buteo buteo* | (Linn.). | Common Buzzard | |
| *Buteo oreophilus* | Hartert & Neumann. | African Mountain Buzzard | |
| *Buteo rufinus* | Cretzschmar. | Long-legged Buzzard | |
| *Buteo auguralis* | Salvadore. | African Red-tailed Buzzard | |
| *Buteo augur* | (Rüppell) | Augur Buzzard | |
| *Aquila pomarina* | Brehm. | Lesser Spotted Eagle | |
| *Aquila clanga* | Pallas. | Greater-spotted Eagle | |
| *Aquila rapax* | (Temminck). | Tawny Eagle | |
| *Aquila nipalensis* | Hodgson | Steppe Eagle | |
| *Aquila helioca* | Savigny. | Imperial Eagle | |
| *Aquila wahlbergi* | Sundevall. | Wahlberg's Eagle | |
| *Aquila verreauxii* | Lesson. | Verreaux's Eagle | |
| *Hieraaetus pennatus* | (Gmelin). | Booted Eagle | |
| *Hieraaetus spilogaster* | (Bonaparte) | African Hawk-Eagle | |
| *Hieraaetus ayresii* | Guerney | Ayres' Hawk Eagle | |
| *Lophaetus occipitalis* | (Daudin). | Long-crested Eagle | |
| *Stephanoaetus coronatus* | (Linn.). | Crowned Eagle | |
| *Polemaetus bellicosus* | (Daudin). | Martial Eagle | |
| Family Pandionidae - Osprey | | | |
| *Pandion haliaetus* | (Linn.). | Osprey | |

| Scientific Name | Determinator | English Name | Status |
|---|---|---|---|
| Family Sagittariidae - Secretary Bird | | | |
| *Sagittarius serpentarius* | (Miller). | Secretary Bird | |
| Order Falconiformes | | | |
| Family Falconidae - Falcons | | | |
| *Polihierax semitorquatus* | (A. Smith). | African Pygmy Falcon | |
| *Falco naumanni* | Fleischer. | Lesser Kestrel | |
| *Falco rupicoloides* | A. Smith. | Greater Kestrel | |
| *Falco alopex* | (Heuglin). | Fox Kestrel | |
| *Falco tinnunculus* | Linn. | Common Kestrel | |
| *Falco ardosiaceus* | Viellot. | Grey Kestrel | |
| *Falco chicquera* | Daudin | Red-necked Falcon | |
| *Falco vespertinus* | Linn. | Red-footed Falcon | |
| *Falco amurensis* | Radde | Eastern Red-footed Falcon | |
| *Falco subbuteo* | Linn. | European Hobby | |
| *Falco cuvieri* | Smith. | African Hobby | |
| *Falco eleonorae* | Géné. | Eleonora's Falcon | |
| *Falco concolor* | Temminck. | Sooty Falcon | |
| *Falco biarmicus* | Temminck. | Lanner Falcon | |
| *Falco cherrug* | Gray. | Saker Falcon | |
| *Falco fasciinucha* | Reichenow & Neumann. | Taita Falcon | |
| *Falco peregrinus* | Tunstall. | Peregrine Falcon | |
| *Falco pelegrinoides* | Temminck | Barbary Falcon | |
| Order Galliformes | | | |
| Family Phasianidae - Francolins, Quails | | | |
| *Alectoris melanocephala* | (Rüppell). | Arabian Chukor | |
| *Ammoperdix heyi* | (Temminck). | Sand Partridge | |
| *Francolinus coqui* | (Smith). | Coqui Francolin | |
| *Francolinus sephaena* | (Smith). | Crested Francolin | |
| *Francolinus psilolaemus* | Gray. | Grey-wing | |
| *Francolinus levaillantoides* | (Smith). | Archer's Grey-wing | |
| *Francolinus harwoodi* | Blundell & Lovat. | Harwood's Francolin | E |
| *Francolinus clappertoni* | Children. | Clapperton's Francolin | |
| *Francolinus leucoscepus* | (Gray). | Yellow-necked Spurfowl | |
| *Francolinus castaneicollis* | Salvadori. | Chestnut-naped Francolin | |
| *Francolinus erckelii* | (Rüppell). | Erckel's Francolin | |
| *Francolinus squamatus* | Cassin | Scaly Francolin | |
| *Coturnix coturnix* | (Linn.). | European Quail | |
| *Coturnix delegorguei* | Delegorgue. | Harlequin Quail | |
| *Coturnix chinensis* | Linn. | Blue Quail | |
| *Ptilopachus petrosus* | (Gmelin). | Stone-Partridge | |
| Family Numididae - Guinea-fowls | | | |
| *Numida meleagris* | (Linn.). | Tufted Guinea-fowl | |
| *Acryllium vulturinum* | (Hardwicke). | Vulturine Guinea-fowl | |
| Order Gruiformes | | | |
| Family Turnicidae - Button-quails | | | |
| *Turnix sylvatica* | (Desfontaines). | Button Quail | |
| *Ortyxelos meiffrenii* | (Viellot). | Quail Plover | |

| Scientific Names | Determinator | English Name | Status |
|---|---|---|---|
| Family Rallidae - Rails, Crakes, Coots | | | |
| *Rallus caerulescens* | Gmelin. | Kaffir Rail | |
| *Rougetius rougetii* | (Guérin-Méneville. | Rouget's Rail | E |
| *Porzana porzana* | (Linn.). | Spotted Crake | |
| *Porzana parva* | (Scopoli). | Little Crake | |
| *Porzana pusilla* | (Pallas). | Baillon's Crake | |
| *Limnocorax flavirostra* | (Swainson). | Black Crake | |
| *Crex crex* | Linn. | Corn Crake | |
| *Crex egregia* | Peters. | African Crake | |
| *Sarothrura ayresi* | (Gurney). | White-winged Crake | T |
| *Sarothrura rufa* | (Viellot). | Red-chested Crake | |
| *Sarothrura elegans* | (Smith). | Buff-spotted Crake | |
| *Gallinula angulata* | Sundevall. | Lesser Moorhen | |
| *Gallinula chloropus* | Linn. | Moorhen | |
| *Porphyrio alleni* | (Thomson) | Allen's Gallinule | |
| *Porphyrio porphyrio* | (Linn.). | Purple Gallinule | |
| *Fulica atra* | Linn. | Coot | |
| *Fulica cristata* | Gmelin. | Red-knobbed Coot | |
| Family Heliornithidae - Finfoot | | | |
| *Podica senegalensis* | (Viellot). | Finfoot | |
| Family Gruidae - Cranes | | | |
| *Grus grus* | (Linn.). | Common Crane | |
| *Grus carunculatus* | (Gmelin). | Wattled Crane | T |
| *Anthropoides virgo* | (Linn.). | Demoiselle Crane | |
| *Balearica pavonina* | (Linn.). | Crowned Crane | |
| Family Otididae - Bustards | | | |
| *Neotis denhami* | (Children). | Denham's Bustard | |
| *Neotis heuglini* | (Hartlaub). | Heuglin's Bustard | |
| *Ardeotis kori* | (Burchell). | Kori Bustard | |
| *Ardeotis arabs* | (Linn.). | Arabian Bustard | |
| *Eupodotis ruficrista* | (Smith). | Crested Bustard | |
| *Eupodotis senegalensis* | (Viellot). | Senegal Bustard | |
| *Eupodotis melanogaster* | (Rüppell). | Black-bellied Bustard | |
| *Eupodotis hartlaubii* | (Heuglin). | Hartlaub's Bustard | |
| *Eupodotis humilis* | (Blyth). | Little Brown Bustard | |
| Order Charadriiformes | | | |
| Family Jacanidae - Jacanas | | | |
| *Actophilornis africana* | (Gmelin). | Jacana | |
| *Microparra capensis* | (Smith). | Smaller Jacana | |
| Family Rostratulidae - Painted Snipe | | | |
| *Rostratula benghalensis* | (Linn.). | Painted Snipe | |
| Family Haematopodidae - Oystercatcher | | | |
| *Haematopus ostralegus* | Linn. | Oystercatcher | |
| Family Recurvirostridae - Stilt, Avocet | | | |
| *Himantopus himantopus* | (Linn.). | Black-winged Stilt | |
| *Recurvirostra avosetta* | Linn. | Avocet | |
| Family Dromadidae - Crab Plover | | | |
| *Dromas ardeola* | Paykull. | Crab Plover | |
| Family Burhinidae - Thicknees | | | |
| *Burhinus oedicnemus* | (Linn.). | Stone Curlew | |
| *Burhinus senegalensis* | (Swainson). | Senegal Thicknee | |
| *Burhinus capensis* | (Lichtenstein). | Spotted Thicknee | |
| *Burhinus vermiculatus* | (Cabanis). | Water Thicknee | |

| Scientific Name | Determinator | English Name | Status |
|---|---|---|---|
| Family Glareolidae - Coursers, Pratincoles | | | |
| *Pluvianus aegyptius* | (Linn.). | Egyptian Plover | |
| *Cursorius cursor* | (Latham). | Cream-coloured Courser | |
| *Cursorius temminckii* | Swainson. | Temminck's Courser | |
| *Hemerodromus africanus* | (Temminck). | Two-banded Courser | |
| *Hemerodromus cinctus* | Heuglin | Heuglin's Courser | |
| *Rhinoptilus chalcopterus* | (Temminck). | Violet-tipped Courser | |
| *Glareola pratincola* | (Linn.). | Pratincole | |
| *Glareola nordmanni* | Fischer. | Black-winged Pratincole | |
| *Glareola nuchalis* | (Gray). | Rock Pratincole | |
| *Glareola ocularis* | Verreaux. | Madagascar Pratincole | |
| Family Charadriidae - Plovers | | | |
| *Charadrius dubius* | Scopoli. | Little Ringed Plover | |
| *Charadrius hiaticula* | Linn. | Ringed Plover | |
| *Charadrius pecuarius* | Temminck. | Kittlitz's Sand-Plover | |
| *Charadrius tricollaris* | Viellot. | Three-banded Plover | |
| *Charadrius alexandrinus* | Linn. | Kentish Plover | |
| *Charadrius mongolus* | Pallas. | Mongolian Sand-Plover | |
| *Charadrius leschenaultii* | Lesson. | Great Sand-Plover | |
| *Charadrius asiaticus* | Pallas. | Caspian Plover | |
| *Pluvialis fulva* | (Gmelin) | Pacific Golden Plover | |
| *Pluvialis squatarola* | (Linn.). | Grey Plover | |
| *Hoplopterus crassirostris* | (Hartlaub). | Long-toed Lapwing | |
| *Hoplopterus spinosus* | (Linn.). | Spur-winged Plover | |
| *Hoplopterus tectus* | (Boddaert). | Black-headed Plover | |
| *Hoplopterus melanopterus* | (Cretzschmar). | Black-winged Plover | |
| *Hoplopterus coronatus* | (Boddaert). | Crowned Lapwing | |
| *Hoplopterus senegallus* | (Linn.). | Wattled Plover | |
| *Hoplopterus melanocephalus* | (Rüppell). | Spot-breasted Plover | E |
| *Chettusia gregaria* | (Pallas). | Sociable Plover | |
| Family Scolopacidae - Sandpipers | | | |
| *Calidris alba* | (Pallas). | Sanderling | |
| *Calidris minuta* | (Leisler). | Little Stint | |
| *Calidris temminckii* | (Leisler). | Temminck's Stint | |
| *Calidris subminuta* | Middendorff. | Long-toed Stint | |
| *Calidris melanotos* | (Viellot). | Pectoral Sandpiper | |
| *Calidris ferruginea* | (Pontoppidan). | Curlew Sandpiper | |
| *Calidris alpina* | (Linn.). | Dunlin | |
| *Limicola falcinellus* | (Pontoppidan). | Broad-billed Sandpiper | |
| *Philomachus pugnax* | (Linn.). | Ruff | |
| *Lymnocryptes minimus* | (Brünnich). | Jack Snipe | |
| *Gallinago gallinago* | (Linn.). | Common Snipe | |
| *Gallinago nigripennis* | Bonaparte | African Snipe | |
| *Gallinago media* | (Latham). | Great Snipe | |
| *Limosa limosa* | (Linn.). | Black-tailed Godwit | |
| *Limosa lapponica* | (Linn.). | Bar-tailed Godwit | |
| *Numenius phaeopus* | (Linn.). | Whimbrel | |
| *Numenius arquata* | (Linn.). | Curlew | |
| *Tringa erythropus* | (Pallas). | Spotted Redshank | |
| *Tringa totanus* | (Linn.). | Redshank | |
| *Tringa stagnatilis* | (Bechstein). | Marsh Sandpiper | |
| *Tringa nebularia* | (Gunnerus). | Greenshank | |
| *Tringa ochropus* | Linn. | Green Sandpiper | |
| *Tringa glareola* | Linn. | Wood Sandpiper | |
| *Xenus cinereus* | (Güldenstädt) | Terek Sandpiper | |
| *Actitis hypoleucos* | Linn. | Common Sandpiper | |
| *Arenaria interpres* | (Linn.). | Turnstone | |
| *Phalaropus lobatus* | (Linn.). | Red-necked Phalarope | |
| *Phalaropus fulicarius* | [illegible] | | |

| Scientific Name | Determinator | English Name | Status |
|---|---|---|---|
| Family Stercorariidae - Skuas | | | |
| *Stercorarius pomarinus* | (Temminck). | Pomarine Skua | |
| *Stercorarius parasiticus* | (Linn.). | Arctic Skua | |
| *Stercorarius skua* | (Brünnich). | Great Skua | |
| Family Laridae - Gulls | | | |
| *Larus hemprichii* | (Bruch). | Sooty Gull | |
| *Larus leucophthalmus* | Temminck. | White-eyed Gull | |
| *Larus ichthyaetus* | (Pallas). | Great Black-headed Gull | |
| *Larus ridibundus* | Linn. | Black-headed Gull | |
| *Larus cirrocephalus* | Viellot. | Grey-headed Gull | |
| *Larus genei* | Brème. | Slender-billed Gull | |
| *Larus fuscus* | Linn. | Lesser Black-backed Gull | |
| *Larus argentatus* | Pontoppidan. | Herring Gull | |
| Family Sternidae - Terns | | | |
| *Gelochelidon nilotica* | (Gmelin) | Gull-billed Tern | |
| *Sterna caspia* | Pallas | Caspian Tern | |
| *Sterna bergii* | Lichtenstein. | Swift Tern | |
| *Sterna bengalensis* | Lesson. | Lesser-crested Tern | |
| *Sterna sandvicensis* | Latham. | Sandwich Tern | |
| *Sterna dougallii* | Montagu. | Roseate Tern | |
| *Sterna hirundo* | Linn. | Common Tern | |
| *Sterna repressa* | Hartert. | White-cheeked Tern | |
| *Sterna anaethetus* | Scopoli. | Bridled Tern | |
| *Sterna albifrons* | Pallas. | Little Tern | |
| *Sterna saundersi* | Hume | Saunder's Little Tern | |
| *Chlidonias hybridus* | (Pallas) | Whiskered Tern | |
| *Chlidonias niger* | (Linn.) | Black Tern | |
| *Chlidonias leucopterus* | (Temminck) | White-winged Black Tern | |
| *Anous stolidus* | (Linn.). | Noddy | |
| Family Rynchopidae - Skimmers | | | |
| *Rhynchops flavirostris* | Viellot. | Skimmer | |
| Order Pteroclidiformes | | | |
| Family Pteroclididae - Sandgrouse | | | |
| *Pterocles lichtensteinii* | Temminck | Lichtenstein's Sandgrouse | |
| *Pterocles senegallus* | (Linn.) | Spotted Sandgrouse | |
| *Pterocles exustus* | Temminck | Chestnut-bellied Sandgrouse | |
| *Pterocles decoratus* | Cabanis | Black-faced Sandgrouse | |
| *Pterocles gutturalis* | Smith | Yellow-throated Sandgrouse | |
| *Pterocles quadricinctus* | Temminck | Four-banded Sandgrouse | |
| Order Columbiformes | | | |
| Family Columbidae - Pigeons, Doves | | | |
| *Columba livia* | Gmelin | Rock Dove (feral) | |
| *Columba albitorques* | Rüppell | White-collared Pigeon | E |
| *Columba guinea* | Linn. | Speckled Pigeon | |
| *Columba arquatrix* | Temminck | Olive Pigeon | |
| *Aplopelia larvata* | (Temminck) | Lemon Dove | |
| *Streptopelia capicola* | (Sundevall) | Ring-necked Dove | |
| *Streptopelia roseogrisea* | (Sundevall) | Pink-headed Dove | |
| *Streptopelia semitorquata* | (Rüppell) | Red-eyed Dove | |
| *Streptopelia decipiens* | (Hartlaub & Finch) | Mourning Dove | |
| *Streptopelia vinacea* | (Gmelin) | Vinaceous Dove | |
| *Streptopelia turtur* | Linn. | Turtle Dove | |
| *Streptopelia lugens* | (Rüppell) | Pink-breasted Dove | |
| *Streptopelia senegalensis* | (Linn.) | Laughing Dove | |
| *Streptopelia reichenowi* | (Erlanger) | White-winged Dove | |
| *Oena capensis* | (Linn.) | Namaqua Dove | |
| *Turtur tympanistria* | (Temminck) | Tambourine Dove | |
| *Turtur afer* | (Linn.) | Blue-spotted Wood-Dove | |
| *Turtur chalcospilos* | (Wagler) | Emerald-spotted Wood-Dove | |
| *Turtur abyssinicus* | (Sharpe) | Black-billed Blue-spotted Wood-Dove | |
| *Treron australis* | (Linn.) | Green Pigeon | |
| *Treron waalia* | (Meyer) | Bruce's Green Pigeon | |

| Scientific Name | Determinator | English Name | Status |
|---|---|---|---|
| Order Psittaciformes | | | |
| Family Psittacidae - Parrots, Lovebirds | | | |
| *Poicephalus flavifrons* | (Rüppell) | Yellow-fronted Parrot | E |
| *Poicephalus meyeri* | (Cretzschmar) | Brown Parrot | |
| *Poicephalus rufiventris* | (Rüppell) | Orange-bellied Parrot | |
| *Psittacula krameri* | (Scopoli) | Rose-ringed Parakeet | |
| *Agapornis taranta* | (Stanley) | Black-winged Lovebird | E |
| *Agapornis pullaria* | (Linn.) | Red-headed Lovebird | |
| Order Cuculiformes | | | |
| Family Musophagidae - Turacos | | | |
| *Tauraco leucotis* | (Rüppell) | White-cheeked Turaco | |
| *Tauraco ruspolii* | (Salvadori) | Prince Ruspoli's Turaco | E T |
| *Corythaixoides personata* | (Rüppell) | Bare-faced Go-away Bird | |
| *Corythaixoides leucogaster* | (Rüppell) | White-bellied Go-away Bird | |
| *Crinifer zonurus* | (Rüppell) | Eastern Grey Plantain-eater | |
| Family Cuculidae - Cuckoos | | | |
| *Clamator jacobinus* | (Boddaert) | Black-and-White Cuckoo | |
| *Clamator levaillantii* | (Swainson) | Levaillant's Cuckoo | |
| *Clamator glandarius* | (Linn.) | Great Spotted Cuckoo | |
| *Chrysococcyx caprius* | (Boddaert) | Didric Cuckoo | |
| *Chrysococcyx klaas* | (Stephens) | Klaas' Cuckoo | |
| *Chrysococcyx cupreus* | (Shaw) | Emerald Cuckoo | |
| *Ceuthmochares aereus* | (Viellot) | Yellowbill | |
| *Cuculus clamosus* | Latham | Black Cuckoo | |
| *Cuculus solitarius* | Stephens | Red-chested Cuckoo | |
| *Cuculus canorus* | Linn. | Cuckoo | |
| *Cuculus gularis* | Stephens | African Cuckoo | |
| *Centropus grillii* | Hartlaub | Black Coucal | |
| *Centropus monachus* | (Rüppell) | Blue-headed Coucal | |
| *Centropus senegalensis* | (Linn.) | Senegal Coucal | |
| *Centropus superciliosus* | Hemprich & Ehrenberg | White-browed Coucal | |
| Order Strigiformes | | | |
| Family Tytonidae - Barn Owls | | | |
| *Tyto alba* | (Scopoli) | Barn Owl | |
| *Tyto capensis* | (Smith) | Cape Grass Owl | |
| Family Strigidae - Owls | | | |
| *Otus scops* | (Linn.) | Eurasian Scops Owl | |
| *Otus senegalensis* | (Swainson) | African Scops Owl | |
| *Otus leucotis* | (Temminck) | White-faced Scops Owl | |
| *Bubo capensis* | Smith | Cape Eagle-owl | |
| *Bubo africanus* | (Temminck) | Spotted Eagle-owl | |
| *Bubo lacteus* | (Temminck) | Verreaux's Eagle-owl | |
| *Scotopelia peli* | (Bonaparte) | Pel's Fishing Owl | |
| *Glaucidium perlatum* | (Viellot) | Pearl-spotted Owlet | |
| *Athene noctua* | (Scopoli) | Little Owl | |
| *Ciccaba woodfordii* | (Smith) | African Wood Owl | |
| *Asio abyssinicus* | (Guérin-Méneville) | Abyssinian Long-eared Owl | |
| *Asio flammeus* | (Pontoppidan) | Short-eared Owl | |
| *Asio capensis* | (Smith) | African Marsh Owl | |

| Scientific Name | Determinator | English Name | Status |
|---|---|---|---|
| Order Caprimulgiformes | | | |
| Family Caprimulgidae - Nightjars | | | |
| *Caprimulgus inornatus* | Heuglin | Plain Nightjar | |
| *Caprimulgus nubicus* | Lichtenstein | Nubian Nightjar | |
| *Caprimulgus europaeus* | Linn. | European Nightjar | |
| *Caprimulgus aegyptius* | Lichtenstein | Egyptian Nightjar | |
| *Caprimulgus fraenatus* | Salvadori | Northern Dusky Nightjar | |
| *Caprimulgus donaldsoni* | Sharpe | Donaldson Smith's Nightjar | |
| *Caprimulgus poliocephalus* | Rüppell | Abyssinian Nightjar | |
| *Caprimulgus stellatus* | Blundell & Lovat | Star-spotted Nightjar | |
| *Caprimulgus tristigma* | Rüppell | Freckled Nightjar | |
| *Caprimulgus clarus* | Reichenow | Slender-tailed Nightjar | |
| *Caprimulgus climacurus* | Viellot | Long-tailed Nightjar | |
| *Caprimulgus natalensis* | Smith | White-tailed Nightjar | |
| *Macrodipteryx longipennis* | (Shaw) | Standard-wing Nightjar | |
| Order Apodiformes | | | |
| Family Apodidae - Swifts | | | |
| *Apus myioptilus* | (Salvadori) | Scarce Swift | |
| *Apus apus* | (Linn.) | Common Swift | |
| *Apus niansae* | (Reichenow) | Nyanza Swift | |
| *Apus melba* | (Linn.) | Alpine Swift | |
| *Apus aequatorialis* | (Müller) | Mottled Swift | |
| *Apus horus* | (Heuglin) | Horus Swift | |
| *Apus caffer* | (Lichtenstein) | White-rumped Swift | |
| *Apus affinis* | (Gray) | Little Swift | |
| *Cypsiurus parvus* | (Lichtenstein) | Palm Swift | |
| Order Coliiformes | | | |
| Family Coliidae - Mousebirds | | | |
| *Colius striatus* | Gmelin | Speckled Mousebird | |
| *Colius macrourus* | (Linn.) | Blue-naped Mousebird | |
| Order Trogoniformes | | | |
| Family Trogonidae - Trogon | | | |
| *Apaloderma narina* | (Stephens) | Narina's Trogon | |
| Order Coraciformes | | | |
| Family Alcedinidae - Kingfishers | | | |
| *Halcyon senegalensis* | (Linn.) | Woodland Kingfisher | |
| *Halcyon malimbica* | (Shaw) | Blue-breasted Kingfisher | |
| *Halcyon chelicuti* | (Stanley) | Striped Kingfisher | |
| *Halcyon chloris* | (Boddaert) | White-collared Kingfisher | |
| *Halcyon leucocephala* | (Müller) | Grey-headed Kingfisher | |
| *Alcedo semitorquata* | Swainson | Half-collared Kingfisher | |
| *Alcedo cristata* | (Pallas) | Malachite Kingfisher | |
| *Ceyx picta* | (Boddaert) | Pygmy Kingfisher | |
| *Ceryle rudis* | (Linn.) | Pied Kingfisher | |
| *Ceryle maxima* | (Pallas) | Giant Kingfisher | |
| Family Meropidae - Bee-eaters | | | |
| *Merops hirundineus* | Lichtenstein | Swallow-tailed Bee-eater | |
| *Merops albicollis* | Viellot | White-throated Bee-eater | |
| *Merops pusillus* | Müller | Little Bee-eater | |
| *Merops variegatus* | Viellot | Blue-breasted Bee-eater | |
| *Merops orientalis* | Latham | Little Green Bee-eater | |
| *Merops superciliosus* | Linn. | Olive Bee-eater | |
| *Merops persicus* | Pallas | Blue-cheeked Bee-eater | |
| *Merops apiaster* | Linn. | European Bee-eater | |
| *Merops nubicus* | Gmelin | Carmine Bee-eater | |
| *Merops revoilii* | Oustalet | Somali Bee-eater | |
| *Merops bulocki* | Viellot | Red-throated Bee-eater | |

