



AFRICAN WILDLIFE FOUNDATION

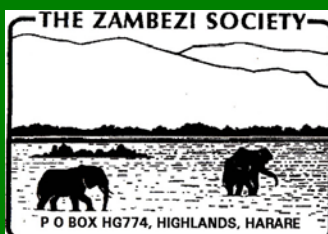
# FOUR CORNERS TBNRM PROJECT

Funded by USAID through the Regional Center for Southern Africa



## INTRODUCTORY BIODIVERSITY INFORMATION

BIODIVERSITY INFORMATION PACKAGE  
No: 1



Produced for  
The African Wildlife Foundation  
by  
THE ZAMBEZI SOCIETY  
and  
BIODIVERSITY FOUNDATION FOR AFRICA



## INTRODUCING....



### AFRICAN WILDLIFE FOUNDATION FOUR CORNERS TBNRMA INITIATIVE

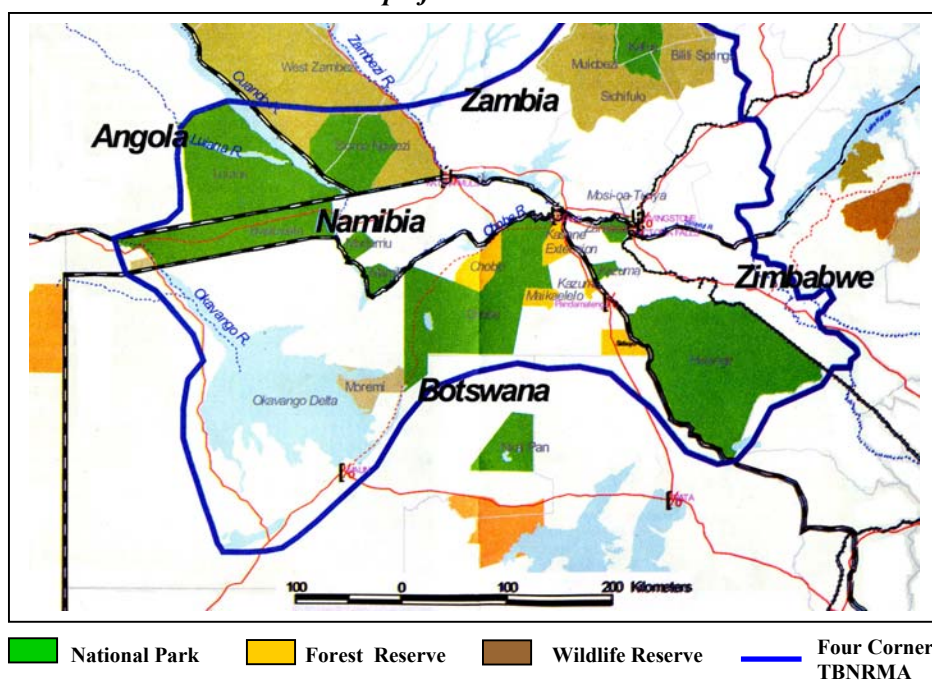
funded by



The **Four Corners Transboundary Natural Resources Management Area (TBNRMA) Initiative** is being implemented by the **African Wildlife Foundation (AWF)** in collaboration with various regional partners in the area defined as Chobe-Hwange-Mosi-Oa-Tunya-Caprivi-Kafue. The initiative is supported by the United States Agency for International Development (USAID) Regional Center for Southern Africa (RCSA).

The Four Corners area covers some 220,000 km<sup>2</sup>. Protected lands within it include the Hwange and Zambezi National Parks in Zimbabwe; the southern part of Kafue National Park, the Mosi-Oa-Tunya and Sioma Ngwezi National Parks in Zambia; and the Chobe National Park and Moremi Wildlife Reserve in Botswana, the Mudumo, Mamili and Bwabwata National Parks in Namibia. These cover an estimated 115,953 km<sup>2</sup> or just over 52% of the area.

*Illustrative map of the Four Corners Area*



The “Four Corners” initiative aims to provide the enabling environment (opportunities and mechanisms) for increased cooperation among the four constituent country interests in the management of the natural resources that are shared among them, particularly water, migratory wildlife and critical ecosystems.

AWF has packaged the Four Corners TBNRMA Initiative into a set of interrelated four key results that when achieved, should contribute to a significant increase in the adoption of sustainable natural resource management practices in shared water and wildlife resources. Such practices include natural resource management plans, ecological monitoring systems and conservation business ventures. The adoption of these viable practices in the four countries will only be made possible through the enabling environment that the initiative should provide. The four sets of results also form the four components of the project.

## INTRODUCING....



## AFRICAN WILDLIFE FOUNDATION

The *AFRICAN WILDLIFE FOUNDATION* is an international conservation organization that has been working solely in Africa since 1961. Most of AWF's work has been in East and Central Africa but it has now expanded to include Southern Africa.

The mission of AWF is to *craft and deliver creative solutions for the long-term well-being of Africa's remarkable species, their habitats and the people who depend on them*. To effect this mission across the continent, AWF has condensed its program operations into two essential themes, which are synergistic in application:

*Landscape-level conservation through the AWF-African Heartlands Program:* African Heartlands are large African landscapes of exceptional wildlife and natural value extending across state, private, and community lands. Heartlands are further defined in ecological, economical, socio-political, cultural and institutional terms. AWF works with landholders, governments, and others in the African Heartlands to conserve wild species, communities, and natural processes. A key tool for landscape conservation work is the heartlands planning process that prioritises what needs to be conserved in a particular landscape and rallies stakeholders to craft management strategies for conservation.

Several heartlands initiatives are currently being implemented with partners throughout Africa:

- East and Central Africa: Maasai Steppe; Kilimanjaro; Samburu; and Greater Virunga.
- Southern Africa: Lower Zambezi; Upper Zambezi; Limpopo.

*Livelihood impact through the AWF-Conservation Service Centers (CSCs) Program.* CSCs are small, multi-disciplinary teams of professionals based in strategic locations. CSCs prepare, broker, and sustain conservation business ventures to bring about positive economic and conservation impact. CSCs typically service beneficiaries situated in heartlands by offering a suite of services such as business planning, legal and contractual services, fund management, community mobilization. CSCs are currently located in:

- Victoria Falls, Zimbabwe;
- Livingstone, Zambia;
- Arusha, Tanzania;
- White River, South Africa;
- Nairobi, Kenya.

The two programs are inter-related. The livelihoods program is tasked to leverage conservation as a land use in strategic parts of landscape where AWF is working. Connectivity between protected areas is often a challenging issue. AWF is concerned that the necessity for economic development is compatible with biodiversity conservation and strives to ensure that it is an asset and not a liability in conserving wildlife habitat. Therefore, human livelihoods and wildlife habitats are locked in a dialectic that could be characterized by conflict or mutual benefit. Consequently, AWF wants tourism and natural resource enterprise to become the optimal and preferred land use in selected priority landscapes in order that Africa's unique wildlife is conserved in perpetuity.

## INTRODUCING....



The Zambezi Society and the Biodiversity Foundation for Africa are working together within the AWF Four Corners TBNRM project to acquire and disseminate important information about biological diversity to policymakers, planners, consultants and other key stakeholders.

**THE ZAMBEZI SOCIETY** was established in 1982. Its goals include the conservation of biological diversity and wilderness values in the Zambezi Basin through the application of sustainable, scientifically sound natural resource management strategies.

Since its establishment the Society has implemented many projects in Zambezi Basin countries, including the conservation of black rhinos and the reintroduction of cheetah in Zimbabwe's Matusadona National Park; the identification of elephant habitats and movement corridors in northern Zimbabwe and western Mozambique; and the identification of community-based biodiversity conservation strategies in settled parts of the Zambezi Valley.

**THE BIODIVERSITY FOUNDATION FOR AFRICA** is an association of biological specialists from a range of disciplines including ecology, biology and taxonomy. Individual BFA members have expertise with biological groups including plants, vegetation, mammals, reptiles, fish, insects and aquatic species and ecosystems.

The Biodiversity Foundation for Africa specialises in the acquisition and recording of scientifically sound information on biological diversity. It has undertaken projects in several southern African countries including surveys of valuable sites such as the Haroni-Rusitu forests in Zimbabwe and the establishment of biodiversity monitoring regimes in Zambian miombo woodlands.

**THE PARTNERSHIP** between the Zambezi Society and the Biodiversity Foundation for Africa was formed in 1996 as a result of mutual recognition of their complementarity. Biodiversity information acquired by the Biodiversity Foundation for Africa requires interpretation and dissemination to a wider, non-specialist audience if it is to play an effective role in biodiversity conservation. This role is filled by The Zambezi Society, which has skills and experience in advocacy and information dissemination. The Society also utilises Biodiversity Foundation expertise to provide a technically sound basis for the implementation of conservation projects within the Zambezi Basin.

The two agencies have previously worked together on several major projects, including IUCN's Zambezi Basin Wetland project and the evaluation of biodiversity in Tete province described elsewhere in this information pack.

## ***BIOLOGICAL DIVERSITY AND THE AWF FOUR CORNERS TBNRM INITIATIVE***

"African Heartlands," as defined by the African Wildlife Foundation (AWF) are "large African landscapes, of exceptional wildlife and natural value, extending across state, private and communally-settled lands". Heartlands are based on biological rather than political boundaries, and may therefore include parts of two or more countries. Heartlands are therefore often "transboundary" in nature.

The Four Corners "African Heartland" is some 220 000km<sup>2</sup> in extent, centred roughly on the Victoria Falls, and including parts of Botswana, Namibia, Zambia and Zimbabwe (see map on Sheet 1). This area includes state, private and communal lands, and is important because of the natural assets it embraces, and the income these assets can generate for the countries, local authorities and rural communities involved.



*The Zambezi River at Victoria Falls*

One of the objectives of the Four Corners project is to improve the management of these natural resources, so that the project's other goals – in particular, the development of sustainable business ventures by local people – can be achieved.

AWF's initial consultations identified several particular natural features as being critical conservation "targets" upon which the sustainability of these activities depends. They are –

*Okavango Swamps, Botswana*



- *River systems.* The key river systems in the area are the Zambezi and the Okavango. Rivers are often critical to the survival of important wetlands; provide clean water if unpolluted; and support resources such as fish populations. Because of its geological history, the Upper Zambezi also supports a biologically important range of indigenous fish species that could be threatened by pollution, dams, and displacement by the introduction of alien species.
- *Wetlands.* These are seasonally-inundated areas, often not only rich in species, but also providing essential "goods and services" such as clean water. Some, such as the Okavango Swamps and the Chobe-Linyanti area, may depend on the health of associated river systems. Others, such as vleis and dambos, may exist independently.

- *Representative woodlands*. There are numerous woodland types within the "Four Corners" area. Some may be conserved within protected areas; others may not, and are therefore vulnerable. "Representative examples" of these woodlands should be identified, and strategies developed for their conservation. Woodlands and forests in general are also important conservation targets from national and global perspectives.
- *Woodland/grassland "mosaics"*. These are areas of woodland interspersed with grasslands, thus providing a diversity of habitats. They occur in several parts of the "Four Corners" area. Because of this diversity, they provide important habitats not only for large mammals, in places in which they can easily be seen by ecotourists, but also for many other less spectacular but equally important species.
- *Species assemblages*. Species – of plant, animal, insect, and many other groups – may form important and distinctive, interdependent "assemblages" or communities.
- *Declining or threatened species*: some species may be declining in numbers, or facing threats from known or unknown causes. Their loss may cause valuable ecosystems to malfunction, and may also have implications for economic activities such as ecotourism and community resource management schemes. It is important to identify such species and to develop strategies for their conservation.
- *Wildlife migration corridors*. There are several important "protected areas" in the Four Corners area, such as the Chobe, Bwabwata, Mudumo, Mamili, Hwange, Zambezi, Sioma-Ngwezi, Mosi-oa-Tunya and Kafue National Parks. However, some wildlife species move freely across both protected and unprotected areas, and, although this ability to move is important to their survival, it also produces problems of conflict with humans.

Other key targets may be identified during the course of the project, through improved knowledge or by key stakeholders such as local authorities and rural communities.

### **GOOD SCIENCE IS IMPORTANT**

Conservation and development are inextricably interlinked in the "Four Corners" area, where many communities live in conditions of hardship and poverty. "Win-win" socio-economic strategies that benefit local people while ensuring the conservation of their natural resource base are essential.

However, it is equally essential that such strategies are based on good science and a sound understanding of the ecosystems and natural processes involved. Without this understanding, ecosystems and species - and the "goods and services" they provide to local people - may be degraded and, in extreme cases, lost altogether. It is impossible to formulate truly effective strategies, that provide sustainable benefits to countries and communities, without some technical knowledge of the biology of the species and ecosystems within a particular area. Therefore, one of the most important technical keys to the achievement of the Four Corners project goals is a knowledge of the "biological diversity" – or, as usually abbreviated, "biodiversity" - of the project area.