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|---|---|---|---|
| Family Coraciidae - Rollers | | | |
| *Coracias garrulus* | Linn. | European Roller | |
| *Coracias abyssinica* | Hermann | Abyssinian Roller | |
| *Coracias caudata* | Linn. | Lilac-breasted Roller | |
| *Coracias naevia* | Daudin | Rufous-crowned Roller | |
| *Eurystomus glaucurus* | (Müller) | Broad-billed Roller | |
| Family Upupidae - Hoopoe | | | |
| *Upupa epops* | Linn. | Hoopoe | |
| Family Phoeniculidae - Wood-hoopoes | | | |
| *Phoeniculus purpureus* | (Miller) | Green Wood-hoopoe | |
| *Phoeniculus somaliensis* | (Ogilvie-Grant) | Black-billed Wood-hoopoe | |
| *Phoeniculus granti* | (Neumann) | Violet Wood-hoopoe | |
| *Phoeniculus aterrimus* | (Stephens) | Black Wood-hoopoe | |
| *Phoeniculus minor* | (Rüppell) | Abyssinian Scimitar-bill | |
| Family Bucerotidae - Hornbills | | | |
| *Tockus nasutus* | (Linn.) | Grey Hornbill | |
| *Tockus erythrorhynchus* | (Temminck) | Red-billed Hornbill | |
| *Tockus deckeni* | (Cabanis) | Von der Decken's Hornbill | |
| *Tockus flavirostris* | (Rüppell) | Yellow-billed Hornbill | |
| *Tockus hemprichii* | (Ehrenberg) | Hemprich's Hornbill | |
| *Tockus alboterminatus* | (Büttikofer) | Crowned Hornbill | |
| *Bycanistes brevis* | Friedmann | Silvery-cheeked Hornbill | |
| *Bucorvus abyssinicus* | (Boddaert) | Abyssinian Ground Hornbill | |
| Order Piciformes | | | |
| Family Capitonidae - Barbets | | | |
| *Lybius bidentatus* | (Shaw) | Double-toothed Barbet | |
| *Lybius guifsobalito* | Hermann | Black-billed Barbet | |
| *Lybius vieilloti* | (Leach) | Viellot's Barbet | |
| *Lybius undatus* | (Rüppell) | Banded Barbet | E |
| *Lybius melanocephalus* | (Cretzschmar) | Black-throated Barbet | |
| *Lybius diadematum* | (Heuglin) | Red-fronted Barbet | |
| *Pogoniulus pusillus* | (Dumont) | Red-fronted Tinker-bird | |
| *Pogoniulus chrysoconus* | (Temminck) | Yellow-fronted Tinker-bird | |
| *Trachyphonus margaritatus* | (Cretzschmar) | Yellow-breasted Barbet | |
| *Trachyphonus darnaudii* | (Prévost & Des Murs) | D'Arnaud's Barbet | |
| *Trachyphonus erythrocephalus* | Cabanis | Red-and-yellow Barbet | |
| Family Indicatoridae - Honey-guides | | | |
| *Indicator variegatus* | Lesson | Scaly-throated Honey-guide | |
| *Indicator indicator* | (Sparrman) | Black-throated Honey-guide | |
| *Indicator minor* | Stephens | Lesser Honey-guide | |
| *Prodotiscus insignis* | (Cassin) | Cassin's Honey-bird | |
| *Prodotiscus regulus* | Sundevall | Wahlberg's Honey-bird | |
| Family Picidae - Woodpeckers | | | |
| *Jynx torquilla* | Linn. | Wryneck | |
| *Jynx ruficollis* | Wagler | Red-breasted Wryneck | |
| *Campethera nubica* | (Boddaert) | Nubian Woodpecker | |
| *Campethera cailliautii* | (Malherbe) | Little Spotted Woodpecker | |
| *Dendropicos fuscescens* | Viellot | Cardinal Woodpecker | |
| *Dendropicos abyssinicus* | Stanley | Golden-backed Woodpecker | E |
| *Dendropicos obsoletus* | (Wagler) | Brown-backed Woodpecker | |
| *Mesopicos goertae* | (Müller) | Grey Woodpecker | |
| *Thripias namaquus* | (Lichtenstein) | Bearded Woodpecker | |

| Scientific Name | Determinator | English Name | Status |
|---|---|---|---|
| Order Passeriformes | | | |
| Family Pittidae - Pitta | | | |
| *Pitta angolensis* | Viellot | African Pitta | |
| Family Alaudidae - Larks | | | |
| *Mirafra cantillans* | Blyth | Singing Bush-Lark | |
| *Mirafra albicauda* | Reichenow | White-tailed Bush-lark | |
| *Mirafra pulpa* | Friedmann | Friedmann's Bush-lark | |
| *Mirafra hypermetra* | (Reichenow) | Redwing Lark | |
| *Mirafra rufocinnamomea* | (Salvadori) | Flappet-Lark | |
| *Mirafra collaris* | Sharpe | Collared Lark | |
| *Mirafra africanoides* | Smith | Fawn-coloured Lark | |
| *Mirafra gilletti* | Sharpe | Gillett's Lark | |
| *Mirafra poecilosterna* | (Reichenow) | Pink-breasted Lark | |
| *Mirafra degodiensis* | Erard | Degodi Lark | E T |
| *Heteromirafra sidamoensis* | (Erard) | Sidamo Long-clawed Lark | E T |
| *Eremopterix nigriceps* | (Gould) | White-fronted Sparrow-Lark | |
| *Eremopterix signata* | (Oustalet) | Chestnut-headed Sparrow-Lark | |
| *Eremopterix leucotis* | (Stanley) | Chestnut-backed Sparrow-Lark | |
| *Ammomanes deserti* | (Lichtenstein) | Desert Lark | |
| *Alaemon alaudipes* | (Desfontaine) | Hoopoe-Lark | |
| *Melanocorypha bimaculata* | (Ménétriés) | Calandra Lark | |
| *Calandrella cinerea* | (Gmelin) | Red-capped Lark | |
| *Calandrella brachydactila* | (Leisler) | Short-toed Lark | |
| *Calandrella somalica* | (Sharpe) | Rufous Short-toed Lark | |
| *Calandrella personata* | (Sharpe) | Masked Lark | |
| *Pseudalaemon fremantlii* | (Phillips) | Short-tailed Lark | |
| *Galerida cristata* | (Linn.) | Crested Lark | |
| *Galerida theklae* | (Brehm) | Short-crested Lark | |
| Family Hirundinidae - Swallows, Martins | | | |
| *Riparia paludicola* | (Viellot) | African Sand Martin | |
| *Riparia riparia* | (Linn.) | Sand Martin | |
| *Riparia cincta* | (Boddaert) | Banded Martin | |
| *Hirundo griseopyga* | Sundevall | Grey-rumped Swallow | |
| *Hirundo fuligula* | Lichtenstein | African Rock Martin | |
| *Hirundo rupestris* | Scopoli | European Crag Martin | |
| *Hirundo rustica* | Linn. | Swallow | |
| *Hirundo lucida* | Hartlaub | Red-chested Swallow | |
| *Hirundo smithii* | Leach | Wire-tailed Swallow | |
| *Hirundo aethiopica* | Blanford | Ethiopian Swallow | |
| *Hirundo megaensis* | Benson | White-tailed Swallow | E T |
| *Hirundo senegalensis* | Linn. | Mosque Swallow | |
| *Hirundo daurica* | Linn. | Red-rumped Swallow | |
| *Hirundo abyssinica* | Guérin-Méneville | Striped Swallow | |
| *Delichon urbica* | (Linn.) | House Martin | |
| *Psalidoprocne pristoptera* | (Rüppell) | Rough-winged Swallow | |
| *Psalidoprocne albiceps* | Sclater | White-headed Rough-winged Swallow | |
| Family Motacillidae - Wagtails, Pipits | | | |
| *Anthus novaeseelandiae* | (Gmelin) | Richard's Pipit | |
| *Anthus campestris* | (Linn.) | Tawny Pipit | |
| *Anthus leucophrys* | Viellot | Plain-backed Pipit | |
| *Anthus similis* | Jerdon | Long-billed Pipit | |
| *Anthus caffer* | Sundevall | Little Tawny Pipit | |
| *Anthus trivialis* | Linn. | Tree Pipit | |
| *Anthus cervinus* | (Pallas) | Red-throated Pipit | |
| *Tmetothylacus tenellus* | (Cabanis) | Golden Pipit | |
| *Macronyx flavicollis* | Rüppell | Abyssinian Longclaw | E |
| *Motacilla flava* | Linn. | Yellow Wagtail | |
| *Motacilla cinerea* | Tunstall | Grey Wagtail | |

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| Order Passeriformes | | | |
| Family Pittidae - Pitta | | | |
| *Pitta angolensis* | Viellot | African Pitta | |
| Family Alaudidae - Larks | | | |
| *Mirafra cantillans* | Blyth | Singing Bush-Lark | |
| *Mirafra albicauda* | Reichenow | White-tailed Bush-lark | |
| *Mirafra pulpa* | Friedmann | Friedmann's Bush-lark | |
| *Mirafra hypermetra* | (Reichenow) | Redwing Lark | |
| *Mirafra rufocinnamomea* | (Salvadori) | Flappet-Lark | |
| *Mirafra collaris* | Sharpe | Collared Lark | |
| *Mirafra africanoides* | Smith | Fawn-coloured Lark | |
| *Mirafra gilletti* | Sharpe | Gillett's Lark | |
| *Mirafra poecilosterna* | (Reichenow) | Pink-breasted Lark | |
| *Mirafra degodiensis* | Erard | Degodi Lark | E T |
| *Heteromirafra sidamoensis* | (Erard) | Sidamo Long-clawed Lark | E T |
| *Eremopterix nigriceps* | (Gould) | White-fronted Sparrow-Lark | |
| *Eremopterix signata* | (Oustalet) | Chestnut-headed Sparrow-Lark | |
| *Eremopterix leucotis* | (Stanley) | Chestnut-backed Sparrow-Lark | |
| *Ammomanes deserti* | (Lichtenstein) | Desert Lark | |
| *Alaemon alaudipes* | (Desfontaine) | Hoopoe-Lark | |
| *Melanocorypha bimaculata* | (Ménétriés) | Calandra Lark | |
| *Calandrella cinerea* | (Gmelin) | Red-capped Lark | |
| *Calandrella brachydactila* | (Leisler) | Short-toed Lark | |
| *Calandrella somalica* | (Sharpe) | Rufous Short-toed Lark | |
| *Calandrella personata* | (Sharpe) | Masked Lark | |
| *Pseudalaemon fremantlii* | (Phillips) | Short-tailed Lark | |
| *Galerida cristata* | (Linn.) | Crested Lark | |
| *Galerida theklae* | (Brehm) | Short-crested Lark | |
| Family Hirundinidae - Swallows, Martins | | | |
| *Riparia paludicola* | (Viellot) | African Sand Martin | |
| *Riparia riparia* | (Linn.) | Sand Martin | |
| *Riparia cincta* | (Boddaert) | Banded Martin | |
| *Hirundo griseopyga* | Sundevall | Grey-rumped Swallow | |
| *Hirundo fuligula* | Lichtenstein | African Rock Martin | |
| *Hirundo rupestris* | Scopoli | European Crag Martin | |
| *Hirundo rustica* | Linn. | Swallow | |
| *Hirundo lucida* | Hartlaub | Red-chested Swallow | |
| *Hirundo smithii* | Leach | Wire-tailed Swallow | |
| *Hirundo aethiopica* | Blanford | Ethiopian Swallow | |
| *Hirundo megaensis* | Benson | White-tailed Swallow | E T |
| *Hirundo senegalensis* | Linn. | Mosque Swallow | |
| *Hirundo daurica* | Linn. | Red-rumped Swallow | |
| *Hirundo abyssinica* | Guérin-Méneville | Striped Swallow | |
| *Delichon urbica* | (Linn.) | House Martin | |
| *Psalidoprocne pristoptera* | (Rüppell) | Rough-winged Swallow | |
| *Psalidoprocne albiceps* | Sclater | White-headed Rough-winged Swallow | |
| Family Motacillidae - Wagtails, Pipits | | | |
| *Anthus novaeseelandiae* | (Gmelin) | Richard's Pipit | |
| *Anthus campestris* | (Linn.) | Tawny Pipit | |
| *Anthus leucophrys* | Viellot | Plain-backed Pipit | |
| *Anthus similis* | Jerdon | Long-billed Pipit | |
| *Anthus caffer* | Sundevall | Little Tawny Pipit | |
| *Anthus trivialis* | Linn. | Tree Pipit | |
| *Anthus cervinus* | (Pallas) | Red-throated Pipit | |
| *Tmetothylacus tenellus* | (Cabanis) | Golden Pipit | |
| *Macronyx flavicollis* | Rüppell | Abyssinian Longclaw | E |
| *Motacilla flava* | Linn. | Yellow Wagtail | |
| *Motacilla cinerea* | Tunstall | Grey Wagtail | |
| *Motacilla clara* | Sharpe | Mountain Wagtail | |
| *Motacilla alba* | Linn. | White Wagtail | |
| *Motacilla aguimp* | Dumont | African Pied Wagtail | |

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| Family Sylviidae - Warblers | | | |
| *Bradypterus baboecala* | (Viellot) | Little Rush Warbler | |
| *Bradypterus cinnamomeus* | (Rüppell) | Cinnamon Bracken-Warbler | |
| *Bradypterus alfredi* | Hartlaub | Bamboo Warbler | |
| *Schoenicola platyura* | (Jerdon) | Fan-tailed Warbler | |
| *Parisoma boehmi* | Reichenow | Banded Tit-flycatcher | |
| *Parisoma lugens* | (Rüppell) | Brown Tit-flycatcher | |
| *Cisticola erythrops* | (Hartlaub) | Red-faced Cisticola | |
| *Cisticola cantans* | (Heuglin) | Singing Cisticola | |
| *Cisticola chiniana* | (A. Smith) | Rattling Cisticola | |
| *Cisticola bodessa* | Mearns | Boran Cisticola | |
| *Cisticola galactotes* | (Temminck) | Winding Cisticola | |
| *Cisticola robusta* | (Rüppell) | Stout Cisticola | |
| *Cisticola natalensis* | (Smith) | Croaking Cisticola | |
| *Cisticola cinereola* | Salvadori | Ashy Cisticola | |
| *Cisticola nana* | Fischer & Reichenow | Tiny Cisticola | |
| *Cisticola ruficeps* | (Cretzschmar) | Red-pate Cisticola | |
| *Cisticola brachyptera* | (Sharpe) | Siffling Cisticola | |
| *Cisticola troglodytes* | (Antinori) | Foxy Cisticola | |
| *Cisticola juncidis* | (Rafinesque) | Zitting Cisticola | |
| *Cisticola aridula* | Witherby | Desert Cisticola | |
| *Cisticola eximia* | (Heuglin) | Black-backed Cisticola | |
| *Cisticola brunnescens* | Heuglin | Pectoral-patch Cisticola | |
| *Prinia gracilis* | (Lichtenstein) | Striped-back Prinia | |
| *Prinia subflava* | (Gmelin) | Tawny-flanked Prinia | |
| *Prinia somalica* | (Elliot) | Pale Prinia | |
| *Heliolais erythroptera* | (Jardine) | Red-wing Warbler | |
| *Apalis flavida* | (Strickland) | Black-breasted Apalis | |
| *Spiloptila clamans* | (Temminck) | Cricket Warbler | |
| *Spiloptila rufifrons* | (Rüppell) | Red-faced Warbler | |
| *Phyllolais pulchella* | (Cretzschmar) | Buff-bellied Warbler | |
| *Camaroptera brevicaudata* | (Cretzschmar) | Grey-backed Camaroptera | |
| *Camaroptera simplex* | (Cabanis) | Grey Wren-warbler | |
| *Eremomela icteropygialis* | (Lafresnaye) | Yellow-bellied Eremomela | |
| *Eremomela flavicrissalis* | Sharpe | Yellow-vented Eremomela | |
| *Eremomela canescens* | Antinori | Green-backed Eremomela | |
| *Sylvietta brachyura* | Lafresnaye | Crombec | |
| *Sylvietta whytii* | (Shelley) | Red-faced Crombec | |
| *Sylvietta isabellina* | Elliot | Somali Long-billed Crombec | |
| *Sylvietta philippae* | Williams | Short-billed Crombec | |
| *Locustella naevia* | (Boddaert) | Grasshopper Warbler | |
| *Locustella fluviatilis* | (Wolf) | River Warbler | |
| *Locustella luscinioides* | (Savi) | Savi's Warbler | |
| *Acrocephalus schoenobaenus* | (Linn.) | Sedge Warbler | |
| *Acrocephalus palustris* | (Bechstein) | Marsh Warbler | |
| *Acrocephalus scirpaceus* | (Hermann) | Reed Warbler | |
| *Acrocephalus baeticatus* | (Viellot) | African Reed Warbler | |
| *Acrocephalus gracilirostris* | (Hartlaub) | Swamp Warbler | |
| *Acrocephalus stentoreus* | (Ehrenberg) | Southern Great Reed Warbler | |
| *Acrocephalus griseldis* | (Hartlaub) | Basra Reed Warbler | |
| *Acrocephalus arundinaceus* | (Linn.) | Great Reed Warbler | |
| *Chloropeta natalensis* | Smith | Yellow Flycatcher | |
| *Sphenoeacus mentalis* | (Fraser) | Moustache Warbler | |
| *Hippolais pallida* | (Ehrenberg) | Olivaceous Warbler | |
| *Hippolais languida* | (Ehrenberg) | Upcher's Warbler | |
| *Hippolais olivetorum* | (Strickland) | Olive-tree Warbler | |
| *Hippolais icterina* | (Viellot) | Icterine Warbler | |
| *Sylvia mystacea* | Ménétriés | Ménétriés Warbler | |
| *Sylvia rueppelli* | Temminck | Rüppell's Warbler | |
| *Sylvia nana* | (Ehrenberg) | Desert Warbler | |