This term – biodiversity – is often misunderstood and misused. Some may believe it is synonymous with natural resources, or nature conservation, or endangered species. However, much of this misunderstanding has stemmed from the technical and semantic difficulties involved in agreeing on a concise, globally-acceptable definition.

We can, for our purposes, define biological diversity as "the variety of species and ecosystems that exist within a given area" - in this case, the Four Corners project area. Areas that have many species or ecosystems therefore have much biological diversity; areas with few species or ecosystems have little such diversity. This diversity can be measured at many scales, from a garden to the world as a whole. Although the biological diversity in a small area may be relatively unimportant at global scales, it may be of great importance to the region, country or community within which it occurs.

### **WHY IS BIOLOGICAL DIVERSITY IMPORTANT?**

Conserving – or, as it is often termed, "maintaining" biological diversity - is considered to be important for a range of practical and ethical reasons, depending on viewpoint.

Although the belief may not be voiced in technical language, many cultures, including those of people within the Four Corners area, place a high ethical value on the survival of species and ecosystems. At global levels, many are also deeply concerned about the rapid extinction of species and ecosystems due to human activities.

In purely practical terms, species and ecosystem diversity provides many direct and indirect benefits to local communities, nations, and the world as a whole:

- Natural ecosystems provide benefits such as clean air and water. This function can be seriously impaired through the loss of component species, or of the ecosystem as a whole.
- Properly-functioning ecosystems may also provide specific commodities (e.g. medicines, thatching grass, building poles) to rural and other people.
- Species diversity, especially of large African mammals but also of other flora and fauna, can form the basis for lucrative tourism industries, especially when found in wild and aesthetically pleasing landscapes.
- Long-term evolutionary processes depend on the survival of biological diversity among genes, species and ecosystems.
- The loss of functioning ecosystems can have serious effects on climate at local, regional and global scales.

The importance attached to biodiversity maintenance is reflected in the Global Convention on Biological Diversity. Signatories to the Convention, which include the countries participating in the Four Corners project, have therefore acknowledged this importance and have pledged to maintain biological diversity in accordance with the Convention's articles.

### **HOW DOES THIS AFFECT YOU?**

If you have received this information, you have been identified as being in a position to influence the maintenance or otherwise of biological diversity within your area, country or region. You may be a developmental planner or consultant, an official within a Ministry that takes decisions on development and land use, a high-level policymaker, or an elected local authority leader. Or you may be none of these.

Species and ecosystems are not usually lost through deliberate willfulness. There are several major causes of biodiversity loss:

- Lack of awareness of the importance of maintaining diversity,
- Lack of information and knowledge concerning diversity within a particular area or region,
- Failure to implement adequate biological survey or impact assessment in the course of major developments,
- Land use planning that fails to incorporate, and act upon, sound biodiversity information,
- Unplanned or uncontrolled settlement and land conversion,
- Unsustainable over-exploitation of particular species of commercial value,
- Severe economic hardship leading to over-reliance on natural resources,

The difficulties involved in addressing problems caused by extreme land pressure or economic hardship must be acknowledged. However, the first three causes of biodiversity loss can often be attributed to a lack of understanding of the importance of maintaining biodiversity, and an absence of good biodiversity information for incorporation into planning processes.

It is important to emphasise that biodiversity maintenance does *not* conflict with development. It tends to be concerned more with the *location, planning and implementation* of proposed developments. Put simply, development that requires the modification of ecosystems through changes in land use will ideally be sited in areas of low biodiversity importance. Areas of higher biodiversity importance, on the other hand, should either be conserved, or utilised for activities that capitalise on this diversity, including ecotourism and community resource management projects. And even then, major changes in land use such as large-scale agriculture can often be implemented in a manner that maintains biological diversity.

The keys to achieving this, then, are *awareness* and *good biodiversity information*.

### **ACQUIRING AND DISSEMINATING GOOD BIODIVERSITY INFORMATION**

The Zambezi Society and the Biodiversity Foundation for Africa (BFA) have been requested by AWF to *acquire* technically sound information on biological diversity within the Four Corners project area, *to assess* it in terms of future action, and to *disseminate* the results to policymakers, planners and other key stakeholders for incorporation into developmental planning.

#### ***Acquiring biodiversity information***

Much information already exists. Many institutions and individuals have studied differing species and ecosystems within the Four Corners project area. However, this information is scattered among these institutions and individuals locally, regionally and even internationally. It has to be collected and analysed, and the major gaps identified.

The Biodiversity Foundation for Africa has commissioned a number of experts in various biological fields to gather and review this existing knowledge, with particular reference to the conservation



targets identified by AWF and noted earlier. These reviews will be edited and synthesised into a comprehensive technical report on the biodiversity of the project area. This report will include sections on the *ecosystem processes* that occur within the area, and will identify priority ecosystems, sites and species from a biodiversity perspective.

The BFA will also generate a large-scale vegetation map of the Four Corners project area. This will be based initially on the interpretation of satellite imagery, but will be refined through aerial survey and field visits by suitable biological experts.

It is also important to identify trends in diversity through the use of appropriate monitoring techniques. The BFA will design a practical monitoring system, make proposals for the establishment of suitable biodiversity monitoring sites, and establish at least one such site in an agreed area.

### ***Disseminating biodiversity information***

Information on biodiversity is of little use unless it can be disseminated to people in a position to utilise it, in a manner that they can understand, assimilate and apply.

The Zambezi Society has considerable experience of this work, as will be seen from the brief case studies included in this information package.

The Society makes extensive use of interpretive mapping, based on GIS technologies, to present biodiversity information in an easily-assimilable manner. Generally, this illustrative mapping will highlight *areas* and, where possible, *sites* that are of high biodiversity importance. It will also identify such features as important *wildlife movement areas*, and existing and proposed conservation areas.

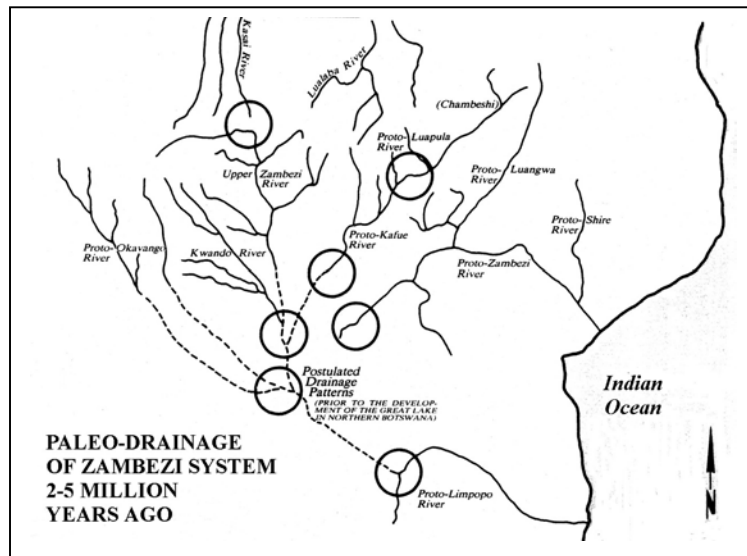
You will receive three separate biodiversity information packages, of which this is the first, during the course of this phase of the Four Corners project. A second package will be produced and distributed after the BFA have completed their technical reviews. The third and final package, summarising and interpreting all project findings, will be produced and distributed in 2004.

In addition, three *biodiversity bulletins* will be produced and distributed in 2003 and 2004. These will keep you up to date on the progress of the biodiversity project.

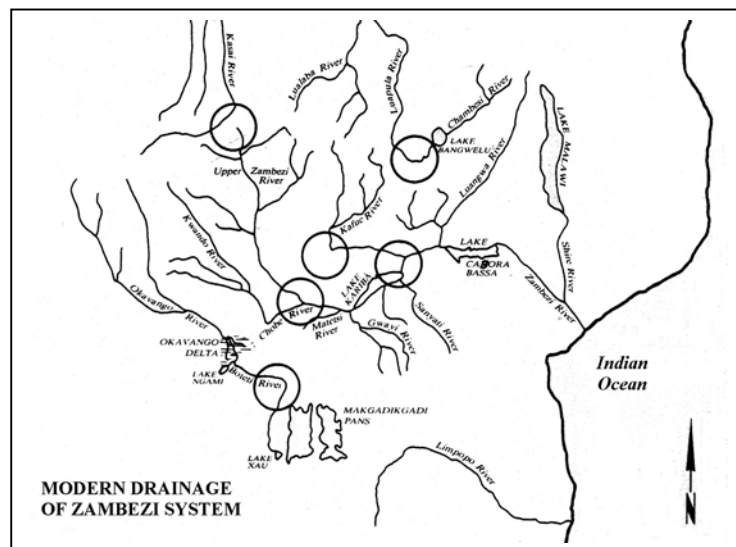
## WHAT DO WE KNOW BEFORE WE START?

We already know quite a lot about parts of the Four Corners area, and its biological values as a whole.

Around a million years ago, the area was a major meeting-place for the drainage of a vast part of the Central African plateau. Parts of the area were characterised by large lakes, such as the Makgadigadi complex in northern Botswana. However, the courses of the large rivers were very different from those of today (see Figures 1 and 2 below).



**Figure 1:** Suggested patterns of drainage of the ancient Zambezi, before the river system we have today was established. Comparison of the circled areas on this figure and Figure 2 below illustrates changes in the draining system.



**Figure 2:** The Zambezi and its tributaries today. Circled areas draw attention to places where significant alterations in the original drainage pattern have taken place.

(Source for Figures 1 & 2 : *Zambezi: Journey of a River* by Michael Main 1992 based on Graham Bell Cross 1982)

Later geological changes, in particular a gradual uplifting across much of the area, is reflected in changes in drainage patterns. The Zambezi River, which once flowed south and west, was “captured” by a much younger river, with its source in what is now northwestern Zimbabwe, and flowing east and south to the Indian Ocean. The modern Zambezi changes its character dramatically as it flows through the Four Corners area. From its source in northwestern Zambia to the Victoria Falls, the Zambezi is an “old” river, characterised by gentle gradients and large wetland areas, notably in Barotseland, where flows can be almost imperceptible. At the Victoria Falls, it becomes a relatively “new” river, with steeper gradients.

The high occurrence of major wetlands in the Four Corners area is a legacy of these changes. The gradual geological uplifting of the area deprived the Makgadigadi depressions of their water supply, changing them into seasonal saline lakes. The swamps of the inland Okavango Delta developed, as did the Barotseland and Chobe floodplains. These wetlands, together with the Zambezi and its tributaries, form the biological heart of the Four corners area. The legacy of these changes is also evident in today’s biological scenario: the Four Corners area is a “meeting place” for the ecosystems and species that developed on the old Upper Zambezi, which still flows along its ancient course, and those of the younger Middle Zambezi.

As an example, the Zambezi’s fish fauna differs significantly above and below the Victoria Falls. There are many more fish species above the Victoria Falls, and some of them are “endemic species”, meaning that they occur there and nowhere else. Also, and because of the associated changes in the landscape over geological time, the upper catchment above the Victoria Falls - and some areas that now lie outside the present-day catchment because of geological changes - have become an important “centre of speciation” for several biological groups, including antelopes and plants. Lechwe antelopes, for example, are “endemic” to the area, occurring here and nowhere else.

## ***HOW MUCH BIODIVERSITY INFORMATION IS ENOUGH?***

There are a number of problems inherent in the issue of biodiversity information - the first being that we can never, in the foreseeable future, have really comprehensive information on the biological diversity of an area as complex and varied as the Four Corners area.

In the past, much information was gathered by enthusiastic “amateurs” or academics, who tended to focus on their own favourite specialisations. The distributions and species of birds, mammals and fish within the area, for example, are relatively wellknown. The vegetation of the area is also well-known in a broad sense, and it should be noted that the Four Corners area is the continental centre for *Baikiaea* (teak) woodlands. This, and the endemic species in the upper Zambezi catchment, give the Four Corners area considerable significance in terms of global biological diversity.

The wetlands of the project area have also been relatively well studied. The Zambezi Society and Biodiversity Foundation for Africa undertook a major biological study of the Barotseland floodplains and, to a lesser extent, of the Chobe-Linyanti system in the course of IUCN’s Zambezi Basin wetland project. The Kafue Flats and the Okavango Delta have also been well studied, and the results of these investigations have been published.

However, one of the key questions that biodiversity scientists aim to answer is: how do ecosystems work? How do they maintain the “ecosystem services” that they provide? And although the spectacular mammals and birds may play key roles in these processes, they also depend on an

immense variety of smaller, less glamorous organisms that are very difficult to catalogue, and even more difficult to evaluate in terms of their possibly crucial roles in maintaining ecosystems.