| Scientific Name | Determinator | English Name | Status |
|---|---|---|---|
| *Sylvia leucomelaena* | (Ehrenberg) | Red Sea Warbler | |
| *Sylvia hortensis* | (Gmelin) | Orphean Warbler | |
| *Sylvia nisoria* | (Bechstein) | Barred Warbler | |
| *Sylvia curruca* | (Linn.) | Lesser Whitethroat | |
| *Sylvia communis* | Latham | Whitethroat | |
| *Sylvia borin* | (Boddaert) | Garden Warbler | |
| *Sylvia atricapilla* | (Linn.) | Blackcap | |
| *Phylloscopus umbrovirens* | (Rüppell) | Brown Woodland-warbler | |
| *Phylloscopus bonelli* | (Viellot) | Bonelli's Warbler | |
| *Phylloscopus collybita* | (Viellot) | Chiff-chaff | |
| *Phylloscopus trochilus* | (Linn.) | Willow Warbler | |
| Family Muscicapidae - Flycatchers | | | |
| *Muscicapa striata* | (Pallas) | Spotted Flycatcher | |
| *Muscicapa gambagae* | (Alexander) | Gambaga Dusky Flycatcher | |
| *Muscicapa adusta* | (Boie) | Dusky Flycatcher | |
| *Myioparus plumbeus* | (Hartlaub) | Grey Tit-flycatcher | |
| *Ficedula albicollis* | (Temminck) | Collared Flycatcher | |
| *Melaenornis chocolatinus* | (Rüppell) | Abyssinian Slaty Flycatcher | |
| *Melaenornis edolioides* | (Swainson) | Black Flycatcher | |
| *Empidornis semipartitus* | (Rüppell) | Silver-bird | |
| *Bradornis microrhynchus* | (Reichenow) | Grey Flycatcher | |
| *Bradornis pallidus* | (von Müller) | Pale Flycatcher | |
| *Hyliota flavigaster* | Swainson | Yellow-bellied Flycatcher | |
| Family Monarchidae - Monarch Flycatchers | | | |
| *Batis orientalis* | (Heuglin) | Grey-headed Puff-back Flycatcher | |
| *Batis perkeo* | Neumann | Pygmy Puff-back Flycatcher | |
| *Batis minor* | Erlanger | Black-headed Puff-back Flycatcher | |
| *Platysteira cyanea* | (Müller) | Wattle-eye | |
| *Trochocercus albonotatus* | Sharpe | White-tailed Crested Flycatcher | |
| *Terpsiphone viridis* | (Müller) | Paradise Flycatcher | |
| Family Timaliidae - Babblers | | | |
| *Alcippe abyssinica* | (Rüppell) | Abyssinian Hill-babbler | |
| *Parophasma galinieri* | (Guérin-Méneville) | Abyssinian Catbird | E |
| *Turdoides plebejus* | (Cretzschmar) | Brown Babbler | |
| *Turdoides leucocephalus* | Cretzschmar | White-headed Babbler | |
| *Turdoides squamulatus* | (Shelley) | Scaly Babbler | |
| *Turdoides tenebrosus* | (Hartlaub) | Dusky Babbler | |
| *Turdoides leucopygius* | (Rüppell) | White-rumped Babbler | |
| *Turdoides fulvus* | (Desfontaines) | Fulvous Chatterer | |
| *Turdoides rubiginosus* | (Rüppell) | Rufous Chatterer | |
| *Turdoides aylmeri* | (Shelley) | Scaly Chatterer | |
| Family Paridae - Tits | | | |
| *Parus afer* | Gmelin | Grey Tit | |
| *Parus leucomelas* | Rüppell | Black Tit | |
| *Parus leuconotus* | Guérin-Méneville | White-backed Black Tit | E |
| Family Remizidae - Penduline Tits | | | |
| *Remiz musculus* | (Hartlaub) | Mouse-coloured Penduline Tit | |
| *Remiz punctifrons* | (Sundevall) | Sennar Penduline Tit | |

| Scientific Name | Determinator | English Name | Status |
|---|---|---|---|
| Family Salpornithidae - Spotted Creeper | | | |
| *Salpornus spilonota* | (Franklin) | Spotted Creeper | |
| Family Nectariniidae - Sunbirds | | | |
| *Anthreptes orientalis* | Hartlaub | Kenya Violet-backed Sunbird | |
| *Anthreptes collaris* | (Viellot) | Collared Sunbird | |
| *Anthreptes platurus* | (Viellot) | Pygmy Sunbird | |
| *Anthreptes metallicus* | (Lichtenstein) | Nile Valley Sunbird | |
| *Nectarinia olivacea* | (Smith) | Olive Sunbird | |
| *Nectarinia amethystina* | (Shaw) | Amethyst Sunbird | |
| *Nectarinia senegalensis* | (Linn.) | Scarlet-chested Sunbird | |
| *Nectarinia hunteri* | (Shelley) | Hunter's Sunbird | |
| *Nectarinia venusta* | (Shaw & Nodder) | Variable Sunbird | |
| *Nectarinia chloropygia* | (Jardine) | Olive-bellied Sunbird | |
| *Nectarinia bifasciata* | (Shaw) | Purple-banded Sunbird | |
| *Nectarinia mariquensis* | (Smith) | Mariqua Sunbird | |
| *Nectarinia habessinica* | Ehrenberg | Shining Sunbird | |
| *Nectarinia cuprea* | (Shaw) | Copper Sunbird | |
| *Nectarinia tacazze* | (Stanley) | Tacazze Sunbird | |
| *Nectarinia erythrocerca* | Hartlaub | Red-chested Sunbird | |
| *Nectarinia pulchella* | (Linn.) | Beautiful Sunbird | |
| *Nectarinia nectarinoides* | (Richmond) | Smaller Black-bellied Sunbird | |
| *Nectarinia famosa* | (Linn.) | Malachite Sunbird | |
| *Nectarinia kilimensis* | Shelley | Bronze Sunbird | |
| Family Zosteropidae - White-eyes | | | |
| *Zosterops abyssinica* | Guérin-Méneville | White-breasted White-eye | |
| *Zosterops senegalensis* | Bonaparte | Yellow White-eye | |
| *Zosterops poliogastra* | Heuglin | Green White-eye | |
| Family Oriolidae - Orioles | | | |
| *Oriolus oriolus* | (Linn.) | Golden Oriole | |
| *Oriolus auratus* | Viellot | African Golden Oriole | |
| *Oriolus larvatus* | Lichtenstein | Black-headed Oriole | |
| *Oriolus monacha* | (Gmelin) | Black-headed Forest Oriole | E |
| Family Laniidae - Shrikes | | | |
| *Eurocephalus rueppelli* | Bonaparte | White-crowned Shrike | |
| *Prionops plumata* | (Shaw) | Crested Helmet-shrike | |
| *Nilaus afer* | (Latham) | Northern Brubru | |
| *Dryoscopus pringlii* | Jackson | Pringle's Puff-back | |
| *Dryoscopus gambensis* | (Lichtenstein) | Puff-back | |
| *Tchagra minuta* | (Hartlaub) | Blackcap Bush-shrike | |
| *Tchagra jamesi* | (Shelley) | Three-streaked Bush-shrike | |
| *Tchagra senegala* | (Linn.) | Black-headed Bush-shrike | |
| *Rhodophoneus cruentus* | (Ehrenberg) | Rosy-patched Shrike | |
| *Laniarius ruficeps* | (Shelley) | Red-naped Bush-shrike | |
| *Laniarius aethiopicus* | (Gmelin) | Tropical Boubou | |
| *Laniarius erythrogaster* | (Cretzschmar) | Black-headed Gonolek | |
| *Laniarius funebris* | (Hartlaub) | Slate-coloured Boubou | |
| *Malaconotus sulfureopectus* | (Lesson) | Sulphur-breasted Bush-shrike | |
| *Malaconotus blanchoti* | Stephens | Grey-headed Bush-shrike | |
| *Lanius isabellinus* | Ehrenberg | Isabelline Shrike | |
| *Lanius collurio* | Linn. | Red-backed Shrike | |
| *Lanius minor* | Gmelin | Lesser Grey Shrike | |
| *Lanius excubitor* | Linn. | Great Grey Shrike | |
| *Lanius excubitoroides* | Prévost & Des Murs | Grey-backed Fiscal | |
| *Lanius dorsalis* | Cabanis | Taita Fiscal | |
| *Lanius somalicus* | Hartlaub | Somali Fiscal | |
| *Lanius collaris* | Linn. | Fiscal | |
| *Lanius senator* | Linn. | Woodchat Shrike | |
| *Lanius nubicus* | Lichtenstein | Nubian Shrike | |
| Family Dicruridae - Drongo | | | |
| *Dicrurus adsimilis* | (Bechstein) | Fork-tailed Drongo | |

| Scientific Name | Determinator | English Name | Status |
|---|---|---|---|
| *Ploceus taeniopterus* | Reichenbach | Northern Masked Weaver | |
| *Ploceus intermedius* | Rüppell | Masked Weaver | |
| *Ploceus velatus* | Viellot | Vitelline Masked Weaver | |
| *Ploceus spekei* | (Heuglin) | Speke's Weaver | |
| *Ploceus cucullatus* | (Müller) | Black-headed Weaver | |
| *Ploceus dichrocephalus* | (Salvadori) | Jubaland Weaver | |
| *Ploceus melanocephalus* | (Linn.) | Yellow-backed Weaver | |
| *Ploceus rubiginosus* | Rüppell | Chestnut Weaver | |
| *Ploceus superciliosus* | (Shelley) | Compact Weaver | |
| *Ploceus ocularis* | Smith | Spectacled Weaver | |
| *Ploceus nigricollis* | (Viellot) | Black-necked Weaver | |
| *Malimbus rubriceps* | (Müller) | Red-headed Weaver | |
| *Quelea cardinalis* | (Hartlaub) | Cardinal Quelea | |
| *Quelea erythrops* | (Hartlaub) | Red-headed Quelea | |
| *Quelea quelea* | (Linn.) | Red-billed Quelea | |
| *Euplectes afer* | (Gmelin) | Yellow-crowned Bishop | |
| *Euplectes albonotatus* | (Cassin) | White-winged Widow-bird | |
| *Euplectes ardens* | (Boddaert) | Red-collared Widow-bird | |
| *Euplectes axillaris* | (Smith) | Fan-tailed Widow-bird | |
| *Euplectes capensis* | (Linn.) | Yellow Bishop | |
| *Euplectes gierowii* | Cabanis | Black Bishop | |
| *Euplectes hordeaceus* | (Linn.) | Black-winged Red Bishop | |
| *Euplectes macrourus* | (Gmelin) | Yellow-shouldered Widow-bird | |
| *Euplectes franciscanus* | (Isert) | West Nile Red Bishop | |
| *Anomalospiza imberbis* | (Cabanis) | Parasitic Weaver | |
| Family Estrildidae - Whydahs, Waxbills | | | |
| *Vidua macroura* | (Pallas) | Pin-tailed Whydah | |
| *Vidua fischeri* | (Reichenow) | Fischer's Whydah | |
| *Vidua hypocherina* | Verreaux & Verreaux | Steel-blue Whydah | |
| *Vidua paradisaea* | (Linn.) | Paradise Whydah | |
| *Vidua orientalis* | Heuglin | Broad-tailed Paradise Whydah | |
| *Hypochera chalybeata* | (Müller) | Indigo-bird | |
| *Mandingoa nitidula* | (Hartlaub) | Green-backed Twin-spot | |
| *Cryptospiza salvadorii* | Reichenow | Abyssinian Crimson-wing | |
| *Amadina fasciata* | (Gmelin) | Cut-throat | |
| *Pytelia melba* | (Linn.) | Green-winged Pytilia | |
| *Pytelia afra* | (Gmelin) | Orange-winged Pytilia | |
| *Pytelia phoenicoptera* | Swainson | Red-winged Pytilia | |
| *Lagonosticta larvata* | (Rüppell) | Black-faced Firefinch | |
| *Lagonosticta rufopicta* | (Fraser) | Bar-breasted Firefinch | |
| *Lagonosticta senegala* | (Linn.) | Red-billed Firefinch | |
| *Lagonosticta rhodopareia* | (Heuglin) | Jameson's Firefinch | |
| *Lagonosticta rubricata* | (Lichtenstein) | African Firefinch | |
| *Uraeginthus ianthinogaster* | Reichenow | Purple Grenardier | |
| *Uraeginthus bengalus* | (Linn.) | Red-cheeked Cordon-bleu | |
| *Uraeginthus cyanocephalus* | (Richmond) | Blue-capped Cordon-bleu | |
| *Estrilda melanotis* | (Temminck) | Yellow-bellied Waxbill | |
| *Estrilda paludicola* | Heuglin | Fawn-breasted Waxbill | |
| *Estrilda rhodopyga* | Sundevall | Crimson-rumped Waxbill | |
| *Estrilda troglodytes* | (Lichtenstein) | Black-rumped Waxbill | |
| *Estrilda astrild* | (Linn.) | Waxbill | |
| *Estrilda erythronotos* | (Viellot) | Black-cheeked Waxbill | |
| *Amandava subflava* | (Viellot) | Zebra Waxbill | |
| *Ortygospiza atricollis* | (Viellot) | Quail-finch | |
| *Lonchura malabarica* | (Linn.) | Silver-bill | |
| *Lonchura griseicapilla* | Delacour | Grey-headed Silver-bill | |
| *Lonchura fringilloides* | (Lafresnaye) | Magpie Mannikin | |
| *Lonchura bicolor* | (Fraser) | Black-and-white Mannikin | |
| *Lonchura cucullata* | (Swainson) | Bronze Mannikin | |

| Scientific Name | Determinator | English Name | Status |
|---|---|---|---|
| Family Fringillidae - Finches | | | |
| *Serinus mozambicus* | (Müller) | Yellow-fronted Canary | |
| *Serinus atrogularis* | (A. Smith) | Yellow-rumped Seed-eater | |
| *Serinus leucopygius* | (Sundevall) | White-rumped Seed-eater | |
| *Serinus flavigula* | Salvadori | Yellow-throated Seed-eater | E T |
| *Serinus dorsostriatus* | (Reichenow) | White-bellied Canary | |
| *Serinus donaldsoni* | Sharpe | Grosbeak Canary | |
| *Serinus canicollis* | (Swainson) | Yellow-crowned Canary | |
| *Serinus citrinelloides* | Rüppell | African Citril | |
| *Serinus nigriceps* | Rüppell | Black-headed Siskin | E |
| *Serinus striolatus* | (Rüppell) | Streaky Seed-eater | |
| *Serinus tristriatus* | Rüppell | Brown-rumped Seed-eater | |
| *Serinus reichardi* | (Reichenow) | Streaky-headed Seed-eater | |
| *Serinus ankoberensis* | Ash | Ankober Seed-eater | E T |
| *Serinus xantholaema* | Salvadori | Salvadori's Seed-eater | E |
| *Serinus xanthopygius* | Rüppell | White-throated Seed-eater | E |
| Family Emberizidae - Buntings | | | |
| *Emberiza striolata* | (Lichtenstein) | House Bunting | |
| *Emberiza tahapisi* | Smith | Cinnamon-breasted Bunting | |
| *Emberiza cineracea* | Brehm | Cinereous Bunting | |
| *Emberiza hortulana* | Linn. | Ortolan | |
| *Emberiza caesia* | Cretzschmar | Cretzschmar's Bunting | |
| *Emberiza flaviventris* | Stephens | Golden-breasted Bunting | |
| *Emberiza poliopleura* | (Salvadori) | Somali Golden-breasted Bunting | |
| *Emberiza forbesi* | Hartlaub | Brown-rumped Bunting | |

Status:

E - Endemic to Ethiopia

T - Threatened status in the world

## The Endemic Birds of Ethiopia

| Group & Species | Determinator | Vernacular name |
|---|---|---|
| Order Ciconiiformes | | |
| *Bostrychia carunculata* | (Rüppell) | Wattled Ibis |
| Order Anseriformes | | |
| *Cyanochen cyanoptera* | (Rüppell) | Blue-winged Goose |
| Order Galliformes | | |
| *Francolinus harwoodi* | Blundell & Lovat | Harwood's Francolin |
| Order Gruiformes | | |
| *Rougetius rougetii* | Guérin-Méneville | Rouget's Rail |
| Order Charadriiformes | | |
| *Hoplopterus melanocephalus* | (Rüppell) | Spot-breasted Plover |
| Order Columbiformes | | |
| *Columba albitorques* | (Rüppell) | White-collared Pigeon |
| Order Psittaciformes | | |
| *Poicephalus flavifrons* | (Rüppell) | Yellow-fronted Parrot |
| *Agapornis taranta* | (Stanley) | Black-winged Lovebird |
| Order Cuculiformes | | |
| *Tauraco ruspolii* | Salvadori | Prince Ruspoli's Turaco |
| Order Piciformes | | |
| *Lybius undatus* | (Rüppell) | Banded Barbet |
| *Dendropicos abyssinicus* | Stanley | Golden-backed Woodpecker |
| Order Passeriformes | | |
| *Mirafra degodiensis* | Erard | Degodi Lark |
| *Heteromirafra sidamoensis* | (Erard) | Sidamo Long-clawed Lark |
| *Hirundo megaensis* | Benson | White-tailed Swallow |
| *Macronyx flavicollis* | Rüppell | Abyssinian Longclaw |
| *Myrmecocichla semirufa* | (Rüppell) | White-winged Cliff-chat |
| *Myrmecocichla melaena* | (Rüppell) | Rüppell's Chat |
| *Parophasma galinieri* | (Guérin-Méneville) | Abyssinian Catbird |
| *Parus leuconotus* | Guérin-Méneville | White-backed Black Tit |
| *Oriolus monacha* | (Gmelin) | Black-headed Forest Oriole |
| *Zavattariornis stresemanni* | Moltoni | Stresemann's Bush-crow |
| *Corvus crassirostris* | Rüppell | Thick-billed Raven |
| *Onychognathus albirostris* | (Rüppell) | White-billed Starling |
| *Serinus flavigula* | Salvadori | Yellow-throated Seed-eater |
| *Serinus nigriceps* | Rüppell | Black-headed Siskin |
| *Serinus ankoberensis* | Ash | Ankober Seed-eater |
| *Serinus xantholaema* | Salvadori | Salvadori's Seed-eater |
| *Serinus xanthopygius* | Rüppell | White-throated Seed-eater |

Source: Jesse C. Hillman

## Summary

| Group | Total species | Endemic species | % Endemic |
|---|---|---|---|
| *Order Struthioniformes* | | | |
| Family Struthionidae | 1 | 0 | 0.00 |
| Total | 1 | 0 | 0.00 |
| *Order Podicipediformes* | | | |
| Family Podicipedidae | 3 | 0 | 0.00 |
| Total | 3 | 0 | 0.00 |
| *Order Procellariiformes* | | | |
| Family Procellariidae | 1 | 0 | 0.00 |
| Total | 1 | 0 | 0.00 |
| *Order Pelecaniformes* | | | |
| Family Phaethontidae | 1 | 0 | 0.00 |
| Family Sulidae | 2 | 0 | 0.00 |
| Family Phalacrocoracidae | 3 | 0 | 0.00 |
| Family Anhingidae | 1 | 0 | 0.00 |
| Family Pelecanidae | 2 | 0 | 0.00 |
| Family Fregatidae | 1 | 0 | 0.00 |
| Total | 10 | 0 | 0.00 |
| *Order Ciconiiformes* | | | |
| Family Ardeidae | 17 | 0 | 0.00 |
| Family Balaenicipitidae | 1 | 0 | 0.00 |
| Family Scopidae | 1 | 0 | 0.00 |
| Family Ciconiidae | 8 | 0 | 0.00 |
| Family Threskiornithidae | [illegible] | 1 | 14.29 |
| Total | 34 | 1 | 2.94 |
| *Order Phoenicopteriformes* | | | |
| Family Pheonicopteridae | 2 | 0 | 0.00 |
| Total | 2 | 0 | 0.00 |
| *Order Anseriformes* | | | |
| Family Anatidae | 27 | 1 | 3.70 |
| Total | 27 | 1 | 3.70 |
| *Order Accipitriformes* | | | |
| Family Accipitridae | 56 | 0 | 0.00 |
| Family Pandionidae | 1 | 0 | 0.00 |
| Family Sagittariidae | 1 | 0 | 0.00 |
| Total | 58 | 0 | 0.00 |
| *Order Falconiformes* | | | |
| Family Falconidae | 18 | 0 | 0.00 |
| Total | 18 | 0 | 0.00 |
| *Order Galliformes* | | | |
| Family Phasianidae | 16 | 1 | 6.25 |
| Family Numididae | 2 | 0 | 0.00 |
| Total | 18 | 1 | 5.56 |
| *Order Gruiformes* | | | |
| Family Turnicidae | 2 | 0 | 0.00 |
| Family Rallidae | 17 | 1 | 5.88 |
| Family Heliornithidae | 1 | 0 | 0.00 |
| Family Gruidae | 4 | 0 | 0.00 |
| Family Otididae | 9 | 0 | 0.00 |
| Total | 33 | 1 | 3.03 |

| Group | Total species | Endemic species | % Endemic |
|---|---|---|---|
| *Order Charadriiformes* | | | |
| Family Jacanidae | 2 | 0 | 0.00 |
| Family Rostratulidae | 1 | 0 | 0.00 |
| Family Haematopodidae | 1 | 0 | 0.00 |
| Family Recurvirostridae | 2 | 0 | 0.00 |
| Family Dromadidae | 1 | 0 | 0.00 |
| Family Burhinidae | 4 | 0 | 0.00 |
| Family Glareolidae | 10 | 0 | 0.00 |
| Family Charadriidae | 18 | 1 | 5.56 |
| Family Scolopacidae | 28 | 0 | 0.00 |
| Family Stercorariidae | 3 | 0 | 0.00 |
| Family Laridae | 8 | 0 | 0.00 |
| Family Sternidae | 15 | 0 | 0.00 |
| Family Rynchopidae | 1 | 0 | 0.00 |
| Total | 94 | 1 | 1.06 |
| *Order Pteroclidiformes* | | | |
| Family Pteroclididae | 6 | 0 | 0.00 |
| Total | 6 | 0 | 0.00 |
| *Order Columbiformes* | | | |
| Family Columbidae | 21 | 1 | 4.76 |
| Total | 21 | 1 | 4.76 |
| *Order Psittaciformes* | | | |
| Family Psittacidae | 6 | 2 | 33.33 |
| Total | 6 | 2 | 33.33 |
| *Order Cuculiformes* | | | |
| Family Musophagidae | 5 | 1 | 20.00 |
| Family Cuculidae | 15 | 0 | 0.00 |
| Total | 20 | 1 | 5.00 |
| *Order Strigiformes* | | | |
| Family Tytonidae | 2 | 0 | 0.00 |
| Family Strigidae | 13 | 0 | 0.00 |
| Total | 15 | 0 | 0.00 |
| *Order Caprimulgiformes* | | | |
| Family Caprimulgidae | 13 | 0 | 0.00 |
| Total | 13 | 0 | 0.00 |
| *Order Apodiformes* | | | |
| Family Apodidae | 9 | 0 | 0.00 |
| Total | 9 | 0 | 0.00 |
| *Order Coliiformes* | | | |
| Family Coliidae | 2 | 0 | 0.00 |
| Total | 2 | 0 | 0.00 |
| *Order Trogoniformes* | | | |
| Family Trogonidae | 1 | 0 | 0.00 |
| Total | 1 | 0 | 0.00 |
| *Order Coraciformes* | | | |
| Family Alcedinidae | 10 | 0 | 0.00 |
| Family Meropidae | 11 | 0 | 0.00 |
| Family Coraciidae | 5 | 0 | 0.00 |
| Family Upupidae | 1 | 0 | 0.00 |
| Family Phoeniculidae | 5 | 0 | 0.00 |
| Family Bucerotidae | 8 | 0 | 0.00 |
| Total | 40 | 0 | 0.00 |
| *Order Piciformes* | | | |
| Family Capitonidae | 11 | 1 | 9.09 |
| Family Indicatoridae | 5 | 0 | 0.00 |
| Family Picidae | 9 | 1 | 11.11 |
| Total | 25 | 2 | 8.00 |