It is nevertheless important to reach for some understanding of these processes, however tenuous. For this reason the studies proposed for the Four Corners area range across the entire spectrum of its biological diversity, from large mammals to termites and what are known as “aquatic invertebrates” the vast group of organisms that include such diverse species groups as dragonflies and freshwater snails.

The elephant is one of the most obvious large mammals in the Four Corners area, with a population of around 120 000 in northern Botswana alone. Elephants have in general been well studied, as might be expected, and are well-known as one of the most important “modifiers” of vegetation and ecosystems. The details of these modifications, however, are less well-known and a study of the impacts of elephants on vegetation forms part of the Four Corners biodiversity studies. It is also important to know something of their movements, as this can have important implications for managing elephant populations and reducing conflicts between humans and elephants while maximising the benefits from ecotourism and hunting that elephants can create for rural people.

At the other end of the spectrum, very little is known about the area’s aquatic invertebrates, which can play an important role in monitoring water quality; or of the tiny organisms that help cycle nutrients through soils and thus maintain their fertility.

In a sense, then, it is almost never possible to have “enough” information on biological diversity, and on the roles that individual species play in maintaining the integrity of ecosystems and ecosystem processes. At the same time, acquiring this information from scratch is a lengthy and virtually impossible task, certainly from the perspective of a relatively short-term conservation project.

The answer, of course, is to achieve a balance between what may be desirable in theory, and what can be achieved in practice. The studies being undertaken for the Four Corners project by the Biodiversity Foundation for Africa and the Zambezi Society are designed to achieve a reasonable understanding of ecological processes within the project area, within the prevailing constraints of time and finance.

## ***WHAT WILL THE BIODIVERSITY PROJECT DO?***

The Four Corners biodiversity studies will concentrate to a large extent on gathering the widely scattered but nevertheless plentiful information that is already available in technical papers, in museums and herbaria, in various other institutions, and in the knowledge and experience of individuals with wide experience of the project area. This alone will create a substantial body of information, and a valuable foundation for an increasingly comprehensive biodiversity database for the project area.

These studies will initially take the form of *reviews* of available information on various topics, each compiled by a biologist with expertise and experience in the field concerned, and peer-reviewed. These documents will, as far as possible, adhere to a common structure and include a number of key points such as -

- The extent of available information, and significant gaps in information;
- Checklists of the species occurring in the Four Corners area;
- Species of interest - rare or uncommon species, and species known to be threatened or endangered;
- The relevance of transboundary management to the species concerned;
- The relevance of possible climate change to the species group concerned.
- A bibliography of available literature.

These reviews will then be synthesised to create an overview of the biological diversity of the Four Corners project area; of the potential threats to biological diversity; and of biodiversity conservation priorities within the area. This synthesis will be distributed as Information Package No 2 of the project.

## ***THE TECHNICAL REVIEWS***

In this section, we summarise the terms of reference of the various reviews being undertaken for the Four Corners project, and make a subjective evaluation of the importance of each of the reviewed biological groups to rural communities, to ecotourism, and to ecosystem processes. We have done this because of a misconception that emerged from some of the questionnaires sent to stakeholders and designed to evaluate their understanding of the importance of biological diversity. A significant number of respondents considered biological diversity to be primarily concerned with natural resource benefits for rural people. Though maintaining biodiversity is important to the success of rural natural resource management programmes, this is a narrow definition and ignores other, equally critical, aspects of biodiversity maintenance.

### ***Vegetation and Woodlands***

The vegetation of the entire area has been previously mapped, but at a coarse scale. More detailed vegetation maps exist for the Hwange National Park and East Caprivi. Much information is available but is scattered, and individual surveys have not been carried out to a common standard.

This review will highlight the diversity of habitats within the Four Corners area, including the mosaic of woodland and grassland that covers much of the area, and which supports many of the populations of large animals vital to ecotourism and safari hunting.

*Vegetation and woodlands are important to.....*

	Imp	→	V	Imp	
Rural communities	√	√	√	√	√
Tourism	√	√	√	√	√
Ecosystem processes	√	√	√	√	√

**Plants**

A plant checklist for the Kafue National Park already exists, and one for the Hwange National Park is about 80% complete. Much information is available from the herbaria in Namibia and Zimbabwe. Areas of high species richness will be highlighted, and a list of vulnerable and endangered species will be compiled.

*Plants are important to.....*

	Imp → V. Imp				
Rural communities	√	√	√	√	√
Tourism	√	√	√		
Ecosystem processes	√	√	√	√	√

**Mammals**

This is one of the best-known groups in the project area. Furthermore, mammals in most of the wetlands in the Four Corners area have already been studied during the wetlands biodiversity projects undertaken by the Biodiversity Foundation for Africa and the Zambezi Society. However, little information is likely to be available concerning the Angolan portion of the project area. The review will be biased largely towards smaller mammals and their movements, but a section on conservation issues will deal with the entire spectrum of small and large mammals.

*Mammals are important to.....*

	Imp → V. Imp				
Rural communities	√	√	√		
Tourism	√	√	√	√	√
Ecosystem processes	√	√	√	√	√

**Birds**

As with mammals, there is a considerable quantity of information available on the birds of the project area, much of which has come from amateur ornithologists. The Bulawayo Museum has the largest collection of birds in the southern hemisphere. Bird atlases have been compiled for Zambia, and for the region south of the Caprivi Strip and Zambezi River, and there are thought to be over 800 bird species in the four Corners project area. Checklists are available for most National Parks.

*Birds are important to....*

	Imp → V. Imp				
Rural communities	√	√	√		
Tourism	√	√	√	√	√
Ecosystem processes	√	√	√	√	√

**Reptiles and Amphibia**

There is a complex distribution and diversity of reptiles and amphibia within the project area because of its diversity of habitats. The conservation of the Nile crocodile - common throughout waterbodies in the area - has been the subject of much study, and has generated considerable information. There is also considerable information available concerning snakes, a group that presents conservation problems because of common perceptions.

*Reptiles and amphibia are important to..*

	Imp → V.Imp				
Rural communities	√				
Tourism	√	√			
Ecosystem processes	√	√	√	√	√

**Fish**

The fish species of the Four Corners area are well known, and accurate checklists are available. However, there are gaps in knowledge of their biology and ecology. Fish are often of high economic importance to rural people. There are also numerous species not known to occur anywhere else (endemic species) and these may be useful as indicators of ecosystem health and even of climatic change.