# APPENDIX I

| Group | Total species | Endemic species | % Endemic |
|---|---|---|---|
| *Order Passeriformes* | | | |
| Family Pittidae | 1 | 0 | 0.00 |
| Family Alaudidae | 24 | 2 | 8.33 |
| Family Hirundinidae | 17 | 1 | 5.88 |
| Family Motacillidae | 14 | 1 | 7.14 |
| Family Campephagidae | 4 | 0 | 0.00 |
| Family Pycnonotidae | 4 | 0 | 0.00 |
| Family Bombycillidae | 1 | 0 | 0.00 |
| Family Turdidae | 46 | 2 | 4.35 |
| Family Sylviidae | 70 | 0 | 0.00 |
| Family Muscicapidae | 11 | 0 | 0.00 |
| Family Monarchidae | 6 | 0 | 0.00 |
| Family Timaliidae | 10 | 1 | 10.00 |
| Family Paridae | 3 | 1 | 33.33 |
| Family Remizidae | 2 | 0 | 0.00 |
| Family Salpornithidae | 1 | 0 | 0.00 |
| Family Nectariniidae | 20 | 0 | 0.00 |
| Family Zosteropidae | 3 | 0 | 0.00 |
| Family Oriolidae | 4 | 1 | 25.00 |
| Family Laniidae | 25 | 0 | 0.00 |
| Family Dicruridae | 1 | 0 | 0.00 |
| Family Corvidae | 9 | 2 | 22.22 |
| Family Sturnidae | 21 | 1 | 4.76 |
| Family Buphagidae | 2 | 0 | 0.00 |
| Family Passeridae | 11 | 0 | 0.00 |
| Family Ploceidae | 38 | 0 | 0.00 |
| Family Estrildidae | 33 | 0 | 0.00 |
| Family Fringillidae | 15 | 5 | 33.33 |
| Family Emberizidae | 8 | 0 | 0.00 |
| Total | 404 | 17 | 4.21 |
| **Overall Total** | **861** | **28** | **3.25** |

## The Mammals of Ethiopia

| Scientific Name | Determinator | English Name | Status |
|---|---|---|---|
| Order Chiroptera - Bats | | | |
| Family Pteropidae | | | |
| *Hypsignathus monstrosus* | H. Allen 1861 | Hammer-headed Bat | |
| *Epomophorus minimus* | Claessen & De Vree 1991 | | |
| *Epomophorus labiatus* | (Temminck 1837) | Little Epauletted Fruit Bat | |
| *Epomophorus gambianus* | (Ogilby 1835) | Gambian Epauletted Fruit Bat | |
| *Micropteropus pusillus* | (Peters 1868) | Dwarf Epauletted Fruit Bat | |
| *Eidolon helvum* | (Kerr 1792) | Straw-coloured Fruit Bat | |
| *Rousettus aegyptiacus* | (E.Geoffroy 1810) | Egyptian Fruit Bat | |
| *Rousettus angolensis* | (Bocage 1898) | Bocage's Fruit Bat | |
| *Rousettus lanosus* | Thomas 1906 | Long-haired Fruit Bat | |
| Family Rhinopomatidae | | | |
| *Rhinopoma hardwickii* | Gray 1831 | Lesser Mouse-tailed Bat | |
| *Rhinopoma muscatellum* | Thomas 1903 | | |
| Family Emballonuridae | | | |
| *Taphozous perforatus* | E.Geoffroy 1818 | Egyptian Tomb Bat | |
| *Taphozous nudiventris* | Cretzschmar 1830 | Naked-rump Tomb Bat | |
| *Taphozous mauritianus* | E.Geoffroy 1818 | Mauritian Tomb Bat | |
| *Coleura afra* | (Peters 1852) | Sheath-tailed Bat | |
| Family Nycteridae | | | |
| *Nycteris thebaica* | E.Geoffroy 1813 | Common Slit-faced Bat | |
| *Nycteris hispida* | (Schreber 1775) | Hairy Slit-faced Bat | |
| *Nycteris woodi* | Andersen 1914 | | |
| *Nycteris macrotis* | Dobson 1876 | Ethiopian Slit-faced Bat | |
| Family Megadermatidae | | | |
| *Lavia frons* | (E.Geoffroy 1810) | Heart-nosed Big-eared Bat | |
| *Cardioderma cor* | (Peters 1872) | Yellow-winged Bat | |
| Family Rhinolophidae | | | |
| *Rhinolophus clivosus* | Cretzschmar 1828 | Geoffroy's Horseshoe Bat | |
| *Rhinolophus landeri* | Martin 1838 | Lander's Horseshoe Bat | |
| *Rhinolophus hipposideros* | (Bechstein 1800) | Lesser Horseshoe Bat | |
| *Rhinolophus simulator* | K.Andersen 1904 | Bush Horseshoe Bat | |
| *Rhinolophus blasii* | Peters 1867 | Peak-saddle Horseshoe Bat | |
| *Rhinolophus fumigatus* | Rüppell 1842 | Rüppell's Horseshoe Bat | |
| *Rhinolophus hildebrandtii* | Peters 1878 | Hildebrandt's Horseshoe Bat | |
| *Rhinolophus eloquens* | K. Andersen 1905 | | |
| Family Hipposideridae | | | |
| *Hipposideros caffer* | (Sundevall 1846) | Sundevall's African Leaf-nosed Bat | |
| *Hipposideros ruber* | (Noack 1893) | Noack's African Leaf-nosed Bat | |
| *Hipposideros commersoni* | (E. Geoffroy 1813) | Commerson's Leaf-nosed Bat | |
| *Hipposideros fuliginosus* | (Temminck 1853) | Sooty Leaf-nosed Bat | |
| *Hipposideros megalotis* | (Heuglin 1861) | Large-eared Leaf-nosed Bat | |
| *Triaenops persicus* | Dobson 1871 | Persian Leaf-nosed Bat | |
| *Asellia tridens* | (E.Geoffroy 1831) | Trident Leaf-nosed Bat | |
| *Asellia patrizii* | De Beaux 1931 | | |

Source: Jesse C. Hillman

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| Scientific Name | Determinator | English Name | Status |
|---|---|---|---|
| Family Vespertilionidae | | | |
| *Pipistrellus tenuipinnis* | (Peters 1872) | | |
| *Pipistrellus somalicus* | (Thomas 1901) | Somali Serotine Bat | |
| *Pipistrellus capensis* | (A.Smith 1829) | Cape Serotine Bat | |
| *Pipistrellus guineensis* | (Bocage 1889) | | |
| *Pipistrellus nanus* | (Peters 1852) | Banana Bat | |
| *Pipistrellus kuhlii* | (Natterer 1819) | Kuhl's Pipistrelle Bat | |
| *Pipistrellus rusticus* | (Tomes 1861) | Rusty Bat | |
| *Pipistrellus rueppellii* | (J.B.Fischer 1829) | Rüppell's Bat | |
| *Mimetillus moloneyi* | (Thomas 1891) | Moloney's Flat-headed Bat | |
| *Glauconycteris variegata* | (Tomes 1861) | Butterfly Bat | |
| *Laephotis wintoni* | Thomas 1901 | Winton's Long-eared Bat | |
| *Plecotus austriacus* | (J.B.Fischer 1829) | Grey Long-eared Bat | |
| *Barbastella leucomelas* | (Cretzschmar 1826) | Common Barbastelle | |
| *Miniopterus inflatus* | Thomas 1901 | Greater Long-fingered Bat | |
| *Miniopterus schreibersii* | (Kuhl 1819) | Schreiber's Long-fingered Bat | |
| *Nycticeinops schlieffenii* | (Peters 1859) | Schlieffen's Bat | |
| *Scotoecus hindei* | Thomas 1901 | | |
| *Scotoecus hirundo* | (De Winton 1899) | Dark-winged Lesser House Bat | |
| *Myotis bocagii* | (Peters 1870) | | |
| *Myotis tricolor* | (Temminck 1832) | Temminck's Hairy Bat | |
| *Myotis scotti* | Thomas 1927 | Scott's Hairy Bat | E |
| *Myotis morrisi* | Hill 1971 | Morris' Hairy Bat | |
| *Myotis welwitschii* | (Gray 1866) | Welwitsch's Hairy Bat | |
| *Scotophilus dinganii* | (A. Smith 1833) | Giant Yellow House Bat | |
| *Scotophilus leucogaster* | (Cretzschmar 1830) | Lesser Yellow House Bat | |
| *Kerivoula lanosa* | (A.Smith 1847) | Woolly Bat | |
| *Kerivoula eriophora* | (Heuglin 1877) | | E |
| Family Molossidae | | | |
| *Otomops martiensseni* | (Matschie 1897) | Large-eared Free-tailed Bat | |
| *Platymops setiger* | (Peters 1878) | Peters' Flat-headed Bat | |
| *Tadarida pumila* | (Cretzschmar 1830) | Little Free-tailed Bat | |
| *Tadarida chapini* | (J.A. Allen 1917) | | |
| *Tadarida nigeriae* | (Thomas 1913) | Nigerian Free-tailed Bat | |
| *Tadarida bivittata* | (Heuglin 1861) | Spotted Free-tailed Bat | |
| *Tadarida midas* | (Sundevall 1843) | Midas Free-tailed Bat | |
| *Tadarida condylura* | (A.Smith 1833) | Angola Free-tailed Bat | |
| *Tadarida nanula* | (J.A. Allen 1917) | Dwarf Free-tailed Bat | |
| *Tadarida ansorgei* | (Thomas 1913) | Ansorge's Free-tailed Bat | |
| *Tadarida aegyptiaca* | (E.Geoffroy 1818) | Egyptian Free-tailed Bat | |
| *Tadarida ventralis* | (Heuglin 1861) | Transvaal Free-tailed Bat | |
| *Mormopterus acetabulosus* | (Hermann 1804) | Natal Free-tailed Bat | |

| Scientific Name | Determinator | English Name | Status |
|---|---|---|---|
| Order Insectivora - Hedgehogs and Shrews | | | |
| Family Erinaceidae | | | |
| *Atelerix albiventris* | (Wagner 1841) | White-bellied Hedgehog | |
| *Paraechinus aethiopicus* | (Hemprich & Ehrenberg 1833) | Ethiopian Hedgehog | |
| Family Soricidae | | | |
| *Crocidura baileyi* | Osgood 1936 | | E |
| *Crocidura bottegi* | Thomas 1898 | | |
| *Crocidura bottegoides* | Hutterer & Yalden 1990 | | E |
| *Crocidura fulvastra* | (Sundevall 1843) | | |
| *Crocidura fuscomurina* | (Heuglin 1965) | | |
| *Crocidura glassi* | Heim de Balsac 1966 | | E |
| *Crocidura harenna* | Hutterer & Yalden 1990 | | E |
| *Crocidura cf. hildegardeae* | Thomas 1904 | | |
| *Crocidura lucina* | Dippenaar 1980 | | E |
| *Crocidura cf. lusitania* | Dollman 1915 | | |
| *Crocidura macmillani* | Dollman 1915 | | E |
| *Crocidura nana* | Dobson 1890 | | |
| *Crocidura cf. nigrofusca* | Matschie 1895 | | |
| *Crocidura niobe* | Thomas 1906 | | |
| *Crocidura olivieri* | (Lesson 1827) | | |
| *Crocidura parvipes* | Osgood 1910 | | |
| *Crocidura pasha* | Dollman 1915 | | |
| *Crocidura phaeura* | Osgood 1936 | | E |
| *Crocidura planiceps* | Heller 1910 | | |
| *Crocidura smithii* | Thomas 1895 | | |
| *Crocidura somalica* | Thomas 1895 | | |
| *Crocidura thalia* | Dippenaar 1980 | | E |
| *Crocidura viaria* | (I. Geoffroy 1834) | | |
| *Crocidura voi* | Osgood 1910 | | |
| *Crocidura yankariensis* | Hutterer & Jenkins 1980 | | |
| *Crocidura zaphiri* | Dollman 1915 | | E? |
| *Suncus etruscus* | (Savi 1822) | Dwarf Shrew | |
| *Suncus murinus* | (Linn 1766) | House Shrew | |
| *Sylvisorex megalura* | (Jentink 1888) | Climbing Shrew | |
| Family Macroscelidea | | | |
| *Elephantulus rufescens* | (Peters 1878) | Rufous Elephant Shrew | |
| Order Rodentia - Rodents | | | |
| Family Sciuridae - Squirrels | | | |
| *Heliosciurus gambianus* | (Ogilby 1835) | Gambian Sun-squirrel | |
| *Xerus erythropus* | (E.Geoffroy 1803) | Geoffroy's Ground Squirrel | |
| *Xerus rutilus* | (Cretzschmar 1828) | Unstriped Ground Squirrel | |
| *Paraxerus ochraceus* | (Huet 1880) | Huet's Bush Squirrel | |
| Family Gliridae - Dormouse | | | |
| *Graphiurus parvus* | (True 1893) | Small Dormouse | |
| *Graphiurus murinus* | (Desmarest 1822) | African Dormouse | |

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| Scientific Name | Determinator | English Name | Status |
|---|---|---|---|
| Family Muridae - Rats and Mice | | | |
| *Lophiomys imhausii* | Milne-Edwards 1867 | Crested Rat | |
| *Tatera robusta* | (Cretzschmar 1830) | Large Gerbil | |
| *Tatera valida* | (Bocage 1890) | Bocage's Gerbil | |
| *Tatera phillipsi* | (De Winton 1898) | Gerbil | |
| *Tatera nigricauda* | (Peters 1878) | Black-tailed Gerbil | |
| *Taterillus harringtoni* | (Thomas 1906) | | |
| *Taterillus emini* | (Thomas 1892) | Emin's Gerbil | |
| *Ammodillus imbellis* | (De Winton 1898) | | |
| *Gerbillus pulvinatus* | Rhoads 1896 | | |
| *Gerbillus gerbillus* | (Olivier 1800) | | |
| *Gerbillus pusillus* | Peters 1878 | | |
| *Gerbillus nanus* | Blanford 1875 | | |
| *Saccostomus mearnsi* | Heller 1910 | Pouched Mouse | |
| *Dendromus mesomelas* | (Brants 1827) | Brant's Mouse | |
| *Dendromus mystacalis* | Heuglin 1863 | Banana Mouse | |
| *Dendromus melanotis* | A. Smith 1834 | Grey Mouse | |
| *Dendromus lovati* | De Winton 1899 | Lovat's Mouse | E |
| *Megadendromus nikolausi* | Dieterlen & Rupp 1978 | Nikolaus' Mouse | E |
| *Steatomys parvus* | Rhoads 1896 | Fat Mouse | |
| *Steatomys pratensis* | Peters 1846 | | |
| *Otomys typus* | (Heuglin 1877) | Swamp Rat | |
| *Mus domesticus* | Rutty 1772 | House Mouse | |
| *Mus tenellus* | (Thomas 1903) | Pigmy Mouse | |
| *Mus proconodon* | Rhoads 1896 | | |
| *Mus mahomet* | Rhoads 1896 | Mahomet's Mouse | E |
| *Mus triton* | (Thomas 1909) | | |
| *Muriculus imberbis* | (Rüppell 1842) | Simien Mouse | E |
| *Rattus rattus* | (Linn. 1758) | House Rat | |
| *Rattus norvegicus* | (Berkenhout 1769) | Brown Rat | |
| *Praomys fumatus* | (Peters 1878) | African Meadow Rat | |
| *Praomys albipes* | (Rüppell 1842) | White-footed Rat | E |
| *Praomys erythroleucus* | (Temminck 1853) | Multimammate Mouse | |
| *Praomys huberti* | (Wroughton 1908) | | |
| *Praomys ruppi* | Van der Straeten & Dieterlen 1984 | Rupp's Rat | E |
| *Stenocephalemys albocaudata* | Frick 1914 | White-tailed Rat | E |
| *Stenocephalemys griseicauda* | Petter 1972 | Grey-tailed Rat | E |
| *Oenomys hypoxanthus* | (Pucheran 1855) | Rusty-nosed Rat | |
| *Grammomys macmillani* | (Wroughton 1907) | Tree Rat | |
| *Grammomys minnae* | Hutterer & Dieterlen 1984 | Mrs. Nikolaus' Mouse | E |
| *Thallomys paedulcus* | (Sundevall 1847) | Tree Mouse | |
| *Aethomys hindei* | (Thomas 1902) | | |
| *Acomys wilsoni* | Thomas 1892 | Wilson's Spiny Mouse | |
| *Acomys cahirinus* | (Desmarest 1819) | Spiny Mouse | |
| *Uranomys ruddi* | Dollman 1909 | | |
| *Arvicanthis abyssinicus* | (Rüppell 1842) | Ethiopian Grass Rat | E |
| *Arvicanthis niloticus* | (Desmarest 1822) | Lowland Grass Rat | |
| *Arvicanthis blicki* | Frick 1914 | Blick's Grass Rat | E |
| *Arvicanthis somalicus* | Thomas 1903 | Somali Grass Rat | |
| *Pelomys harringtoni* | Thomas 1903 | Harrington's Scrub Rat | E |
| *Pelomys rex* | (Thomas 1906) | King Scrub Rat | E |
| *Lemniscomys striatus* | (Linn. 1758) | Punctated Grass-mouse | |
| *Lemniscomys barbarus* | (Linn. 1767) | Striped Grass-mouse | |
| *Lemniscomys macculus* | (Thomas & Wroughton 1910) | | |
| *Lophuromys flavopunctatus* | Thomas 1888 | Harsh-furred Mouse | |
| *Lophuromys melanonyx* | Petter 1972 | Black-clawed Mouse | E |
| *Dasymys incomtus* | (Sundevall 1847) | Shaggy Swamp-rat | |
| *Colomys goslingi* | Thomas & Wroughton 1907 | White-bellied Forest-rat | |

| Scientific Name | Determinator | English Name | Status |
|---|---|---|---|
| Family Protelidae | | | |
| *Proteles cristatus* | (Sparrman 1783) | Aardwolf | |
| Family Hyaenidae - Hyaenas | | | |
| *Hyaena hyaena* | (Linn. 1758) | Striped Hyaena | |
| *Crocuta crocuta* | (Erxleben 1777) | Spotted Hyaena | |
| Family Felidae - Cats | | | |
| *Acinonyx jubatus* | (Schreber 1775) | Cheetah | |
| *Felis silvestris* | Schreber 1777 | Wildcat | |
| *Felis serval* | Schreber 1776 | Serval | |
| *Felis caracal* | Schreber 1776 | Caracal | |
| *Panthera pardus* | (Linn. 1758) | Leopard | |
| *Panthera leo* | (Linn. 1758) | Lion | |
| Order Artiodactyla - Even-toed Ungulates | | | |
| Family Hippopotamidae - Hippopotamus | | | |
| *Hippopotamus amphibius* | Linn. 1758 | Hippopotamus | |
| Family Suidae - Pigs | | | |
| *Hylochoerus meinertzhageni* | Thomas 1904 | Giant Forest Hog | |
| *Potamochoerus larvatus* | (Smuts 1832 | Bushpig | |
| *Phacochoerus africanus* | (Gmelin 1788) | Common Warthog | |
| *Phacochoerus aethiopicus* | (Pallas 1767) | Somali Warthog | |
| Family Giraffidae - Giraffe | | | |
| *Giraffa camelopardalis* | (Linn. 1758) | Giraffe | |
| Family Bovidae - Bovids | | | |
| *Alcelaphus buselaphus* | (Pallas 1766) | Hartebeest | |
| *Damaliscus lunatus* | (Burchell 1823) | Tiang | |
| *Sylvicapra grimmia* | (Linn. 1758) | Bush Duiker | |
| *Cephalophus natalensis* | A. Smith 1834 | Red Duiker | |
| *Cephalophus weynsi* | Thomas 1901 | Weyn's Duiker | |
| *Oreotragus oreotragus* | (Zimmermann 1783) | Klipspringer | |
| *Ourebia ourebi* | (Zimmermann 1783) | Oribi | |
| *Dorcatragus megalotis* | (Menges 1894) | Beira | |
| *Madoqua saltiana* | (De Blainville 1816) | Salt's Dikdik | |
| *Madoqua guentheri* | Thomas 1894 | Guenther's Dikdik | |
| *Kobus kob* | (Erxleben 1777) | Kob (White-eared) | |
| *Kobus megaceros* | (Fitzinger 1855) | Nile Lechwe | |
| *Kobus ellipsiprymnus* | (Ogilby 1833) | Waterbuck | |
| *Redunca redunca* | (Pallas 1767) | Bohor Reedbuck | |
| *Redunca fulvorufula* | (Afzelius 1815) | Mountain Reedbuck | |
| *Ammodorcas clarkei* | (Thomas 1891) | Dibatag | |
| *Gazella rufifrons* | Gray 1846 | Red-fronted Gazelle | |
| *Gazella dorcas* | (Linn. 1758) | Dorcas Gazelle | |
| *Gazella spekei* | Blyth 1863 | Speke's Gazelle | |
| *Gazella soemmerringii* | (Cretzschmar 1828) | Soemmerring's Gazelle | |
| *Gazella granti* | Brooke 1872 | Grant's Gazelle | |
| *Gazella thomsonii* | Günther 1884 | Thomson's Gazelle (Mongalla) | |
| *Litocranius walleri* | (Brooke 1879) | Gerenuk | |
| *Hippotragus equinus* | (Desmarest 1804) | Roan | |
| *Oryx gazella* | (Linn. 1758) | Oryx | |
| *Tragelaphus imberbis* | (Blyth 1869) | Lesser Kudu | |
| *Tragelaphus strepsiceros* | (Pallas 1766) | Greater Kudu | |
| *Tragelaphus buxtoni* | (Lydekker 1910) | Mountain Nyala | E |
| *Tragelaphus scriptus* | (Pallas 1766) | Bushbuck | |
| *Tragelaphus oryx* | (Pallas 1766) | Common Eland | |
| *Capra ibex* | Linn. 1758 | Ibex (Nubian) | |
| *Capra walie* | Rüppell 1835 | Walia Ibex | ET |
| *Syncerus caffer* | (Sparrman 1779) | Buffalo | |