*Fish are important to....*

	Imp → V.Imp				
Rural communities	√	√	√	√	√
Tourism	√	√	√		
Ecosystem processes	√	√	√	√	√

**Butterflies**

Butterfly checklists are available for all parts of the Four Corners area, except Angola. This review will cover all species of butterfly.

*Butterflies are important to....*

	Imp → V. Imp				
Rural communities	√	√			
Tourism	√	√	√		
Ecosystem processes	√	√	√	√	√

**Soil fauna**

This review will pay particular attention to termites, as they play an important role in cycling nutrients through soils, change land forms, and modify drainage patterns.

*Soil fauna are important to....*

	Imp → V. Imp				
Rural communities	√	√	√	√	√
Tourism	√	√			
Ecosystem processes	√	√	√	√	√

## **“ECOSYSTEM PROCESSES”**

Although conserving species and biodiversity is important in its own right and for the benefits that arise from activities such as ecotourism, the “goods and services” that healthy ecosystems produce are not only essential for human wellbeing but also depend heavily on the species of which these ecosystems are composed. Living plants and animals combine with the nonliving components of ecosystems - water, air, climate - to maintain these processes, goods and services. This review will deal with a range of subjects -

- *Hydrology*: the way in which water, originating from rainfall and captured in rivers and groundwater - moves through a natural ecosystem is obviously a critical issue. If these flows are disturbed or disrupted, the results can be catastrophic in human and natural terms. Possible examples include the “canalisation” or damming of rivers, the removal of water for irrigation projects, and the destruction of wetlands. An understanding of hydrology is central, not only to understanding the way in which Four Corners ecosystems work, but also to highlighting critical features that require conservation.
- *Nutrient flow*: nutrients cycle endlessly through healthy ecosystems. As already noted, termites can play an important role in the way in which nutrients are cycled through soils. The micro-organisms that break down leaf litter or dead timber, or the scavengers that feed on dead animal carcasses, are seldom considered by the layman, but are all essential to healthy ecosystems.
- *Fire*: fire plays a critical role in the health of local ecosystems. Fire is a natural occurrence, as shown by the fire-resistant bark developed by several tree species, but has increased vastly in frequency due to human activity. Generally speaking, infrequent fire at suitable times of year has positive benefits; frequent, fierce fire is likely to have serious impacts on vegetation, wildlife and general ecosystem health.
- *Herbivory*: herbivory simply means “the consumption of vegetable matter.” Many species are “vegetarian”, ranging from elephants to ants and termites, and their cumulative impact on an ecosystem can be enormous. Elephants are often assumed to be the major factors in herbivory, together with other grazing or browsing mammals, but huge quantities of plant matter are consumed by insects. Many plant-eating species can become pests - for example, locusts and quelea birds- when natural ecosystems are disrupted without thought for the consequences.

## **THE MOVEMENTS OF ANIMALS IN THE PROJECT AREA**

AWF has a particular interest in the movements of animals – notably elephants, but also smaller animals and of course migratory species such as some birds - in the Four Corners area.

A knowledge of these movements is of particular importance when land or other developmental planning is taking place. Large animals, in particular, are of value to the tourism and hunting industries, and developments that block or change animal movement routes can have severe consequences both on these industries and on the animal populations themselves. The erection of fences across wildebeest movement routes in Botswana provides a striking example, and there are many others.



The restriction of movements of elephants, in particular, can have severe consequences. Animals confined to a restricted area are likely to cause serious damage to vegetation and to have impacts on the diversity of other species due to the destruction of their habitats or increased competition for food.

As often, the answer is not to halt development or necessary agricultural projects, but to incorporate the need to maintain these movement routes into land and other planning within the project area. The review of animal movements will draw on existing studies of elephant, wildebeest, zebra, lion, buffalo, bushbuck, brown hyaena and leopard, and will encompass known regular seasonal migrations, other seasonal movements such as convergence on available surface water during the dry seasons, and possible changes in distribution in light of changing climate. The resulting overview will provide factual information for incorporation into future planning designed to maintain both biodiversity, and species and habitats of economic importance.

## ***MAPPING***

The Four Corners area is large, composed of a wide variety of vegetation types and landscape units, and extends across parts of several countries. These vegetation types and landscape units need to be classified and mapped. This will highlight, in a graphic and easily-understood manner, the range of biological diversity across the four Corners area; the extent and distribution of the key conservation targets identified by the Four Corners project, and broad areas of conservation concern.

This mapping will be based initially on LandSat TM imagery, which can provide an excellent “first cut” at such a classification in trained hands. However, satellite imagery can be misleading and the results of this initial interpretation need to be verified.

This will be done, firstly, by using a light aircraft to undertake low-level aerial surveys in selected areas, flying along predetermined flight paths to cover as many of the various units as possible.

Finally, field biologists will visit a number of sites and areas to undertake “ground truthing” of the provisional results gained from the satellite image interpretation and the aerial surveys. Mapping and presentation will be done on GIS, and the results made available.

These techniques have been used very successfully by The Zambezi Society and Biodiversity Foundation for Africa in several other major biodiversity areas, including the Zambezi Delta and the area surrounding Cabora Bassa. Details of the Cabora Bassa surveys are included in this package as a case study, as they illustrate very clearly how biodiversity conservation can be incorporated into land and developmental planning.

## ***MONITORING***

The Four Corners project requires the monitoring of biodiversity so that the success of its conservation initiatives can be measured.

It is important that the limitations of such monitoring are understood. Put simply, monitoring merely detects changes in ecosystems and their diversity. It does *not*, of itself, say anything about the possible causes of such changes. Its value lies in providing a baseline against which future changes can be measured, and in alerting management institutions to the need for an investigation into possible causes - and therefore, if possible, remedies.

Some causes of change may be forecast and easy to evaluate. To take a simple example, the construction of a dam is almost certain to cause detectable changes in downstream ecosystems; and remedies might include the controlled release of water to simulate former flooding.

Other changes are less easy to evaluate. Climate change, for instance, may cause subtle symptoms that may be indistinguishable from those caused by normal fluctuations in rainfall or temperature. Nevertheless, this does not detract from the need for careful monitoring and investigation of possible causes.

Biodiversity monitoring is also a long-term activity. Changes may not show up during the life of a particular project, and some mechanism to ensure sustained follow-up is essential. Ideally, biodiversity monitoring programmes should be established by - or at least in close collaboration with - official institutions responsible for biological and environmental issues, such as environment ministries; and these institutions should take responsibility for long-term monitoring.

The Four Corners project does not therefore initially intend to establish a large-scale biodiversity monitoring programme. Rather, it will develop practical and appropriate monitoring systems that can be applied widely in future.

The Biodiversity Foundation for Africa will make suggestions concerning suitable monitoring sites within the Four Corners area. These proposed sites will cover the range of habitat diversity within the area, and address the project's key conservation targets. The Biodiversity Foundation for Africa will also establish one "model" monitoring site, probably one or two hectares in extent, in a key location. This will provide an opportunity to provide practical training in field techniques for members of collaborating national institutions.

## ***TRAINING AND CAPACITY BUILDING***

The skills involved in collecting and identifying plants, animals, birds and other specimens "in the field" is essential to biodiversity conservation. Unfortunately, these skills are declining throughout much of the region as trained experts retire or move away, and fewer younger people undergo the intensive training required.

This is of great concern to AWF, the Zambezi Society and the Biodiversity Foundation for Africa, to whom these skills are essential if they are to achieve their biodiversity conservation goals. One of the Four Corners project objectives, therefore, is to contribute to the training of the next generation of field biologists, to replace the skills being lost from the region.

Two of the biodiversity project components - the landscape and vegetation mapping and the siting and establishment of monitoring plots - involve fieldwork, and present opportunities for the staff of local and national institutions to be exposed to field recording and collecting techniques, and the identification of specimens both in the field and in museums and herbaria.

This training will be aimed both at qualified professionals who lack field experience, and at technical assistants. Up to ten such staff can be accommodated during this fieldwork.

---

# ***BIODIVERSITY CONSERVATION IN ACTION***

## **CASE STUDY 1**

### ***Sustainable development around Lake Cabora Bassa***

The experience of Tete province, Mozambique, offers useful insights into the identification and conservation of biological diversity.

Tete province lies in western Mozambique, on the borders of Zambia and Zimbabwe. Some 43 000 km<sup>2</sup> sq km in area, much of the province is still undeveloped, except for one major exception: the Cabora Bassa dam and associated reservoir, completed in 1974 and providing hydroelectric power for South Africa, Zimbabwe, and Mozambique itself.



*Gorge and dam site, Cabora Bassa*



*Landscape along the powerlines south of Cabora Bassa dam*

*View of Lake Cabora Bassa from hill near Daque Camp*

Much of the province, and especially the areas surrounding Cabora Bassa, offer immense opportunities both for some forms of industrial development, and for ecotourism based on the area's natural resources. Some districts within the province have good populations of wildlife species such as elephant, lion and antelopes. Cabora Bassa is not only scenic, but also creates opportunities for both recreational and commercial fishing.

Until recently, much of the development that took place within the province was haphazard and unplanned. There was also considerable pressure on the authorities to take hurried decisions concerning developmental proposals ranging from tourism camps to fish processing facilities. Such proposals, if accepted, could have eroded much of the area's potential value for ecotourism and other lucrative activities based on natural resources. Good planning, on the other hand, could accommodate the interests of all potential developers without compromising the area's natural assets. The key to this lay in the incorporation of biodiversity and other natural values into a comprehensive process of land use planning and management.

The Tete authorities wished to incorporate two distinct natural features into their planning. One was biological diversity, in the form of identified areas and sites, at differing scales. The other was "wilderness value", a quality of particular importance to ecotourism. Whereas biological diversity is capable of objective technical evaluation, wilderness values are often aesthetic and subjective. This meant that two sets of criteria – resulting in two differing outputs – had to be applied.

A project to evaluate both qualities was written by the Tete authorities in collaboration with The Zambezi Society and the Biodiversity Foundation for Africa. Funding was provided by the Ford Foundation, and the project was implemented from 1999-2002.

### ***Step 1: Review of existing information***

The project was carried out in several stages. The biodiversity evaluation commenced with the collation and review of existing information. This was followed by an initial evaluation of LandSat TM imagery, involving the purchase of data in South Africa, the production of photo positives in Germany, and final printing by SIRDC in Harare.

### ***Step 2: Satellite imagery***

A trained eye can derive much information about vegetation from satellite imagery, produced in appropriate "false colours". Vegetation is also a useful indicator of the probable diversity of other biological groups, including mammals, birds, reptiles and others. The output from this initial evaluation, then, was a very tentative map of the differing types of vegetation within the project area. Some of these types could be provisionally named from previous experience, but required confirmation. Others needed identification by physical survey.

### ***Step 3: Aerial survey***

The next step was to undertake aerial surveys of selected areas to confirm these tentative identifications. These surveys were mainly carried out using the Zambezi Society's Super Cub light aircraft, which is ideally suited to this kind of work.

### ***Step 4: Field work***

This produced a further refinement of the mapping developed from the satellite imagery. However, final confirmation – and evaluations of biological groups other than vegetation – requires field work, on the ground, by biologists with specialised knowledge of these groups. A team consisting of biologists, botanists and ornithologists from the Biodiversity Foundation for Africa visited a selection of appropriate sites and areas, and also examined much of the Cabora Bassa lake shore, in the course of field trips extending over several weeks.

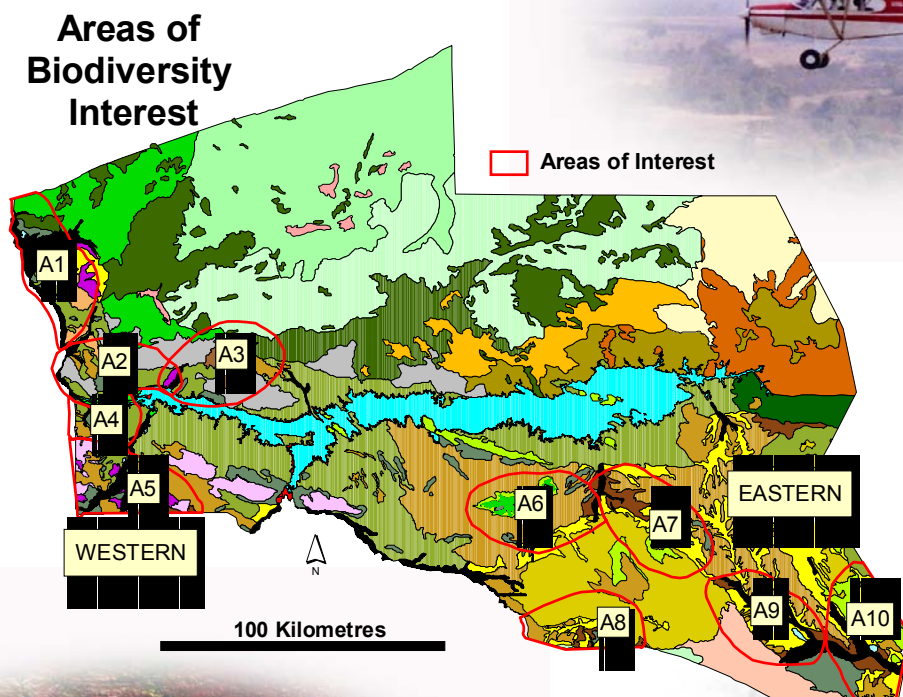
### ***Step 5: Analysis and mapping***

The technical project co-ordinator then analysed the information resulting from the initial literature search, the imagery evaluation, the aerial surveys and the ground field trips to produce a synthesised overall evaluation of biological diversity within the project area. The results of this analysis were