| Scientific Name | Determinator | English Name | Status |
|---|---|---|---|
| Order Perissodactyla - Odd-toed Ungulates | | | |
| Family Equidae - Asses and Zebras | | | |
| *Equus africanus* | (Fitzinger 1857) | African Wildass | T |
| *Equus grevyi* | Oustalet 1882 | Grevy's Zebra | T |
| *Equus burchellii* | (Gray 1824) | Burchell's Zebra | |
| Family Rhinocerotidae - Rhinoceros | | | |
| *Diceros bicornis* | (Linn. 1758) | Black Rhinoceros | T |
| Order Proboscidea - Elephant | | | |
| Family Elephantidae - Elephant | | | |
| *Loxodonta africana* | (Blumenbach 1797) | African Elephant | |
| Order Hyracoidea - Hyraces | | | |
| Family Procaviidae - Hyraces | | | |
| *Procavia capensis* | (Pallas 1766) | Rock Hyrax | |
| *Heterohyrax brucei* | (Gray 1868) | Yellow-spotted Hyrax | |
| Order Lagomorpha - Hares | | | |
| Family Leporidae - Hares | | | |
| *Lepus habessinicus* | Hemprich & Ehrenberg 1833 | Abyssinian Hare | |
| *Lepus fagani* | Thomas 1903 | Fagan's Hare | |
| *Lepus starcki* | Petter 1963 | Starck's Hare | E |
| *Lepus crawshayi* | De Winton 1899 | Crawshay's Hare | |
| Order Tubulidentata - Aardvark | | | |
| Family Orycteropodidae - Aardvark | | | |
| *Orycteropus afer* | (Pallas 1766) | Aardvark | |
| Order Pholidota - Pangolin | | | |
| Family Manidae - Pangolin | | | |
| *Phataginus temminckii* | Smuts 1832 | Ground Pangolin | |
| Order Sirenia - Dugong and Manatee | | | |
| Family Dugongidae - Dugong | | | |
| *Dugong dugon* | (P.L.S. Müller 1776) | Dugong | |
| Order Cetacea - Whales and Dolphins | | | |
| Family Balaenopteridae - Baleen Whales | | | |
| *Balaenoptera borealis* | Lesson 1828 | Sei Whale | |
| *Balaenoptera edeni* | Anderson 1879 | Bryde's Whale | |
| *Balaenoptera acutorostrata* | Lacépède 1804 | Minke Whale | |
| *Megaptera novaeangliae* | (Borowski 1781) | Humpback Whale | |
| Family Ziphiidae | | | |
| *Ziphius cavirostris* | G.Cuvier 1823 | Cuvier's Beaked Whale | |
| Family Physeteridae | | | |
| *Physeter catodon* | Linn. 1758 | Sperm Whale | |
| Family Delphinidae - Dolphins | | | |
| *Grampus griseus* | (G.Cuvier 1812) | Risso's Dolphin | |
| *Globicephala macrorhynchus* | Gray 1846 | Short-finned Pilot Whale | |
| *Steno bredanensis* | (Lesson 1828) | Rough-toothed Dolphin | |
| *Stenella attenuata* | (Gray 1846) | Spotted Dolphin | |
| *Stenella longirostris* | (Gray 1828) | Long-snouted Dolphin | |
| *Delphinus delphis* | Linn. 1758 | Common Dolphin | |
| *Delphinus tropicalis* | Van Bree 1971 | Tropical Dolphin | |
| *Sousa plumbea* | (G.Cuvier 1829) | Humpback Dolphin | |
| *Tursiops aduncus* | (Ehrenberg 1833) | Indian Ocean Bottlenosed Dolphin | |
| *Orcinus orca* | (Linn. 1758) | Killer Whale | |
| *Pseudorca crassidens* | (Owen 1846) | False Killer Whale | |

Status:

E - endemic to Ethiopia

T - threatened status in the world

The Endemic Mammals of Ethiopia

| Group & Species | Determinator & date | Vernacular name |
|---|---|---|
| Order Chiroptera - Bats | | |
| *Myotis scotti* | Thomas 1927 | Scott's Hairy Bat |
| *Kerivoula eriphora* | (Heuglin 1877) | |
| Order Insectivora - Shrews | | |
| *Crocidura baileyi* | Osgood 1936 | |
| *Crocidura bottegoides* | Hutterer & Yalden 1990 | |
| *Crocidura glassi* | Heim de Balsac 1966 | |
| *Crocidura harenna* | Hutterer & Yalden 1990 | |
| *Crocidura lucina* | Dippenaar 1980 | |
| *Crocidura macmillani* | Dollman 1915 | |
| *Crocidura phaeura* | Osgood 1936 | |
| *Crocidura thalia* | Dippenaar 1980 | |
| *Crocidura zaphiri* | Dollman 1915 | |
| Order Rodentia - Rodents | | |
| *Mus mahomet* | Rhoads 1896 | Mahomet's Mouse |
| *Muriculus imberbis* | (Rüppell 1842) | Simien Mouse |
| *Praomys albipes* | (Rüppell 1842) | White-footed Rat |
| *Praomys ruppi* | Van der Straeten & Dieterlen 1983 | Rupp's Rat |
| *Stenocephalemys albocaudata* | Frick 1914 | White-tailed Rat |
| *Stenocephalemys griseicauda* | Petter 1972 | Grey-tailed Rat |
| *Grammomys minnae* | Hutterer & Dieterlen 1984 | Mrs. Nikolaus' Mouse |
| *Arvicanthis abyssinicus* | Rüppell 1842 | Ethiopian Grass Rat |
| *Arvicanthis blicki* | Frick 1914 | Blick's Grass Rat |
| *Pelomys harringtoni* | Thomas 1903 | Harrington's Scrub Rat |
| *Pelomys rex* | (Thomas 1906) | King Scrub Rat |
| *Lophuromys melanonyx* | Petter 1972 | Black-clawed Mouse |
| *Dendromus lovati* | De Winton 1899 | Lovat's Mouse |
| *Megadendromus nikolausi* | Dieterlen & Rupp 1978 | Nikolaus' Mouse |
| *Tachyoryctes macrocephalus* | (Rüppell 1842) | Giant Molerat |
| Order Primata - Monkeys | | |
| *Theropithecus gelada* | (Rüppell 1835) | Gelada |
| Order Carnivora - Carnivores | | |
| *Canis simensis* | Rüppell 1838 | Ethiopian Wolf |
| Order Artiodactyla - Even-toed Ungulates | | |
| *Tragelaphus buxtoni* | (Lydekker 1910) | Mountain Nyala |
| *Capra walie* | Rüppell 1835 | Walia Ibex |
| Order Lagomorpha - Hares | | |
| *Lepus starcki* | Petter 1963 | Starck's Hare |

Source: Jesse C. Hillman

## Summary

| Group | Total species | Endemic species | % Endemic |
|---|---|---|---|
| *Order Chiroptera - Bats* | | | |
| Family Pteropidae | 9 | 0 | 0 |
| Family Rhinopomatidae | 2 | 0 | 0 |
| Family Emballonuridae | 4 | 0 | 0 |
| Family Nycteridae | 4 | 0 | 0 |
| Family Megadermatidae | 2 | 0 | 0 |
| Family Rhinolophidae | 8 | 0 | 0 |
| Family Hipposideridae | 8 | 0 | 0 |
| Family Vespertilionidae | 27 | 2 | 7.41 |
| Family Molossidae | 13 | 0 | 0 |
| Total | 77 | 2 | 2.60 |
| *Order Insectivora - Hedgehogs and Shrews* | | | |
| Family Erinaceidae | 2 | 0 | |
| Family Soricidae | 29 | 9 | 31.03 |
| Family Macroscelidea | 1 | 0 | 0 |
| Total | 32 | 9 | 28.13 |
| *Order Rodentia - Rodents* | | | |
| Family Sciuridae - Squirrels | 4 | 0 | 0 |
| Family Gliridae - Dormouse | 2 | 0 | 0 |
| Family Muridae - Rats and Mice | 57 | 14 | 24.56 |
| Family Rhizomyidae - Molerats | 2 | 1 | 50.00 |
| Family Dipodidae | 1 | 0 | 0 |
| Family Bathyergidae | 1 | 0 | 0 |
| Family Ctenodactylidae | 1 | 0 | 0 |
| Family Thryonomyidae | 1 | 0 | 0 |
| Family Hystricidae - Porcupines | 1 | 0 | 0 |
| Total | 70 | 15 | 21.43 |
| *Order Primates - Bushbabies and Monkeys* | | | |
| Family Lorisidae - Bushbabies | 2 | 0 | 0 |
| Family Cercopithecidae - Monkeys | 10 | 1 | 10.00 |
| Family Colobidae - Colobus Monkeys | 1 | 0 | 0 |
| Total | 13 | 1 | 7.69 |
| *Order Carnivora - Carnivores* | | | |
| Family Mustelidae | 5 | 0 | 0 |
| Family Canidae - Dogs | 8 | 1 | 12.50 |
| Family Viverridae | 11 | 0 | 0 |
| Family Protelidae | 1 | 0 | 0 |
| Family Hyaenidae - Hyaenas | 2 | 0 | 0 |
| Family Felidae - Cats | 6 | 0 | 0 |
| Total | 33 | 1 | 3.03 |

| Group | Total species | Endemic species | % Endemic |
|---|---|---|---|
| *Order Artiodactyla - Even-toed Ungulates* | | | |
| Family Hippopotamidae - Hippopotamus | 1 | 0 | 0 |
| Family Suidae - Pigs | 4 | 0 | 0 |
| Family Giraffidae - Giraffe | 1 | 0 | 0 |
| Family Bovidae - Bovids | 33 | 2 | 6.06 |
| Total | 39 | 2 | 5.13 |
| *Order Perissodactyla - Odd-toed Ungulates* | | | |
| Family Equidae - Asses and Zebras | 3 | 0 | 0 |
| Family Rhinocerotidae - Rhinoceros | 1 | 0 | 0 |
| Total | 4 | 0 | 0 |
| *Order Proboscidea - Elephant* | | | |
| Family Elephantidae - Elephant | 1 | 0 | 0 |
| Total | 1 | 0 | 0 |
| *Order Hyracoidea - Hyraces* | | | |
| Family Procaviidae - Hyraces | 2 | 0 | 0 |
| Total | 2 | 0 | 0 |
| *Order Lagomorpha - Hares* | | | |
| Family Leporidae - Hares | 4 | 1 | 25.00 |
| Total | 4 | 1 | 25.00 |
| *Order Tubulidentata - Aardvark* | | | |
| Family Orycteropodidae - Aardvark | 1 | 0 | 0 |
| Total | 1 | 0 | 0 |
| *Order Pholidota - Pangolin* | | | |
| Family Manidae - Pangolin | 1 | 0 | 0 |
| Total | 1 | 0 | 0 |
| **Total terrestrial mammals** | **277** | **31** | **11.19** |

## Marine Mammals

| | | | |
|---|---|---|---|
| *Order Sirenia - Dugong and Manatee* | | | |
| Family Dugongidae - Dugong | 1 | 0 | 0 |
| Total | 1 | 0 | 0 |
| *Order Cetacea - Whales and Dolphins* | | | |
| Family Balaenopteridae - Baleen Whales | 4 | 0 | 0 |
| Family Ziphiidae | 1 | 0 | 0 |
| Family Physeteridae | 1 | 0 | 0 |
| Family Delphinidae - Dolphins | 11 | 0 | 0 |
| Total | 17 | 0 | 0 |
| Total marine mammals | 18 | 0 | 0 |
| **Overall Total** | **295** | **31** | **10.51** |

# APPENDIX III

# Ethiopia - Surface area of Wildlife Conservation Areas.

## 1. Principal Wildlife Conservation Areas

| Wildlife Conservation Area | | | | km sq |
|---|---|---|---|---|
| N.1 | Abijatta-Shalla Lakes NP | | | 887 |
| | | L. Shalla | 316 | |
| | | L. Abijatta | 166 | |
| | | total water | 482 | |
| N.2 | Awash NP | | | 756 |
| N.3 | Bale Mountains NP | | | 2,471 |
| N.4 | Dahlak Marine NP | | ~ | 2,000 |
| | | Green Is. | | |
| | | Assarca Is. | | |
| | | Dissei Is. | | |
| | | Sciumma Is. | | |
| | | Ito Um Narus | | |
| N.5 | Gambella NP | | ** | 5,061 |
| N.6 | Mago NP | | | 2,162 |
| N.7 | Nechisar NP | | | 514 |
| | | L. Chamo | 32 | |
| | | L. Abbaye | 46 | |
| | | total water | 78 | |
| N.8 | Omo NP | | | 4,068 |
| N.9 | Simen Mountains NP | | * | 179 |
| N.10 | Yangudi Rassa NP | | | 4,731 |
| S.1 | Babille Elephant Sct. | | | 6,982 |
| S.2 | Kuni-Muktar Mountain Nyala Sct. | | ~ | |
| S.3 | Senkelle Swayne's Hartebeest Sct. | | | 54 |
| S.4 | Yabello Sct. | | | 2,496 |
| | | Total Water | | 560 |
| | | Total Land | | 31,802 |
| | | Total NP Area | | 22,829 |
| | | Total Sanctuary Area | | 9,532 |
| | | Total NP & Sct. | | 32,362 |
| | | as % Ethiopia (1.2mn km. sq.) | | 2.70 |

Notes: Measured from 1:250,000 series maps of Ethiopia (1979), using Lasico L30 Compensating Polar Planimeter, unless noted otherwise:

* measured from "Simen Mountains Management Zones" Map (1983
** measured from "Safari Ethiopia" map (1973)
~ area approximate, detailed studies required

Source: Jesse C. Hillman

## Ethiopia - Surface area of Wildlife Conservation Areas.

### 2. Wildlife Reserves **

| Wildlife Conservation Area | | km sq |
|---|---|---|
| W.1 | Alledeghi WR | 1,832 |
| W.2 | Awash West WR | 1,781 |
| W.3 | Bale WR | 1,766 |
| W.4 | Chew Bahr WR | 4,212 |
| W.5 | Gash-Setit WR | 709 |
| W.6 | Gewane WR | 2,439 |
| W.7 | Mille-Sardo WR | 8,766 |
| W.8 | Nakfa WR | 1,639 |
| W.9 | Shire WR | 753 |
| W.10 | Tama WR | 3,269 |
| W.11 | Yob WR | 2,658 |
| | Total Wildlife Reserves | 29,824 |

### 3. Controlled Hunting Areas **

| Wildlife Conservation Area | | km sq |
|---|---|---|
| C.1 | Afdem-Gewane CHA | 5,932 |
| C.2 | Akobo CHA | 5,049 |
| C.3 | Arssi CHA | 10,876 |
| C.4 | Awash West CHA | 9,136 |
| C.5 | Bale CHA | 9,663 |
| C.6 | Borana CHA | 45,366 |
| C.7 | Boyo Swamp CHA ~ | |
| C.8 | Chercher & Arba Guggu Mountain CHA | 3,045 |
| C.9 | Dabus Valley CHA | 2,127 |
| C.10 | Erer-Gota CHA | 2,386 |
| C.11 | Jikau CHA | 3,375 |
| C.12 | Lower Wabe Shebelle CHA | 23,788 |
| C.13 | Maze CHA ~ | |
| C.14 | Mizan-Teferi CHA ~ | |
| C.15 | Murle CHA | 4,172 |
| C.16 | Omo West CHA | 4,561 |
| C.17 | Segen CHA ~ | |
| C.18 | Tedo CHA | 2,347 |
| | Total CHAs | 131,823 |

## Ethiopian Wetlands

| Name | Location | Length (km) | Width (km) | Area ($km^2$) | Depth (metres) | Altitude (m ASL) | Remarks |
|---|---|---|---|---|---|---|---|
| 1. Abay Lake | 07°55'N 38°22'E | | | | | 1,850 | |
| 2. Abaya Lake | 06°15'N 37°55'E | 60 | 20 | 1,160 | 13 | 1,169 | 46 $km^2$ in NNP (a) |
| 3. Abbe Lake | 11°10'N 41°45'E | | | 450 | | 243 | Abhebid |
| 4. Abijatta Lake | 07°37'N 38°35'E | 17 | 15 | 205 | 14 | 1,578 | 166 $km^2$ protected in ASLNP (b) |
| 5. Adobed Lakes | 11°22'N 41°36'E | | | | | 340 | 5 lakes (c) |
| 6. Affambo Lake | 11°25'N 41°42'E | 13 | 2 | 18 | | 800 | |
| 7. Afrera Lake | 13°10'N 40°52'E | | | 125 | 160 ? | - 102 | |
| 8. Alemaya Lake | 09°24'N 42°01'E | | | | | 2,100 | (r) |
| 9. Aloba Lake | 10°14'N 39°39'E | | | | | 1,800 | |
| 10. Ardibu Lake | 11°15'N 39°46'E | | | | | 1,900 | "Hardibo" |
| 11. Aruato Lake | 09°42'N 41°14'E | | | | | 900 | |
| 12. Asaita Lake | 11°34'N 41°28'E | | | | | 400 | |
| 13. Ashenge Lake | 12°35'N 39°30'E | 5 | 4 | 20 | 25 | 2,443 | |
| 14. Assab Islands | 12°55'N 42°55'E | | | | | 0 | Sea bird breeding |
| 15. Assale Lake | 14°10'N 40°20'E | | | 70 | | - 125 | 3 lakes |
| 16. Awasa Lake | 07°00'N 38°25'E | 16 | 9 | 129 | 10 | 1,675 | (d) |
| 17. Awash Melkasa Lake | 08°29'N 39°19'E | | | | | 1,500 | man-made |
| 18. Bale Mountains Lakes | 06°50'N 39°51'E | | | | | 4,000 | numerous, incl. Garba Guracha |
| 19. Barachet Lake | 08°17'N 39°03'E | | | | | 1,800 | |

| Name | Location | Length (km) | Width (km) | Area ($km^2$) | Depth (metres) | Altitude (m ASL) | Remarks |
|---|---|---|---|---|---|---|---|
| 20. Basaka Lake | 08°55'N 39°52'E | | | 6 | | 980 | (e) |
| 21. Beda Lake | 09°55'N 40°23'E | | | | | 609 | |
| 22. Billi'uli Lake | 11°50'N 41°45'E | | | | | 100 | |
| 23. Bishoftu Lakes | 08°47'N 39°01'E | | | | | 1,900 | around Debre Zeit town (u) |
| 24. Boyo Lake and Swamp | 07°30'N 38°02'E | | | | | 1,900 | (v) |
| 25. Budamada-Tido-Ameda Lakes | 07°04'N 38°06'E | | | | | 1,550 | 3 crater lakes |
| 26. Chamo Lake | 05°50'N 37°45'E | 26 | 2 | 551 | 10 | 1,108 | 32 $km^2$ in NNP (f) |
| 27. Chew Bahir Lake | 04°45'N 36°50'E | 45 | 30 | 1,125 | | 520 | (g) |
| 28. Chitu Lake | 07°24'N 38°25'E | | | | | 1,540 | |
| 29. Chomen Lake | 09°30'N 37°17'E | | | | | 2,000 | + 700 $km^2$ swamps (h) |
| 30. Coastal Wetlands | 1,200 kms long | | | | | 0 | migrating/wintering shore birds |
| 31. Dabashi Lake | 07°11'N 38°33'E | | | | | 1,680 | and swamps |
| 32. Dahlak Islands | 16°00'N 40°00'E | | | | | 0 | > 120 islands |
| 33. Dalay Lake | 10°08'N 40°31'E | | | | | 700 | |
| 34. Debhile Lake | 09°20'N 40°06'E | | | | | 800 | |
| 35. Dendy Lake | 08°50'N 38°05'E | | | | | 2,800 | |
| 36. Deneba Salt Lake | 11°04'N 40°53'E | | | | | 400 | |
| 37. Dip'a Lake | 05°11'N 36°16'E | | | | | 400 | |
| 38. Dukhani Lake | 08°55'N 38°45'E | | | | | 1,800 | |
| 39. Dunkaga Lake | 09°40'N 40°15'E | | | | | 1,000 | |
| 40. Ellen Lake | 08°23'N 38°59'E | | | | | 1,700 | (q) |
| 41. Etosha Lakes | 07°55'N 39°19'E | | | | | 3,200 | |
| 42. Fogara swamps | 12°05'N 37°50'E | | | | 1,000 | 2,500 | east of lake Tana |

*Ethiopian wetlands - 3*

| Name | Location | Length (km) | Width (km) | Area ($km^2$) | Depth (metres) | Altitude (m ASL) | Remarks |
|---|---|---|---|---|---|---|---|
| 43. Gamarri Lake | 11°30'N 41°42'E | 40 | 28 | 760 | | 339 | (i) |
| 44. Gargori Lake | 11°45'N 41°30'E | | | | | 400 | |
| 45. Garner Lake | 06°56'N 34°29'E | | | | | 500 | (s) |
| 46. Gefu Lake | 11°22'N 41°28'E | | | | | 400 | |
| 47. Gesi Lake | 07°34'N 34°11'E | | | | | 440 | |
| 48. Gewane swamps | 09°55'N 40°32'E | | | | | 1,500 | |
| 49. Giuletti Lake | 13°18'N 41°02'E | | | | | - 80 | (p) |
| 50. Hara Gebaya Lake | 11°50'N 39°50'E | | | | | 2,600 | |
| 51. Hayk Lake | 11°20'N 39°43'E | 7 | 5 | 23 | 23 | 1,900 | |
| 52. Hertale Lake | 09°55'N 40°25'E | | | | | 600 | |
| 53. Kaddabasa Lake | 10°15'N 40°30'E | | | | | 600 | |
| 54. Kemisse Swamps | 10°42'N 39°50'E | | | | | 1,400 | |
| 55. Koka Lake | 08°26'N 39°10'E | 20 | 15 | 258 | 9 | 1,589 | man-made (j) |
| 56. Langano Lake | 07°35'N 38°45'E | 18 | 16 | 230 | 46 | 1,582 | |
| 57. Liddo-Debado Lakes | 09°33'N 40°14'E | | | | | 750 | 2 lakes (k) |
| 58. Loma Lake | 11°58'N 40°57'E | | | | | 400 | |
| 59. Mago Lake | 05°43'N 36°16'E | | | | | 600 | |
| 60. Melka Wakana Lake | 07°09'N 39°25'E | | | | | 2,300 | man-made |
| 61. Mey Igir Lake | 10°59'N 39°39'E | | | | | 2,500 | |
| 62. Ota Lake | 09°38'N 40°19'E | | | | | 800 | |
| 63. Sawata Lake | 11°30'N 41°40'E | | | | | 700 | |
| 64. Shalla Lake | 07°28'N 38°30'E | 28 | 12 | 409 | 230 | 1,558 | 316 $km^2$ in ASLNP (l) |
| 65. Tana Lake | 12°00'N 37°20'E | 70 | 60 | 3,600 | 9 | 1,785 | + Fogara/Dambia wetlands (m) |

| Name | Location | Length (km) | Width (km) | Area ($km^2$) | Depth (metres) | Altitude (m ASL) | Remarks |
|---|---|---|---|---|---|---|---|
| 66. Tefki swamps | 08°50'N 38°35'E | | | | | 2,700 | |
| 67. Tehiyo Lake | 11°39'N 41°30'E | | | | | 250 | |
| 68. Temren Lake | 07°57'N 38°04'E | | | | | 2,900 | |
| 69. Turkana Lake | 04°35'N 36°04'E | 52 | | 1,200 | | 400 | part within Ethiopia only (n) |
| 70. Wagaan Lakes & swamps | 08°00'N 34°00'E | | | 2,860 | | 400 | Gambella swamps |
| 71. Weyto Lake | 05°25'N 36°53'E | | | | | 520 | |
| 72. Wonchi Lake | 08°53'N 37°54'E | | | | | 3,387 | |
| 73. Yardi Lake | 10°13'N 40°29'E | | | 66 | | 562 | and swamps |
| 74. Zangana Lake | 10°55'N 37°01'E | | | | | 2,700 | (t) |
| 75. Zula Lake | 15°16'N 39°38'E | | | | | 57 | man-made, on Haddos River |
| 76. Zuqala Lake | 08°32'N 38°52'E | | | | | 3,500 | |
| 77. Zwai Lake | 08°00'N 38°50'E | 25 | 20 | 434 | 4 | 1,636 | (o) |

Total water area in Table = 13,699 $km^2$, or 1.14% of Ethiopia's land surface.

Notes:

(a) also known as "Hora" Lake, "Hora Deka", "Afgaia", "Afjada".
(b) also known as "Margherita".
(c) also known as "Bario".
(d) also known as "Auasa".
(e) also known as "Metahara".
(f) also known as "Ganjule", "Shamo".
(g) also known as "Stephanie", "Chouwaha", "Chew Bahr".
(h) also known as "Finchaa", enlarged as a dam from the original lake.
(i) also known as "Gumare", "Gemeri", "Adobarda".
(j) previously known as "Airarobi", "Ararobi", Horarobi", Guirarobi", which lake was incorporated into the man-made Lake Koka.
(k) also known as "Lihado", "Le Ado", "Lamina".
(l) also known as "Chalo", "Tchalo", "Hora Schala".
(m) also known as "Dembea".
(n) also known as "Rudolph".
(o) also known as "Dembel", "Zuai", "Zouai".
(p) also known as "Julietta".
(q) also known as "Ailan", "Helene".
(r) also known as "Aramaio".
(s) also known as "Ulut".
(t) also known as "Zinguinea".
(u) includes lakes Aranguade (also known as"Verde", "Horaro", "Green"); Bishoftu (also known as "Guda", "Hora", "Melca"); Bishoftu Guda (also known as "Babogaya", "Paulo", "Bishoftu"); Hora Arsedi (also known as "Biete Mengist", "Hora", "Hora Seddi"); and Kilole (also known as "Kilotes", "Hora Kilole", "Flamingo").
(v) also known as "Bilate" lake.

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Major Rivers:

| | | |
|---|---|---|
| Abay (Blue Nile) | 800 | km (length within Ethiopia) |
| Angereb | 220 | |
| Awash | 1,200 | |
| Baro(-Akobo) | 227 | |
| Dawa | 740 | |
| Genale | 480 | |
| Mereb | 440 | |
| Omo-Gibe | 760 | |
| Tacazze | 608 | |
| Wabe Shebelle | 1,340 | |

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# APPENDIX IV

## Ethiopian Wildlife Conservation Organisation

## Legal Documents concerning Wildlife Conservation in Ethiopia

1. <u>Published Legislation</u>: (All in ***Negarit Gazetta***, except 1.2)

1.1 Game Proclamation Nº.61 of 1944

1.2 Elenco Primo, Riserve Privatissime. ***Gazetta Eritrea*** Nº.4, p.31, Yob, Nakfa and Gash-Setit Wildlife Reserve Boundaries. 16 March 1959

1.3 Powers of Rangers Regulations, Legal Notice Nº.349 of 1968

1.4 Awash National Park Order, Nº.54 of 1969

1.5 Simien National Park Order, Nº.59 of 1969

1.6 Wildlife Conservation Order, Nº.65 of 1970

1.7 Wildlife Conservation Regulations, Legal Notice Nº.416 of 1972

1.8 Wildlife Conservation (Amendment) Regulations, Legal Notice Nº.445 of 1974

1.9 Endangered Species of Wildlife Commemerative Coins Regulation, Legal Notice Nº.61 of 1978

1.10 Forest and Wildlife Conservation and Development Proclamation, Proclamation Nº.192 of 1980

1.11 A Decree to ratify the Covention on International Trade in Endangered Species of Wild Fauna and Flora, State Decree Nº.14 of 1989

2. **<u>Relevant, indirectly concerned with Wildlife</u>**:

2.1 Council of State Special Decree to Provide for the Establishment of the Fish Production and Marketing Corporation, Council of State Special Decree Nº.13 of 1989

2.2 Proclamation to Provide for the Study and Protection of Antiquities, Proclamation Nº.26 of 1989

3. <u>Repealed Legislation</u>:

Repealed by Proclamation Nº.192 of 1980:

3.1 Game Proclamation Nº.61 of 1944

3.2 Wildlife Conservation Order №.65 of 1970

**4. Proposed:**

4.1 Proposed legislation exists for new Wildlife Legislation, establishing the Wildlife Conservation Organisation and Regulations, draft proposals dated 1977 Ethiopian Calendar; 1984 Western Calendar (Amharic only).

4.2 Proposed Proclamation to Provide for the Conservation, Development and Management of National Wildlife Resources, draft dated October 1979.

4.3 Proposed Wildlife Conservation Policy exists, revised draft dated February 1988.

4.4 Proposed boundaries for the legal gazettment of various Wildlife Conservation Areas - National Parks, Wildlife Sanctuaries, Wildlife Reserves, and Controlled Hunting Areas - (in English) as follows:

- Awash National Park (amended 1989)
- Abijatta-Shalla Lakes National Park
- Bale Mountains National Park
- Dahlak Marine National Park
- Mago National Park
- Nechisar National Park
- Omo National Park
- Simien Mountains National Park (amended 1984)
- Yangudi Rassa National Park

- Awash-Rassa Wildlife Sanctuary
- Awash Wildlife Sanctuary
- Danakil Wildlife Sanctuary
- Babille Elephant Wildlife Sanctuary

- Awash Controlled Hunting Area
- Afdem-Gota Controlled Hunting Area

## The estimated cost of wildlife conservation to Ethiopia:

in Ethiopian Birr per average year.

### 1. Support (Expenditure on Wildlife Conservation)

| | |
|---|---|
| 1.1 Ethiopian government | 1 |
| 1.1.1 Salaries | 756,000 |
| 1.1.2 Petty cash | 1,152,000 |
| 1.1.3 Capital grants | 1,918,200 |
| subtotal | 3,826,200 |
| 1.2 Assistance aid | 2 |
| 1.2.1 WWF | 374,463 |
| 1.2.2 WCI | 234,413 |
| 1.2.3 UiOslo | 344,862 |
| 1.2.4 Other | 196,869 |
| subtotal | 1,150,607 |
| total support for wildlife | 4,976,807 |

### 2. Earnings (Income brought in by wildlife)

| | | |
|---|---|---|
| 2.1 Direct | | |
| 2.1.1 WCA gate fees | 36,974 | |
| 2.1.2 Hunting fees | 719,776 | |
| 2.1.3 Wildlife utilisation (excl. Crocodile Farm) | 57,821 | |
| 2.1.4 Crocodile products | 2,500,000 | 3 |
| 2.1.5 Live exports (primates) | 182,274 | |
| subtotal | 3,496,845 | |
| 2.2 Indirect | | |
| 2.2.1 Ethiopian Airlines | 190,000 | 4 |
| 2.2.2 Ethiopian Hotels Corporation | 110,000 | 4 |
| 2.2.3 NTO (wildlife viewing) | 514,500 | 5 |
| 2.2.4 Taxidermy, trophy export) | 400,000 | |
| 2.2.5 Professional hunters & NTO | 780,224 | |
| 2.2.6 Curios, souvenirs | 50,000 | 4 |
| subtotal | 2,044,724 | |
| total earned by wildlife | 5,541,569 | |

### 3. Balance of support for wildlife

| | |
|---|---|
| 3.1 Support given to wildlife conservation | 4,976,807 |
| 3.2 Earnings by wildlife | 5,541,569 |
| net balance - excess of earnings over support | 564,762 |

**Notes:**

1 - Data from years 1980 and 1981 (Eth. year)
2 - average of 8 year period (1983-1990).
3 - for 1990 production year.
4 - Estimated for hunting clients only (Hilton standard)
5 - 1,494 total Foreign Tourists to all WCAs in Ethiopian year 1980 (1988-9); more realistic total is probably that for the highest Park alone, i.e. Abijatta-Shalla Lakes NP with 686 Foreign Tourists in 1988-9.

Jesse C. Hillman

Source: Jesse C. Hillman

## GENERAL HOLDING

| SPECIES | PGRC-COLL | OTHERINST | DONA-TED | SELE-CTION | REPATRET | TOTALER |
|---|---|---|---|---|---|---|
| Abelmoschus esculentus | 13 | 5 | 0 | 0 | 0 | 18 |
| Aeschynomene abbssinica | 1 | 0 | 0 | 0 | 0 | 1 |
| Aframomum corrorima | 25 | 0 | 0 | 0 | 0 | 25 |
| Allium spp. | 135 | 0 | 0 | 0 | 0 | 135 |
| Amaranthus spp. | 38 | 0 | 0 | 0 | 0 | 38 |
| Amorphophallus sp. | 8 | 0 | 0 | 0 | 0 | 8 |
| Anacardium sp. | 1 | 0 | 0 | 0 | 0 | 1 |
| Arachis hypogaea | 25 | 0 | 5 | 0 | 0 | 30 |
| Arisaema sp. | 1 | 0 | 0 | 0 | 0 | 1 |
| Avena sppp. | 24 | 0 | 4 | 0 | 0 | 28 |
| Brassica spp. | 831 | 212 | 59 | 0 | 93 | 1195 |
| Cajanus cajan | 37 | 0 | 0 | 0 | 0 | 37 |
| Calpurnea ourea | 2 | 0 | 0 | 0 | 0 | 2 |
| Capsicum spp. | 180 | 0 | 14 | 0 | 0 | 194 |
| Cardeospermum | 1 | 0 | 0 | 0 | 0 | 1 |
| Carthamus tinctorius | 79 | 57 | 51 | 0 | 0 | 187 |
| Carum copticum | 24 | 0 | 0 | 0 | 0 | 24 |
| Casia spp. | 2 | 0 | 0 | 0 | 0 | 2 |
| Celosia spp. | 1 | 0 | 0 | 0 | 0 | 1 |
| Cicer arietinum | 711 | 0 | 4 | 162 | 0 | 877 |
| Clematis simensis | 1 | 0 | 0 | 0 | 0 | 1 |
| Coccinia abyssinica | 45 | 0 | 0 | 0 | 0 | 45 |
| Coffea Arabica | 313 | 834 | 4 | 0 | 0 | 1151 |
| Coleus edulis | 10 | 0 | 0 | 0 | 0 | 10 |
| Colocasia spp. | 34 | 0 | 0 | 0 | 0 | 34 |
| Comemela | 0 | 0 | 5 | 0 | 0 | 5 |
| Colchorus olitorius | 2 | 0 | 0 | 0 | 0 | 2 |
| Coriandrum sativum | 62 | 0 | 0 | 0 | 0 | 62 |
| Crambe abyssinica | 1 | 1 | 0 | 0 | 0 | 2 |
| Cucumis | 1 | 0 | 0 | 0 | 0 | 1 |
| Cucurbita spp. | 57 | 0 | 12 | 0 | 0 | 69 |
| Cuminum cyminum | 7 | 0 | 0 | 0 | 0 | 7 |
| Cumisa culiatus | 1 | 0 | 0 | 0 | 0 | 1 |
| Curcuma longa | 2 | 0 | 0 | 0 | 0 | 2 |
| Cyphomandra betacea | 1 | 0 | 0 | 0 | 0 | 1 |
| Datura stramonium | 2 | 0 | 0 | 0 | 0 | 2 |
| Dichrostachis | 1 | 0 | 0 | 0 | 0 | 1 |
| Dioscorea spp. | 15 | 0 | 0 | 0 | 0 | 15 |
| Dodonea viscosa | 1 | 0 | 0 | 0 | 0 | 1 |
| Dolichos | 2 | 0 | 0 | 0 | 0 | 2 |
| Elettarea cardomomum | 1 | 0 | 0 | 0 | 0 | 1 |
| Eleusine coracana | 887 | 0 | 762 | 0 | 0 | 1649 |
| Embelia schimperi | 10 | 0 | 1 | 0 | 0 | 11 |
| Enset ventricosum | 222 | 0 | 0 | 0 | 0 | 222 |
| Eragrostis tef | 1929 | 1310 | 0 | 357 | 187 | 3783 |
| Fagopyrum esculentum | 1 | 0 | 0 | 0 | 0 | 1 |
| Glycine | 2 | 0 | 0 | 0 | 0 | 2 |
| Gnidia sp. | 2 | 0 | 0 | 0 | 0 | 2 |
| Gossypium spp. | 13 | 0 | 0 | 0 | 0 | 13 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Guizotia abyssinica | 716 | 340 | 1 | 1 | 0 | 1058 |
| Helianthus annuus | 23 | 0 | 44 | 0 | 0 | 67 |
| Heteromorpha crenus trifo | 1 | 0 | 0 | 0 | 0 | 1 |
| Hordeum vulgare | 4113 | 3066 | 67 | 5494 | 1463 | 14203 |
| Imperbealeae spp. | 1 | 0 | 0 | 0 | 0 | 1 |
| Ipomoea batatas | 46 | 0 | 0 | 0 | 0 | 46 |
| Lablab purpureus | 36 | 0 | 0 | 0 | 0 | 36 |
| Lagenaria sp. | 11 | 0 | 0 | 0 | 0 | 11 |
| Lathyrus sativus | 245 | 61 | 0 | 0 | 0 | 306 |
| Lens culinaris | 405 | 0 | 134 | 0 | 0 | 539 |
| Lepidium sativum | 88 | 0 | 0 | 0 | 0 | 88 |
| Linum usitatissimum | 696 | 358 | 1 | 32 | 0 | 1087 |
| Lupinus spp. | 32 | 0 | 0 | 0 | 0 | 32 |
| lycopersicon spp. | 10 | 0 | 16 | 0 | 0 | 26 |
| Manihot esculenta | 13 | 0 | 0 | 0 | 0 | 13 |
| Medicago sativa | 2 | 0 | 2 | 0 | 0 | 4 |
| Moringa stenopetala | 2 | 0 | 0 | 0 | 0 | 2 |
| Myrsine africana | 1 | 0 | 0 | 0 | 0 | 1 |
| Nicotiana tabacum | 31 | 2 | 24 | 0 | 0 | 57 |
| Nigella sativa | 39 | 0 | 0 | 0 | 0 | 39 |
| Osimum spp. | 23 | 0 | 0 | 0 | 0 | 23 |
| Oryza spp. | 24 | 0 | 105 | 0 | 0 | 129 |
| Oxytenanthera abyssinica | 1 | 0 | 0 | 0 | 0 | 1 |
| Pennisetum typhoides | 135 | 0 | 10 | 0 | 0 | 145 |
| Phaseolus spp. | 309 | 0 | 18 | 0 | 0 | 327 |
| Phytolacca dodecandra | 159 | 0 | 0 | 0 | 0 | 159 |
| Pimpinella anisum | 6 | 0 | 0 | 0 | 0 | 6 |
| Piper longum | 3 | 0 | 0 | 0 | 0 | 3 |
| Pisum sativum | 914 | 444 | 38 | 11 | 0 | 1407 |
| Plumbago zeylanica | 1 | 0 | 0 | 0 | 0 | 1 |
| Primna shimperi | 2 | 0 | 0 | 0 | 0 | 2 |
| Raphanus sativus | 4 | 0 | 0 | 0 | 0 | 4 |
| Ricinus communis | 360 | 7 | 64 | 74 | 0 | 505 |
| Rubia cordifolia | 1 | 0 | 0 | 0 | 0 | 1 |
| Rumex abyssinica | 4 | 0 | 0 | 0 | 0 | 4 |
| Ruta chalepensis | 1 | 0 | 0 | 0 | 0 | 1 |
| Sesamum indicum | 194 | 51 | 228 | 0 | 0 | 473 |
| Setaria italica | 0 | 0 | 5 | 0 | 0 | 5 |
| Solanum incanum | 13 | 0 | 0 | 0 | 0 | 13 |
| Sorghum bicolor | 1712 | 4000 | 102 | 1850 | 0 | 7664 |
| Tamarindus indica | 0 | 0 | 1 | 0 | 0 | 1 |
| Trigonella foenum-graecum | 297 | 213 | 0 | 0 | 0 | 510 |
| Triticum spp. | 2913 | 2342 | 437 | 4658 | 1871 | 12221 |
| Verbascum sinaticum | 1 | 0 | 0 | 0 | 0 | 1 |
| Vernonia spp. | 48 | 0 | 14 | 0 | 0 | 62 |
| Vicia faba | 989 | 509 | 3 | 0 | 0 | 1501 |
| Vigna unguiculata | 49 | 0 | 4 | 0 | 0 | 53 |
| Xxantium abyssinica | 1 | 0 | 0 | 0 | 0 | 1 |
| Zea mays | 581 | 2 | 10 | 0 | 0 | 593 |
| Zingiber officinale | 55 | 0 | 0 | 0 | 0 | 55 |
| Unknown | 6 | 0 | 2 | 0 | 0 | 8 |
| | 21081 | 13814 | 2251 | 3614 | 3614 | 53399 |

# APPENDIX V

I. QUESTIONNAIRE FOR EXPERTS

ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

SCHOOL OF INFORMATION STUDIES FOR AFRICA (SISA)

1. Name (Full name with the proper title)_________________________

Year of birth __________________________

Sex ______________

Marital status _______________

Nationality __________________

2. Contact Address:

___________________________________

___________________________________

___________________________________

___________________________________

Telephone: Home____________________

Office____________________

Telex ______________________

Fax _________________

3. Academic Qualifications:

| Degree/Diploma | Fields of study | Institution | Year of award |
|---|---|---|---|
| .............. | ............... | ........... | ............... |
| .............. | ............... | ........... | ............... |
| .............. | ............... | ........... | ............... |
| .............. | ............... | ........... | ............... |

4. Main Field(s)of specialization: [ include subject areas you are specifically competent in]

____________________________________________________________

____________________________________________________________

____________________________________________________________

5. Honours and awards Received

____________________________________________________________

____________________________________________________________

____________________________________________________________

6. Membership in Societies (eg.professional association and other areas of activity )

| Type of membership | Society |
|---|---|
| | |
| | |
| | |

7. Main publications ( during the past five years):

Book and Reports:

| Co-author (if any ) | Title | Publisher | year |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

Paper in journal and Monographs

| Co- author (if any) | Title of paper | Title of Journal/Monograph | Volume Number | Year | Pages |
|---|---|---|---|---|---|
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

Language Competence [ Use " Y" for yes and "X" for saying no ]

| Language | Read | Write | Speak |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

8. Employment Record :[ Present empoyment and last employment]

| Employer | Designation | Period |
|---|---|---|
| | | |
| | | |
| | | |

9. Main Consultancy or Expert assignments undertaken in the last three years:

| Description of assignments | Duration |
|---|---|
| | |
| | |
| | |
| | |
| | |

10. Services offered ( mark "x" against your choice):

Consultancy ..........................

Training/Teaching ..............................

Others ( please specify) ........................

.......................................................................

............................................................

11. Comments or any other relevant information :

.......................................................................

.......................................................................

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.......................................................................

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........

# APPENDIX VI

II. QUESTIONNAIRE FOR INSTITUTION DATABASE
ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDY
SCHOOL OF GRADUATE STUDIES FOR AFRICA (SISA)

1.Name of the institution:
..................................................................

Date of establishment:........................................

Address of the institution:
p.o.Box:.............or street address.................
city ........................................
country .....................................
telephone.......................................
telex...........................................
fax.............................................

Associated Entities/branches /units/agencies (if any):

| Name | Location |
|---|---|
| 1........................ | ............................ |
| 2........................ | ............................ |
| 3........................ | ............................ |
| 4........................ | ............................ |
| 5........................ | ............................ |

2. General Objective of the Institution:
..................................................................
..................................................................
..................................................................
..................................................................
..................................................................

Manager/Director/Head of the Institution......................

Contact person ( if other than the above).....................

Number of staff:
total:.......................................
professional.................................
administrative...............................
others.......................................

3. Type of Institution ( Mark "x" against your choice)

.....international intergovernmental
.....international non-governmental
.....private
.....parastatal
.....government
.....trust/endowment
.....charitable institutions
.....others ( please specify)

..................................................................
..................................................................

4. The activities/functions of the institution ( eg. research, training, teaching, trade, etc.)

..................................................................
..................................................................
..................................................................

Services provided ( if any):

1.............................................................
2.............................................................
3.............................................................
4.............................................................

5. Geographical coverage ( please mark "x" against your choice)

.....Local
.....National
.....Regional
.....International

6. Working language(s)

......................................................
......................................................
......................................................

7. Courses offered ( if educational and/or training institution):

1.............................................................
2.............................................................
3.............................................................
4.............................................................
5.............................................................

8. Fellowships offered by the institution ( if any)

..................................................................
..................................................................
..................................................................
..................................................................

9. Sources of funding ( include full name of organization)

1.....................................................................
2.....................................................................
3.....................................................................
4.....................................................................