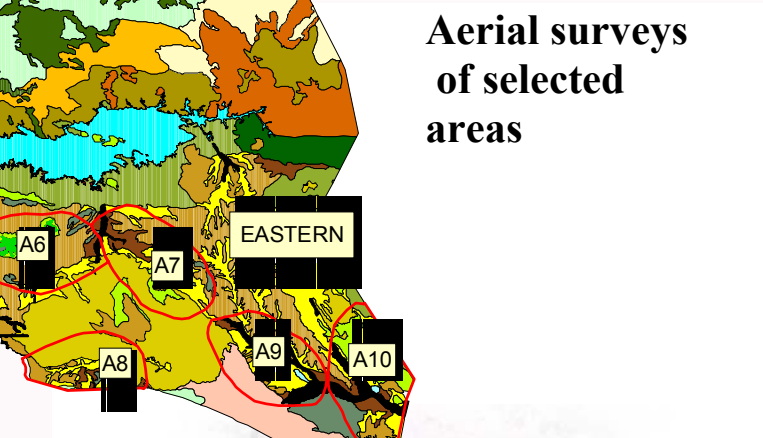
# MAPPING BIOLOGICAL DIVERSITY

The Zambezi Society and Biodiversity Foundation for Africa use satellite imagery and aerial surveys to make a preliminary evaluation of biodiversity. Teams of biologists then visit the areas in question to verify the preliminary assessment and to survey selected biological groups such as birds, mammals and reptiles. This data is added to pre-existing data resulting from literature searches, and synthesised into detailed reports on the diversity of the project area. The data is also mapped and areas of importance to biodiversity are identified and shown graphically as an aid to developmental planners, local authorities and other key stakeholders

## STEP 1 Collate and review existing information



## STEP 3 Aerial surveys of selected areas



## STEP 2 Make an initial examination of suitable satellite imagery



## STEP 4 Ground visits by teams of biologists to verify data from images and aerial surveys

presented in report form. Areas of particular biodiversity interest were mapped at three scales: specific vegetation types; landscape features of high conservation importance; and broader, more general areas of biodiversity importance. The report and mapping, together with recommendations for land and developmental planning, were presented to the Tete provincial authorities early in 2002 and at the time of writing are being incorporated into the overall land and developmental planning process being undertaken by the authorities.

One might ask: why bother with satellite imagery and aerial survey, when field trips are an essential part of the process? The answer lies in both cost and effectiveness. It is neither necessary – nor financially possible – to use ground teams to examine every part of a project area extending over several thousand square kilometres. Ground teams confirm particular aspects of the previous evaluations, and assess other forms of biological diversity in areas preselected from the satellite images and aerial surveys as being of particular biodiversity importance.

And wilderness? Biological diversity is not, of itself, of overriding importance in selecting wilderness areas. Most important are low densities of human settlement and activity, scenery, wildlife (especially large animals) and accessibility. These characteristics can easily be identified from satellite imagery and aerial or field survey, without the need to identify details of species and diversity. Potential wilderness areas were also mapped and included in the final report to the Tete authorities.

One particular value of this approach lies in the ability, not only to plan future development so that it preserves natural assets, but also to pre-empt possible developmental projects that may compromise these assets. All too often, environment ministries and other agencies concerned with conservation are faced with developmental proposals designed without prior information concerning biological diversity or wilderness values. This can impact adversely on the entire developmental process, resulting in lengthy delays while environmental impact assessments are produced and debated. Though not substituting for EIAs, biodiversity and wilderness evaluations as carried out by the Tete authorities can enable developmental planners to rapidly assess the potential impacts of proposed developments and incorporate biological considerations into their planning from the beginning, thus facilitating the entire process of development and eliminating costly delays. This pre-emptive system can also serve as a useful tool against which planning authorities can measure the authenticity and professionalism of EIAs.

## CASE STUDY 2

### *Communities conserving biodiversity*

In another exciting biodiversity project, the Zimbabwean National Herbarium and the Biodiversity Foundation for Africa identified over 80 sites of important plant diversity in several communally-settled lands in the Zambezi Basin. Many of these sites were threatened by the expansion of settlement and the growth of agriculture.

Since 1997 The Zambezi Society and Biodiversity Foundation for Africa have been implementing a project designed to conserve these sites. The project takes, as its start-point, the assumption that these sites are in effect *owned* by neighbouring rural communities and that no conservation effort will succeed unless it is *designed* by the communities themselves and that they are *motivated* to conserve biodiversity.



*Community forest custodians in Muzarabani Zimbabwe*



*Forest clearance in Binga District in Zimbabwe is threatening biodiversity*



*Valuable "dry forest" in Gonono District (above left) and "False Mopane" woodland in Binga District, Zimbabwe*

The project has therefore focused heavily on creating awareness of values and assisting these communities to identify appropriate traditional, social, cultural and economic conservation mechanisms. Often, the loss of valuable sites and species was taking place simply because local people were unaware of their biodiversity and other values. In other cases, sites and species were found to have important traditional and cultural associations, and conservation resulted from a wider acknowledgment of these values. Sometimes, land pressures dictated that conservation required an economic incentive. One forest site, in Zimbabwe's Muzarabani district, is being developed for environmentally sensitive ecotourism. In another site, in Binga district, local people have begun a beekeeping project to create income from honey sold on local and international markets. In both cases, the success of these income-generating projects depends on communities investing in conservation management schemes to sustain their forests' biodiversity.

The Zambezi Society - Biodiversity Foundation role in the Four Corners project does not extend to conservation work with local communities. However, the insights gained from this and other partnership projects can be made available to interested stakeholders.