10. Honours and Awards Received

1.....................................................................
2.....................................................................
3.....................................................................
4.....................................................................

11. Patents taken

1....................................................................
2....................................................................
3....................................................................

12. Specialized /Modern information equipment(s) available ( eg. computers and accessories) ( indicate name, model, and no. of equipment availabe--eg. microcomputers, 486 Dx microprocessor,six)

1.................................................................
2.................................................................
3.................................................................
4.................................................................
5.................................................................

13. What are the types of the publication? (mark "x" against your choice)

......annual reports
......research reports
......conference proceedings
......others (please specify)

.........................................................................
.........................................................................
.........................................................................

14. Types of Serial Publications of the Institution

1.....................................................................
2.....................................................................
3.....................................................................

15. Does the institution ( mark "x" against your choice)

......make studies on biodiversity and/or tourism related matters based on own conducted survey
......make use of studies done by other organization
......others ( please specify)
.............................................................
.............................................................

16. If the institution makes use of outside sources ( other organizations work), pleas list

| Name of institution | Location |
|---|---|
| ................................. | ......................... |
| ................................. | ......................... |
| ................................. | ......................... |
| ................................. | ......................... |
| ................................. | ......................... |
| ................................. | ......................... |

17. Who are the main users ( external as well as internal ) of the services provided by the institution?

1. ........................................................
2. ........................................................
3. ........................................................
4. ........................................................
5. ........................................................
6. ........................................................
7. ........................................................

18. What are frequently requested for information?
..................................................................
..................................................................
..................................................................
..................................................................

19. Are there any ongoing biodiversity and/or tourism related research projects?

......yes
......no

20. If the answer to No. 19 was yes, please describe the details on the next page by including title of the project, objective, period, funding source, collaborating institutions, place of the project , and other relevant information for each of the project).

21. Any other remarks

.....................................................................
.....................................................................
.....................................................................
.....................................................................

# APPENDIX VII

III. QUESTIONNAIRE TO ASSESS INDIVIDUAL INFORMATION NEEDS FOR BIODIVERSITY AND/OR TOURISM STUDIES IN ETHIOPIA

ADDIS ABABA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

SCHOOL OF INFORMATION STUDIES FOR AFRICA [ SISA ]

1. Position ( job title) of the respondent: ......................
   Institution affiliated to ......................
   Highest academic qualifications ......................
   Areas of specialization ......................
   Working in the institution since ......................

2. You need information on studies on biodiversity and/or tourism for ( mark "X" against your choice)

   ......Research and development
   ......Planning and Policy making
   ......Decision making
   ......a visit
   ......general awareness
   ......teaching
   ......others(please specify)

..................................................................
..................................................................
..................................................................
..................................................................

3. You are specifically interested on studies /information about ( mark "X" against your choice)
   .....systems of wildlife conservation
   .....wildlife of Ethiopia
   .....historical sites
   .....biodiversity and/or tourism related institutions, bibliographies, experts, projects on progress, information systems,
   ....others ( please specify)

..................................................................
..................................................................

4. Which are the sources from which you get biodiversity and/or tourism related information from? ( Mark "x" against your choice)
   .....
   .....
   .....
   .....
   .....databases
   .....conference proceedings
   .....others (please specify)

..................................................................
..................................................................

5. Which are the institutions you frequently visit for obtaining information on biodiversity studies and/or tourism? ( List as many as you have in the descending order of importance)

(a) LOCAL:

| NAME | LOCATION |
|---|---|
| ................................ | ........................ |
| ................................ | ........................ |
| ................................ | ........................ |
| ................................ | ........................ |
| ................................ | ........................ |
| ................................ | ........................ |
| ................................ | ........................ |
| ................................ | ........................ |
| ................................ | ........................ |

(b)EXTERNAL:

| NAME | LOCATION |
|---|---|
| ................................ | ........................ |
| ................................ | ........................ |
| ................................ | ........................ |
| ................................ | ........................ |
| ................................ | ........................ |
| ................................ | ........................ |
| ................................ | ........................ |
| ................................ | ........................ |

6. What are the types of service you receive? ( Mark "x" against your choice)

.....Literature search
.....Database search
.....Document Delivery
.....Reprography
.....Current awareness Service
.....Selective Dissemination of information
.....Periodical Reports/Publications such as bulletins etc.
.....Others ( please specify )
..........................................................................
..........................................................................

7. How do you present your query request for information to the agency/agencies which are to provide the service?

.....by visiting place and asking orally
.....by telephone
.....by filling a pre-printed form
.....through an on-line transmission using a networked micro-computer
.....Others ( please specify )
.......................................................................
.......................................................................

8. If your answer for No.-7 was " by filling a pre-printed form", please attach a copy of it? if available.

9. In respect of timeliness, convenience of use, completeness , relevance of information, are you satisfied with the services provided in relation to biodiversity and/or tourism in Ethiopia?

......very much satisfied
......partly satisfied
......little satisfied

10. If your answer to No. 9 was not "very much satisfied", what do you think the reason to be?

......the service is not as timely as it should be
......the service involves too much inconvenience as to where to go, whom to consult
......difficulty in understanding the system
......the limited information content
......Others ( please specify )
.......................................................................
.......................................................................

11. As a means to improve the above situation(s), what are your suggestions?
.......................................................................
.......................................................................
.......................................................................
.......................................................................
.......................................................................

12. What is your opinion towards computer based information system in general? Do you favour or Disfavour?

.................................................................
.................................................................
.................................................................

13. If you are in favour of computer based information system, how do you think it has improved or can improve on the existing service system and what are the additional benefits it has brought or would bring in relation to biodiversity studies and/or tourism?

.................................................................
.................................................................
.................................................................
.................................................................
.................................................................

14. If they do not already exist, what do you think of the creation and provision of computer based information system for fauna and flora, bibliographic materials, institutions, experts, national parks, projects (researches) in progress, tourist attraction sites and centres in relation to biodiversity studies and/or tourism in Ethiopia?

.................................................................
.................................................................
.................................................................

15. Any additional remarks in relation to the generation, dissemination, and utilization of information on biodiversity studies and/or tourism?

.................................................................
.................................................................
.................................................................
.................................................................
.................................................................

IV. QUESTIONNAIRE ON INFORMATION SYSTEM OF INSTITUTIONS'
ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
SCHOOL OF INFORMATION STUDIES IN AFRICA ( SISA )

1. Name of the information system ( library, doc. centre, information centre, etc.,).

.....................................................................................

2. Number of staff:

professional.......................................................
sub professional .................................................
supporting staff ..................................................
external consultancy ............................................
others ( please specify )........................................

.....................................................................................
.....................................................................................

3. Types of information Services provided ( please mark "x" against your choice)

.....reference
.....database search
.....[illegible]
.....current awareness
.....selective dissemination of information
.....circulation/ document loan
.....interlibrary loan
.....others ( please specify)

.....................................................................................
.....................................................................................
.....................................................................................

4. Subject coverage of the information system in use

.....................................................................................
.....................................................................................

5. Facilities:

5.1. Computer Facilities

a. Location of computer facilities

.....in the library/documentation/information centre
.....computer centre
.....other divisions ( please specify)

..........................................................................................
..........................................................................................
..........................................................................................

b. If computer is used in the library/documentation centre/ information centre, what is it used for ?

.....on line database search
.....circulation
.....acquisition
.....CD-ROM search
.....only for data processing
.....geographic data manipulation
.....others ( please specify )

..........................................................................................
..........................................................................................
..........................................................................................

c. Complete the following in relation to the computer facility

| Types of computer | Number | software used ( operating + application) |
|---|---|---|
| Micro computer | .............. | .............................. |
| Mini computer | .............. | .............................. |
| Mainframe computer | .............. | .............................. |

d. If there are computers in other divisions of your institution, are they networked with the one in your section ?

..........................................................................................

e. If computer(s) exist(s) in other divisions, what are the different functions/activities that they are used for?

......word processing
......financial management
......Map ( geographic data manipulation )
......statistical analysis
......object oriented database search ( like for fauna, flora, etc)
......others ( please specify)

..........................................................................................
..........................................................................................
..........................................................................................

f. If databases ( on compact discs like CD-ROM or in h[illegible]se developed ) exist, please indicate below

| database name | in house or developed outside | total No.of record | fre[illegible]ency of [illegible]date |
|---|---|---|---|
| ................ | ........................................ | ........ | ...... |
| ................ | ........................................ | ........ | ...... |
| ................ | ........................................ | ........ | ...... |
| ................ | ........................................ | ........ | ...... |
| ................ | ........................................ | ........ | ...... |

5.2. Other information storage, retrieval, and process[illegible]g facilities you have

a. ..........................................................
b. ..........................................................
c. ..........................................................
d. ..........................................................
e. ..........................................................

[illegible] against your choice)

| Institutions | (Individuals) |
|---|---|
| ......1. Ministries | policy makers |
| ......2. Research institutes/univ. | Researchers |
| ......3. Enterprises | Entrepreneurs |
| ......4. Community/village | Individual |
| ......5. Library/Information service | Info-facili[illegible] |
| ......6. others (please specify ) | |

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7. The types of information most likely to be needed by each one of the above groups are:

Group 1:

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Group 2:

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Group 3:

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Group 4:

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Group 5:

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For others (please Specify)

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8. What are the different information delivery mechanisms for the above groups of users?

.....Contact among colleagues by telephone, telex, correspondence, fax, and the like
.....Consultants or advisers--through visits
.....Libraries /information centres
.....Extension services
.....Conferences /meetings/ travel
.....Massmedia /film shows
.....on line computer network /in diskettes/ and the like magnetic media
.....Professional associations
.....Databases
.....Journals
.....Surveys/Experiments
.....Manuals
.....Exhibitions/Demonstrations
.....Government publications
.....Museums
.....Community networks
.....Directories
.....Others ( please specify)

.......................................................................................
.......................................................................................
.......................................................................................

9. What are the existing constraints? Why are the users not receiving the information they need?

.....Lack of adequate financing ( to provide information services)
.....Lack of professional incentives/rewards
.....Problem with the existing infrastructure ( communication infrastructure)
.....Lack of trained personnel
.....Inhibiting policies
.....Poor library collections due to poor storage facilities or lack of funds and staff to sustain the collection
.....Lack of software for improving computerized services
.....Inappropriate packaging of computers/software
.....Lack of perception or awareness of the importance of information and communication
.....Lack of standardization among the systems ( for those who have networked systems and who use different cataloguing rules)

.....others ( please specify)

10. What must be done to overcome the above constraints? What plans and strategies need to be implemented? ( please, mention your deas in the space below)

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11. Any additional remarks

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## WORKSHEET FOR COLLECTING DATA ON ENDEMIC PLANTS OF ETHIOPIA FOR THE TFLORA DATABASE

PLEASE PROVIDE SPECIFIC DATA

**Name:**

local.........................................
scientific....................................

**Location of plant site:**

region..........................................
district........................................
altitude........................................

Climate data:

mean annual rainfall..........rainfall range...........
mean annual temperature........temperature range.........

Soil characteristics ( PLEASE MARK "X" AGAINST YOUR CHOICE)

**Depth:** shallow........ deep.......
**Drainage:** good..... poor......
**Texture:** heavy/clayey....medium/loamy.....light/sandy....
**Erosion/Water logging:** none.... seasonal.....permanent....
**Reaction(pH):** acid....neutral.....alkaline........

Features of the plant:

**Flower structure:**...............................
**Root structure:**..............................
**Special trait/Environmental resistance:**.....................
.................................................
.................................................
.................................................
.................................................
**Seasonality:** perennial.....biennial......annual........

**Time it takes to grow:** .........................

Agroforestry uses ( PLEASE MARK "X" IN FRONT OF THE RIGHT USE IT IS APPLIED FOR)

.....Live fences
.....Live fence posts
.....Boundary planting for timber and pole production
.....Scattered trees on pasture
.....Scattered trees in cropland
.....Woodlots
.....Fruit trees on house compounds
.....Tree/shrub fallow for soil improvement
.....Hedge row intercropping for soil fertility improvement and fodder
.....cover/shelter for animals (birds & mammals) as den, nest, and the likes
.....Others ( please specify)

Other Utilities: (PLEASE MARK "X" AGAINST YOUR CHOICE IN FRONT OF THE CORRECT UTILITY ALTERNATIVES THE PLANT IS PROVIDING)

**Food:** ....leaves ....fruits ....nuts ....beverages ...spices
....other .....................................
.....................................
.....................................

**Fodder:** ....shoot/leaf ....fruit ....apiculture /bees/
....sericulture /silk worm/
....other .....................................
.....................................
.....................................

**Wood products:** ....fuel wood ....charcoal .....poles
....timber ....pulp wood ....construction
....other.............................
.............................
.............................

**Utilities:** ....essential oils .....insecticides

....latex .....dyes .....waxes
....medicine .....tannin ....fibres
....tobacco .....stimulant ....ornamental
....perfume/scent
....other.............................
.....................................

**Other services:** .....erosion control ....drainage
.....shade .......shelter & breeding site
.....other.............................
.....................................
.....................................

**Propagation:** ....natural ......direct sowing ....seedlings
....stake cuttings ....suckers ...air layering
....stumps .....grafting ....root stock
....other.....................................
.....................................

**Plant morphology:** ....thorny/spiny ....single stemmed
....multistemmed ....open canopy
....deciduous dry season
....deciduous wet season .....evergreen
....other................................
.....................................

**Management:** ....Coppicing .....Pollarding .....trimming
....lopping .....pruning
....other.................................
.....................................

**Plant status:**
.........................................................
.........................................................
.........................................................

Problems that are likely to occur ( eg. termites, fire )

.........................................................
.........................................................
.........................................................
.........................................................
.........................................................

any other remarks

.........................................................
.........................................................
.........................................................
.........................................................

completed by .........................................

## WORK SHEET FOR COLLECTING DATA ON ENDEMIC ANIMALS FOR THE TFAUNA DATABASE

Name :

Local ................................................
Scientific ...........................................
Type ................................................

Location :

Ecological zone(s)...................................
Region(s) ...................................
Altitude ...................................

Climate :

Mean annual rainfall............ Rainfall range...........
Mean annual temperature......... Temprature range......
vegetation type of the environment........................

Habitat Requirement of the animal for :

Food ................................................
................................................

Water ................................................
................................................

Cover ................................................
................................................

Breeding site........................................
........................................

Home range ...................................
...................................

Territory ...................................
...................................

Population of the species........................
........................

Clutches size (Reproductive potential)...............

Environmental Resistance capability (traits).................
................................................
................................................

Other ( please specify)
.................................................................
.................................................................

Use :
Economic value ..............................................

Nutritional value............................................

Recreational value...........................................

Ornamental/Aesthetic value...................................

Ecological value.............................................

Scientific value (for experiment)............................

Other ( please specify)
.................................................................
.................................................................
.................................................................

Status :

Current size....................................
Endangered......................................
Extinct ........................................
Other ( please specify)
.................................................................
.................................................................

Management Concern In :

Habitat development..........................................

Drawing and implementing endangered species Act...............

Sensitizing the public.......................................

Zoological garden approach...................................

Environmental protection ....................................

Favourable time /period/to visit.............................

Other relevant information to provide........................

Completed by.................................................

# APPENDIX VIII

BIODIVERSITY DATABASE OUTPUT

***NATIONAL PARK RECORD***

| | |
|---|---|
| MFN | 0001 |
| CONSERVATION AREA NAME | :Abijata-Shalla National Park |
| DATE: | |
| proposed | :1970 |
| established | :1974 |
| gazzeted | :not |
| LONGITUDE LATITUDE LOCATER | :N 7 degree 30" E 38 degree 30" |
| REGION | :Southern shoa |
| TOTAL AREA | :887 kmsq.(land 405kmsq. water 482kmsq.) |
| CLIMATE: | |
| Rainfall | |
| Temprature | :5-45 degree C. |
| Altitude | :540-2075m ASL |
| Climatic-zone | :Upper kolla |
| VEGETATION TYPES | :Savanna |
| WILDLIFE SPECIES CONSERVED | : |
| Major animals | :Great white pelican,lesser flamingo, white necked cormorant,grant's gazelle, |
| Other animals | :Greater kudu,warthog,anubis baboon, grivet,guereza,orbis,klipspringer, jackal |
| NUMBER OF ENDEMICS RECORDED : | |
| Bird Species | :Six out of the 299 species recorded |
| Mammals species | :Zero out of the 31 species recorded |

| | |
|---|---|
| OTHER NATURAL RESOURCE USES | :Fuelwood and charcoal making:human use of hot spring for medicinal purposes; fishing on Lake Abiyata in the fasting period |

TOURISM ASPECT :

| | |
|---|---|
| Tourist accomodation | :Four rest house beds;camping on shalla lake shore;two hotels near Lake Langanno; |
| Information facilities | :Information sheets in Amharic and English;museum currently closed due to bat damage; |
| Other facilities | :Four vehicles;electricity generators; communication radio;107km. track road distance park. |
| Scenic beauty | :Spectacular numbers of acqatic birds; bird breeding islands in lake shalla; the rugged scenery around shalla and isthmus between the lakes; |
| Measure of service | :4720 average annual vistors;Birr 10,916 average annual income; |

MANAGEMENT ASPECT :

| | |
|---|---|
| Staff | :35 staff; |
| Buildings | :Buildings (for staff, museum,rest house, out-ports,stores); |
| Prevailing threats | :Considerable settlement with cultivation in all areas;considerable livestock in all land areas |

| | |
|---|---|
| ECOLOGICAL ZONE | :Rift valley |
| DESCRIPTORS | :Abijata; Shalla; Lake; National park; Abijata Shalla National Park; White Pelican; Lasser Flammingo |
| REMARKS | :This park was primary created for its spectacular numbers of acquatic birds, especially great white pelican and breeding islands in Lake shalla and its Scenery. Additional features include Lake shalla being the deepest Ethiopian Rift valley lake at over 260m while Abijata is only 14m deep; the rugged scenery around shalla and isthmus between the lakes; both lakes are terminal having no outlets; large lava caves south of shalla; the proximity of the area to |

Addis Ababa (200km) and to the Lake Langanno recreational area with its hotels. At the time of the change of government in Ethiopia in May 1991, major destruction and looting occurred in this park, which virtually destroyed all of the EWCO management infrastructure, in particular buildings and vehicles. At the present time it has not been possible to replace to replace any significant part of this, and management of the area by EWCO is minimal.

***NATIONAL PARK RECORD***

| | |
|---|---|
| MFN | 0002 |
| CONSERVATION AREA NAME | :Awash National Park |
| DATE: | |
| proposed | :1963 |
| established | :1966 |
| gazzeted | :1969 |
| LONGITUDE LATITUDE LOCATER | :N 8 degree 55" E 39 degree 55" |
| REGION | :Eastern Shoa |
| TOTAL AREA | :756sq.km.(no water body) |
| CLIMATE: | |
| Rainfall | :699mm |
| Temprature | |
| Altitude | |
| Climatic-zone | :Upper kolla |
| VEGETATION TYPES | :Arid and semi-arid xeropuilous woodland |

WILDLIFE SPECIES CONSERVED :

| | |
|---|---|
| Major animals | :Beisa oryx,greater kudu,lesser kudu, swanye's Hartbeest,soemmerring's gazzelle, |
| Other animals | :Lion,Ostrich,warthog,gureza,anubis, hamaryas,baboon,grivet,defassawater Buck,salt's dikdik |

NUMBER OF ENDEMICS RECORDED :

| | |
|---|---|
| Bird Species | :five out of 392 recorded |
| Mammals species | :zero out of 46 recorded |

| | |
|---|---|
| OTHER NATURAL RESOURCE USES | :Human use of the hot springs |

TOURISM ASPECT :

| | |
|---|---|
| Tourist accomodation | :Fourty bed for keryou trailer lodge; camping by Awash falls and at Filwoha; |
| Information facilities | :Information sheet in Amharic and English;Museum; |
| Other facilities | :Three vehicles;electric generator; 175km. highway through the park. |
| Scenic beauty | :Mount Fantaller;Filwoha hot springs; |
| Measure of service | :4494 average annual number of visitors; Birr 13,980 average annual income; |

MANAGEMENT ASPECT :

| | |
|---|---|
| Staff | :Forty staff |
| Buildings | :sixty (for office, stores, garage, staff houses, kereyou trailer lodge, museum and outposts) |
| Prevailing threats | :seasonal settlement in the northern area. |

| | |
|---|---|
| ECOLOGICAL ZONE | :Riftvalley |
| DESCRIPTORS | :Awash; National park; Hot spring; Swanye's Hartbeest; Kudu |

REMARKS :This park is primary created because ofits range of larger wildlife species and the lack of settled human population; additional features include the reintroduced swany's Hartbeest; Scenery like Mt. Fantaller; the Filwoha hot springs; the proximity to Addis Ababa(225km.). Considerable problems with respect to the incursion of people and settlement have always existed in the larger northern area, but this was exacerbated in 1991 in the area south of the main road. Communication with the local people shall be imporved. An outbreak of fire in march 1994 had destroyed the wildlife living there.

***ANIMAL RECORD***

MFN 0003

ORDER :Mammal

SCIENTIFIC NAME :canis simensis(semien fox)

VERNACULAR NAME :Kay-Kebero(amh.)

LOCALITY :Bale;Gonder

DESCRIPTION :The semien jackal is a long-legged canid with an elongated muzzle. Its fur is short and reddish in colour, with the under parts-throat, belly and inner legs-white. The tail is furry, with the lower half black and the upper half red flonked by white. Adult males stand 60cm. at the sholder and weight 14-18 kilograms, females are on average 8-20 percent smaller than males. It is one of most beautiful and spectacular members of the dog family in the world, with its bright rufous coat, white undermarking and black tail. It has two cries: a high-pitched long scream,-weeah-weeah-, apparently a

call, and a bark,
-yealp-yealp-uttered in competition or alarm.

HABITAT :Northern grass lands;Heather moorlands; Afro-alpine moorlands

ECOLOGY :South eastern and north western highlands (Bale and Simen Mountains National Park).

FOOD AND FEEDING :Rodents,especially the large and endemic Giant Molerat (Tachyoryetes macrocephalus), are the fox's main food;It will also eat birds, hares ,and three species of grass rats;its feeding habit is on day time as the rodents on which it feeds on come above ground on day time.

TERRITORY AND HOME RANGE :They are territorial. Average pack home range in optimal habitat is 6.2kmsq. and larger in areas of lower rodents prey productivity(10.3kmsq.). All adult and subadult members of the pack participate actively in the defense and marking of their territory. Simien jackals are predominantly diurnal, although in areas with in human interference they may become noctural.

SPECIES STATUS :The individuals survived currently are 700. It is the rarest canid in the world. It is classified as endangered by the IUCN. It is in danger of extinction in all but in the Bale National Park. It is endemic to Ethiopia.

BREEDING POTENTIAL :A female can produce two to four youngs

SPECIES TRAITS :-----

USES AND SERVICES :The fox, aided by various other predators, is a main instrument in keeping down population explosions of rodents as it exclusively feeds on them.

SOCIAL STRUCTURE :The simien jackals are social canids, organized in multi-male packs of 2 to 4 adult animals. Adult-sex ratio is biased to ward males 2:1. Males do not disperse. Females disperse at two years of age.

| | |
|---|---|
| RECOMMENDED MANAGEMENT | :The species needs all the protection as there are probably one thousand left in the world, all in Ethiopia and none in captivity. |
| TIME TO VISIT | :It is currently unusual to visit the Bale Mountain National park and not see one at least in day time. |
| DESCRIPTORS | :Kebero; Fox; Canis simensis; Bale National Park; Rodents; Rare; Endemic |
| REMARKS | :Domestic dogs are common inside and around Bale Mountain National Park. They pose threat to wildlife in the northern areas where stray dogs have taken to hunting in packs. Dogs compete with simien jackals for rodent prey, are vectors of Canid related diseases and are known to mate with jackals producing hybrids, threatening the longterm survival of the species. |

***PLANT RECORD***

| | |
|---|---|
| MFN | 0004 |
| FAMILY | |
| SCIENTFIC NAME | :Acacia abyssinica subsp.abyssinica |
| VERNACULAR NAME | :Bazira Girar(Amh.);Cheha(Tg.); Gerbi(Orm.) |
| LOCALITY | :Gondar;Gojjam;Wolega;Bale;Arsi; Illubabor;Kefa;Sidamo;Western Tigrayand;shewa regions |
| ECOLOGY | :In wooded grassland,highland forest edges of Dry,Moist and Wet Weyna Dega and wet and Moist Dega agroclimatic zones in the range of 1,500-2,800m ASL |
| DESCRIPTION | :A large flat-topped tree to 20m when mature. BARK:Rough,groved,dark brown. THORNS:Very variable,short or long,sometimes none. LEAVES:Compound, 15-36 pairs pinnae when mature, on a stalk to 9 cm,leaflets tiny. FLOWERS:Very many, round heads of Cream flowers, buds pink-red. |

| | |
|---|---|
| | FRUIT :Pods to 12cm, usually straight, red-grey-brown, splitting to set free seed. |
| SPECIES STATUS | :The species is severely disturbed due to illegal cutting for fuelwood and charcoal production |
| SPECIES TRAITS | :It is drought resistant; it has no particular soil requirements; it tolerate high temprature |
| USES AND SERVICES | :Firewood;charcoal;poles;posts;tool handles;medicine;fodder;bee forage;soil conservation;nitrogen fixation;shade (for cattle);fence (cut branches) |
| RECOMMENDED MANAGEMENT | :pollarding;loppicing |
| PROPAGATION | :seedlings;direct sowing;root suckers |
| SEED INFORMATION | :Seed quite small, highly susceptible to beetle attack while still while still in pods. Damaged seeds should be separated by floating. Number of seeds per kg. ranges from 16000-18000. |
| SEASONALITY | :perennial (long lived) |
| DESCRIPTOR | :Girar; Umbrella thorn; weyna Dega; Dega; fodder; medicine; fuel; shade; fence; soil conservation; drought resistant; beetle; pollarding |
| REMARKS | :Spreading roots make it unsuitable for planting beside fields. Drought tolerant, will grow on degraded land and along gullies. It makes good fuelwood but the hard wood is difficult to work. Seed can be stored for long periods if kept in a cool, dry and insect-free place. |

***PLANT RECORD***

| | |
|---|---|
| MFN | 0005 |
| FAMILY | :---- |
| SCIENTFIC NAME | :Arundinaria alpina(Bamboo) |
| VERNACULAR NAME | :Kerkeha(amh.) |
| LOCALITY | :Mountain gorges and tops of Gojam; wollega;keffa |

| | |
|---|---|
| ECOLOGY | :In Moist and Wet Dega agroclimatic zones, up to 3,000m. The grass grows in dense stands with a leafy canopy and stems so close that one can only pass through difficulty. |
| DESCRIPTION | :A very large hollow-stemmed grass, usually 6-8 m but can reach 12-25 m. STEMS:smooth, woody and hollow, growing from swollen underground stems (rhizomes). Whorls of thin branches grow at the upper at the upper nodes between stem sections. In good conditions stems may be 7-10cm in diameter. LEAVES:grow from the branchlet nodes. Pale green, to 20 * 1cm.,the tip long and thin. Feel rough due to short hairs. The leaves arise from a large straw-coloured leaf sheath to 50 cm long which has purple hairs.<br>FLOWERS: rarely seen, in heads 10-20 cm long. After flowering the plant dies down. |
| SPECIES STATUS | :Overexploited and exist only in some restricted areas. |
| SPECIES TRAITS | :--- |
| USES AND SERVICES | :The woody stem of this giant grass have many local uses: Roofing poles;fences; walls;local furniture; local spinning tools; containers for grain; basketry. The stem is split into strips of different sizes. Shoots, leaves and young stems can be used for fodder and are eaten by wild animals. Bamboo fencing has been in used inj soil conservation structures. |
| RECOMMENDED MANAGEMENT | :Seed of A.alpina watered daily will germinate readily.Transfer seedlings to boxes when 2.5cm high. Plant out 8-12 months later, above2,500m. Offsets from one-year old culms can also be planted out and will develop quicker than seedlings. |
| PROPAGATION | :Rhizomes, natural regeneration, seed (possible but rare). |
| SEED INFORMATION | :- |
| SEASONALITY | :perennial |

| | |
|---|---|
| RECOMMENDED MANAGEMENT | :coppicing;pollarding |
| PROPAGATION | :Seedlings |
| SEED INFORMATION | :A prolific seeder;seed can be stored; it requires no special treatment |
| SEASONALITY | :Perenial deciduous plant. |
| DESCRIPTOR | :Millettia; Ferruginea; Birbira; Sotalo; Fish poison; Weyna Dega; Shade |
| REMARKS | :There are two species, one confined to the north of the countryand the other in sidamo. Trees from central and western Ethiopia show a mixture of the characters of these two species. This is an important shade tree for peasant farmers growing coffee. |

***PLANT RECORD***

| | |
|---|---|
| MFN | 0007 |
| FAMILY | :------- |
| SCIENTFIC NAME | :Hagenia abyssinica |
| VERNACULAR NAME | :Kosso(amh.) |
| LOCALITY | :--- |
| ECOLOGY | :Formerly one of the commonest high-altitude forest trees in Ethiopia. Now only scattered trees remain in Moist and Wet Weyna Dega agroclimatic zones,2300-3300m. |
| DESCRIPTION | :A tree 20m with a short trunk and thick branches, the crown leafy and rounded. BARK:Red-brown, thick, flaking irregualrly, branches covered in silky brown hairs and ringed with leaf scars.LEAVES:compound to 40 cm in large terminal tufts, 5-8 leaflets on each side, leaflet bright green above, covered with silvery hairs below, red and sticky when young, leaf edge toothed and fringed with |

hairs, stalk winged and hairy.
FLOWERS: in large attractive masses to 60cm, female heads pink-red, male heads more feathery, orange-white. The sexes are on different trees.
FRUIT: small and dry.

| | |
|---|---|
| SPECIES STATUS | :-- |
| SPECIES TRAITS | :--- |
| USES AND SERVICES | :Firewood;Poles;Timber(furniture, flooring, carving), medicine (bark, roots), mulch, green manure, soil conservation, ornamental, firebreak |
| RECOMMENDED MANAGEMENT | :-- |
| PROPAGATION | :Seedlings;wildings. |
| SEED INFORMATION | :Germination 40-60; in 14-21 days;No. of seeds per kg. 400,000 -500,000;seed stores for 6-12 months |
| SEASONALITY | :Perennial |
| DESCRIPTOR | :Kosso; Hagenia abyssinica; Dega; Weyna Dega; medicine; manure; firebreak; firewood; poles; Timber; ornamental; seedlings |
| REMARKS | :The wood is dark red, hard and useful for furniture but attacked by boreres. Used locally for its medicinal purposes, kosso from the female flowers is used as a dewormer. Not competitive with crops if managed to prevent shading. It is recommended for homestead planting for its good timber. It constantly sheds leaves forming a carpet of dried leaves below. |

***PLANT RECORD***

| | |
|---|---|
| MFN | 0008 |
| FAMILY | :-- |
| SCIENTFIC NAME | :Acacia senegal(Gum arabic) |
| VERNACULAR NAME | :Sbansa girar(Amh);sabansa dima(Or); qentib(Tg.) |
| LOCALITY | :Afar;Wello;Shewa;Arsi;Bale;Gamogofa; Sidamo |
| ECOLOGY | :Dry kolla agroclimatic zone with altitude between 600-1700m and rainfall 100-800mm. |
| DESCRIPTION | :A shrub or tree to 15m, rounded, many low branches, or tall and thin. BARK: variable, smooth or peeling yellow and papery from red-brown base.THORNS:prickles in threes,the central one hooked downwards, the other two curved up, brown black. LEAVES:compound, usually hairy,only 3-6 pairs pinnae on a stalk to 7 cm, leaflets narrow, very small, grey green. FLOWERS:creamy spikes, one or more, 2-10cm, fragrant usually develop before the rainy season. FRUIT:pods, variable, thin and flat, oblong to 14 cm, narrowing at both ends, grey-yellow becoming papery brown, veins clear, splitting to release seed. |
| SPECIES STATUS | :In all the locality it is disturbed (endangered) |
| SPECIES TRAITS | :Drought resistant, tolerate very high temprature, tolerate dry winds and sand storms, it can not tolerate frost. |
| USES AND SERVICES | :Fire wood;Charcoal;posts;Poles;Tools; Handles;Food(seed);medicine(roots); fodder (pods,leaves);soil conservation; soil improvement; gum; dye(seeds) |

| | |
|---|---|
| RECOMMENDED MANAGEMENT | :slow growing and needs weeding and protection from animals during early stages; coppicing;lopping |
| PROPAGATION | :seedlings; direct sowing; natural |
| SEED INFORMATION | :Not a prolific seeder; seed susceptible to beetle attack; germination rate is low; no. of seeds per Kg:8000-11000; seed stores well in a cool, dry and insect-free place after soaking them in cold water for 24 hours first. |
| SEASONALITY | :Perennial. It has a rotation period of 20 years. Trees bear gum between 4-18 years of age. |
| DESCRIPTOR | :Sbansa girar; Gum arabic; Acacia senegal; Dry Kolla; seedlings; direct sowing; natural; beetle; drought; medicine; fodder; gum |
| REMARKS | :Three sub species are recognised in Ethiopia. It can be intercropped(eg. with sorghum and millet). Gum arabic is traded commercially for use in dying, ink making and medicine. Acacia senegal produces most of the commercial gum arabic. The quality of the gum is superior to any other acacias. It is important export product. A large scale afforestation projects with acacia senegal can be started with careful consideration of physical factors, biological factors, land use and marketing. Young plants and seedlings can be browsed, in direct sowing weed competition is very high, rats and insects can damage young seedlings if not portected. |

Sample Outputs from ABNCD Database

*** PROFILE OF EXPERT ***

| | |
|---|---|
| NAME | Mebrate Mihretu |
| BIRTH | 1947 |
| SEX | Male |
| NATIONALITY | Ethiopian |
| AFFILIATION | Forestry Research Center |
| ADDRESS | Box: 30708, Addis Ababa |
| TELEX | ----- |
| FAX | ------ |
| PHONE | 182982 |
| QUALIFIC. | Plant sciences. BSc. Alemaya University of Agric. 1977; Environmental Forestry. M.Sc. Bangor,UK. 1993. |
| SPECIALIZ. | General Forestry, with particular emphasis to Environmental Forestry. |
| LAST EMPLOY. | Institute of Agricultural Research, Ministry of Agriculture, 1978 (five months) |
| SERV. OFFER. | Research in forestry especially in the silviculture aspect of both indegenous and exotic trees/shrubs. |
| PUBLICATION | Provenance Trial of some Exotic and Indegenous species. 1994. AAU. |
| MEMBER. SOCIETY | International Union of Forestry Research Organization (IUFRO); Ethiopian Forester's Association. |

## *** PROFILE OF INSTITUTION ***

| | |
|---|---|
| INSTITUTION | Ethiopian Wildlife and Natural History Society |
| START DT | 1966 |
| LOCATION | Ethiopia |
| ADDRESS | Box: 60074, Addis Ababa |
| TELEX | ------ |
| FAX | ------ |
| PHONE | ------ |
| WORK. LANG. | eng;amh. |
| GEOG. COVERAGE | Ethiopia |
| INST. TYPE | National Non-Government |
| OBJECTIVES | To encourage and support research concerning Ethiopia's flora and fauna, and to disseminate information creating awareness of conservation. |
| INFO. SERVICE | ---------- |
| EQUIPMENT | Personal Computer |
| INST. HEAD | Shibru Tedla (Prof.) |
| PUBLICATIONS | Research Reports, Children's Bood (Amh.), News Letters, Journal entitled "AGAZEN" and "WALIA", Posters. |
| SORCE OF FUND | SIDA;CIDA;British Embast;Wildlife Conservation International (WCI) |
| SERIAL PUB.TYPE | Environment awareness creating publications |

### *** INFORMATION SYSTEM ***

| | |
|---|---|
| INSTITUTION | Plant Genetic Resource Center. Ethiopia's Documentation Center |
| WORK. LANG | Eng. |
| HEAD | Eneyat (w/o). |
| GEOG. COVERAGE | National |
| PERSONNEL | Professional, 3. Supporting 6. |
| INST. TYPE | Government |
| ACTIVITIES | Germplasm Accessioning and Data Acquisition, Data compilation and preparating, Data entry and correction, Data processing, retrieval and research. |
| INFO. SERVICE | Crop germplasm Database Search , Reference service, Training, Reprography, Consultancy and Advisory. |
| EQUIPMENT | Ten Microcompute working on Ms DOS and running DBASE IV, Wordperfect, Excell, Lotus, Foxpro; One Minicomputer, As/400 operating system. |

### *** BIBLIOGRAPHIES ***

| | |
|---|---|
| TITLE | Abijata-Shalla Lakes National Park: Boundary Descrition |
| IMPRINT | Addis Ababa;EWCO;1974. |
| COLLATION | Mimeo 17pp.; Map; English and Amharic. |
| DESCRIPTOR | Abijata-Shalla Lakes National Park;National Park. |
| PERSONAL AUTHOR | ------- |
| CORPORATE BODIES | Ethiopian Wildlife Conservation Organization (EWCO) |

## DISPLAY FORMAT

```
IF v1:'p' then mhu, c30, '***'v2'***'##'MFN',c30,mfn(4)/#
'Conservation Area Name',c30,mhl,":"v3(0,30)/mhu,
'date',c5,':'/#,c5,mpl,'proposed',c30,":"v4^a(0,30)#c5,
'established'c30,":"v4^b(0,30)%#c5,'gazzeted'c30,":"v4^
c(0,30)#, mhu,'longitude latitude locater'mhl,c30,":"
v7(0,30)/#,mhu,'region'c30,mhl":"v8(0,30)+|;|,/# mhu,
'totalarea'c30,mhl,":"v9(0,30)+|;|/#mhu,'Climate'c8,':'
/#mpl,c5,'Rainfall',c30,":"v10^a(0,30)#,c5,'Temprature'
c30,":"v10^b(0,30)#,c5,'Altitude'c30,":"v10^c(0,30)#,c5
,'Climatic-zone'   c30,":"v10^d(0,30)#mhu,'vegetation
types'c30,mhl,":"v11(0,30)+|;|/#,mhu,'wildlife  species
conserved'c30,':'/#,c5,mpl,'Majoranimals'c30,mhl,":"v12
^a(30,30)+|,|#c5,mpl,"Otheranimals"c30,mhl,":"v12^b(30,
30)+|,|/#mhu,'number of endemics recorded'c29,':'/#,c5,
mpl,'Bird    Species',c30,":"v13^a(0,30)#c5,'Mammals
species'c30,":"v13^b(0,30)#mhu,'other natural resource
uses'c30,mhl,":"V14(0,30)+|;|/#mhu,'tourism aspect'
,c16,':'##mpl,c5,'Tourist accomodation'mhl,c30,":"
v15^a(30,30)+|;|#c5,mpl,'Informationfacilities'c30,mhl,
":"v15^b(30,30)+|;|#,c5,'Other facilities'c30,mhl,":",
v15^c(30,30)+|;|#c5,mpl,'Scenic beauty'c30,mhl,":"
v15^d(30,30)+|;|#c5,    mpl,'Measure    of    service'
c30,mhl,":"v15^e(30,30)+|;|/#,mhu,'management
aspect'c20,':'/#c5,mpl,'Staff'c30,mhl,":"V16^a(30,30)
+|;|#c5,mpl,'Buildings'c30,mhl,":"v16^b(30,30)+|;|#c5,m
pl,'Prevailing threats'c30,mhl,":"v16^c(30,30)+|;|
/#mhu,'ecological Zone'c30,mhl,":"v17(0,30)#mhu,'Descri
ptors'c30,mhl,":"v21(0,30)+|;|/# mhu,'Remarks'c30,mhl,":"
v22(0,30)fi,/###,if    v1:'A'then    mhu,c30,'***'v2
'***'##'mfn',c30,mfn(4)/#'order'c30,mhl,":",v31(0,31)#mh
u,'scientific name'c30,mhl,":"v32(0,30)#mhu,'vernacular
name'c30,mhl,":"v33(0,30)+|;|#mhu,    'locality'
c30,mhl,":"v34(30,30)+|;|#mhu,'description'c30,mhl,":"v
35(0,30)+|;|#mhu,'habitat'c30,mhl":"v36(30,30)+|;|#,mhu
,'Ecology'c30,mhl,":"v23(0,30)+|;|#mhu,'food    and
feeding'c30,mhl,":"v37(0,30)+|;|#mhu,'territory and home
range'c30,mhl,":"v38(0,30)+|;|#mhu,'species
status'c30,mhl,    ":"v39(0,30)+|;|#mhu,breeding
potential'c30,mhl,":"v41(0,30)+|;|mhu,'species
traits'c30,mhl,":"v40(30,30)+|;|#mhu,'uses    and
services'c30,mhl,":"v42(30,30)+|;|#mhu,'social structure'
c30,mhl,":"v43(0,30)+|;|#mhu,'recommended    management'
c30,mhl,":"v44(30,30)+|;|##mhu,'time to visit'c30,mhl,":"
v45(0,30)#mhu,'descriptors'c30,mhl,":"v21(30,30)/#
 mhu,'remarks'c30,mhl,":"v22(30,30)FI,/##If    v1:'F'
then,mhu,c30,'***'v2'***'##'mfn',c30,mfn(4)/#'family'c3
0,mhl,":"v60(0,30)#mhu,'scientfic name'c30,mhl,":"v32(
0,30)#mhu,'vernacular    Name'c30,mhl,":"v33(30,30)+|;|
#mhu,'locality'c30,mhl,":"v34(30,30)+|;|#mhu,'Ecology'
```

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c30,mhl,":"v23(0,30)+¦;¦#mhu,'Description'c30,mhl,":"
v35(0,30)+¦;¦#mhu,'species status'c30,mhl,":"v39(30,30)
+¦;¦#mhu,'species traits'c30,mhl,":"v40(30,30)+¦;¦#mhu,
'uses and services'c30,mhl,":"v42(30,30)+¦;¦#mhu,'
recommended Management'c30,mhl,":"v44(30,30)+¦;¦#mhu,
'propagation'c30,mhl,":"v61(0,30)+¦;¦#mhu,'seed
information'c30,mhl,":"v62(0,30)+¦;¦#mhu,'seasonality'
c30,mhl,":"v63(0,30)#,mhu,'descriptor'c30,mhl,":"v21(30
,30)#mhu,'remarks'c30,mhl,":"v22(30,30),FI/##
```

## FIELD DEFINITION TABLE

| TAG | NAME | LEN | TYP | REP | DELIM. |
|---|---|---|---|---|---|
| 1 | Record Type | 1 | P | | A |
| 2 | Record heading | 50 | X | | |
| 3 | Conservation Area name | 100 | X | | |
| 4 | Date | 30 | X | | abc |
| 7 | Longitude Latitu Locat. | 100 | X | | |
| 8 | Region | 200 | X | R | |
| 9 | Total Area | 500 | X | R | |
| 10 | Climate | 500 | X | R | abcd |
| 11 | Vegetation Types | 500 | X | R | |
| 12 | Wildlife Conserved | 1000 | X | R | ab |
| 13 | Number of Endemic Rec. | 500 | X | | ab |
| 14 | Other Natu. Res. uses | 1000 | X | R | |
| 15 | Tourism Aspect | 1000 | X | R | abcde |
| 16 | Management Aspect | 1000 | X | | abc |
| 17 | Ecological Zone | 100 | X | | |
| 21 | Descriptors | 1000 | X | R | |
| 22 | Remarks | 1000 | X | | |
| 23 | Ecology | 200 | X | R | |
| 31 | Order | 100 | X | | |
| 32 | Scientific Name | 100 | X | | |
| 33 | Vernacular Name | 200 | X | R | |
| 34 | Locality | 200 | X | R | |
| 35 | Description | 1000 | X | R | |

| | | | | |
|---|---|---|---|---|
| 36 | Habitat | 500 | X | R |
| 37 | Food and Feeding | 500 | X | R |
| 38 | Territory and home rang. | 500 | X | |
| 39 | Species Status | 200 | X | R |
| 40 | Species Traits | 300 | X | R |
| 41 | Breeding Potential | 200 | X | |
| 42 | Uses and Services | 500 | X | R |
| 43 | Social Structure | 200 | X | |
| 44 | Recommended Management | 300 | X | R |
| 45 | Time to Visit | 100 | X | R |
| 60 | Family | 100 | X | |
| 61 | Propagation | 200 | X | R |
| 62 | Seed Information | 500 | X | R |
| 63 | Seasonality | 500 | X | |