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82a. BIODIVERSITY AND AGRICULTURAL PRACTICE: WHY SHOULD AGRICULTURISTS CARE?

David Vaughan

82b. CONFLICTS IN PROTECTED AREAS IN AFRICA: LIVESTOCK AND THE CONSERVATION OF THE RWENYA WILDLIFE MANAGEMENT AREA, NORTH EAST ZIMBABWE

Stephen Hall and Roger Blench

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edited by Roger Blench

The two papers in this volume (together with those in the accompanying Network paper 81) were originally presented at a conference held at ODI in June 1997. The objective of the conference – which was entitled 'Ghana and Zimbabwe: options for change' – was to bring together and discuss various of the studies of aspects of rural livelihoods which are currently in progress in these countries. The papers dealing with Ghana will be published in book format in 1998.

At the conference a particular emphasis was placed on semi-arid areas; in Zimbabwe many of these are only now beginning to recover from the prolonged drought of the early 1990s. Paper 82a presents a broad perspective on biodiversity in farming systems, particularly within Africa. It argues that until recently agricultural land has been seen as 'off limits' in biodiversity surveys, but that new studies suggest that in some types of farming system, diversity may be as great or greater than in the adjacent 'wild' land. For this and other reasons it is of considerable importance to develop the skills to understand agricultural biodiversity. Paper 82b considers the Rwenya basin in north east Zimbabwe from the point of view of its potential for wildlife conservation. It reviews existing domestic livestock systems in the area and assesses the present and potential future impact of livestock keeping in local communities on the Rwenya reserve.

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Acronyms and Abbreviations

AGRITEX	Agricultural Technical and Extension Services Department
BUN-Zimbabwe	Biomass Users' Network - Zimbabwe
CBD	Convention of Biological Diversity (Brazil)
Colcom	Cold Storage Commission
CV	coefficient of variation (standard deviation/mean expressed as percentage)
DAP	draught animal power
NGO	non-governmental organisation
NS	not statistically significant
p	probability level (here, <0.05 indicates significant difference)
PRA	participatory rural appraisal
RBA	rapid biodiversity assessment
RN	Rwenya North
RS	Rwenya South
RWMA	Rwenya Wildlife Management Area
SBSTTA	Scientific Technical & Technological Advice of the Convention of Biological Diversity
UNEP	United Nations Environment Policy

BIODIVERSITY AND AGRICULTURAL PRACTICE: WHY SHOULD AGRICULTURISTS CARE?

David Vaughan

ABSTRACT

Studies on biological diversity (biodiversity) have primarily been made by and for biologists with a main focus on biological conservation in 'wild' areas beyond the farm or the plantation. Increasingly, however, attention is being focused on the value of such studies for other types of land, notably those used for agriculture. In many countries, the role of biodiversity research is to focus on the use of natural resources, which suggests that biologists should play a greater role in investigation and implementation of sustainable agriculture. Recent research suggests that for many important groups of organisms levels of biodiversity in farmed areas are similar to those in natural areas. Complete biodiversity surveys are usually impractical, in terms of time and resources, and it is becoming common to identify indicator species that flag the levels of biodiversity. The use of these can bring biodiversity into practical use in agriculture as well as help ensure that valuable natural resources are not needlessly lost.

1 INTRODUCTION

For many people, biodiversity is a term synonymous with nature conservation, of relevance in areas of high conservation interest such as equatorial forests but not in man-made or man-influenced systems, such as agricultural areas. The aim here is to challenge this assumption and show that biodiversity is not an abstract issue of little relevance to practical problems, but that analysis of biodiversity can provide crucial insights into the way natural systems support agricultural practices and provide tools to help maintain agricultural productivity.

The political framework

While the issues of biodiversity are not new, they were given considerably more prominence by the development of the Convention of Biological Diversity in 1992 (CBD). This covers a wide range of topics relating to conservation of biological resources, information transfer, intellectual property rights and use of biotechnology, amongst others. The attempt was made in the Convention to incorporate as many as possible of the prevailing views on the relevance of biodiversity. This means that within its articles, nature conservation and economic exploitation of biological resources are both developed as themes. Indeed there is considerable support for the view that the primary role of the Convention is to safeguard countries' rights with respect to current and future development of biological resources, to ensure that the country of origin obtains adequate benefit for exploitation of natural resources. This in itself has some implications for agricultural practices which will be discussed below.

2 WHAT IS BIODIVERSITY?

Biodiversity is a concept designed to demonstrate the wealth of an area in terms of its natural diversity. The term is a contraction of 'biological diversity' and is generally considered to be an amalgam of three separate aspects of natural diversity:

- the diversity of *genes*, which is of considerable importance for agriculture where genetic characteristics of crops and livestock which confer advantages in different localities must be maintained;
- the diversity of *species*, not only of animals and plants, but also of micro-organisms such as fungi, bacteria and viruses; and
- the diversity of *habitats* (ecosystems or landscapes) where whole systems can be identified as a single, ecologically viable unit.

Most of the work connecting biodiversity and agriculture has looked at genetic diversity (coining its own particular term of *agrobiodiversity*) with its obvious implications for plant breeding programmes and maintenance of resistance to environmental stresses. However *species* diversity also deserves attention as this focuses on the components which maintain the ecosystems responsible for sustaining productive capacity. Species diversity will therefore be the main focus of this paper.

The total number of species is never a constant figure: new species are continually being described but equally 'old' species may be reassessed in terms of new evidence as to whether they are truly distinct from each other. Of more concern is the decline in species due to loss of habitat and other human activities; here the reduction in species is very much a loss of genetic variability as well.

Finally, *habitat* diversity is also increasingly becoming an important concept for agricultural work. This is especially true in the development of agroforestry schemes where annual crops are mixed with perennials to improve natural conditions.

It is an *a priori* assumption that more diverse systems are inherently more stable than less diverse ones. This obviously depends greatly on the level of change to the system and the speed of that change; massive changes such as wholesale land clearance will inevitably have a major impact on natural diversity.

What are the diverse species?

Studies and polemics on the subject of biodiversity frequently emphasise 'headline' species, usually mammals. If we are to conserve biodiversity then the emphasis is usually on conserving highly visible species.

Yet, if the range of known organisms on the planet is enumerated, the great majority are insects. While the actual number of species is a matter of debate, a typical estimate is that there are over 1 million known species of insects compared to 1.5 million animal species in total. Certainly, most estimates concur that at least 50% of all known species are insects. This diversity of species is also reflected in the 'productivity' of natural species. Summary data from temperate region pastures indicate that while plants provide the highest overall biomass (20,000 kg fresh weight/hectare), fungi, bacteria, arthropods and annelids provide almost 10,000 kg fresh weight/hectare. These unglamorous species are of course crucial to both farm environments and 'wild' habitats and need to be given greater emphasis in overall evaluations of biodiversity.

3 WHY HAS BIODIVERSITY BEEN NEGLECTED IN AGRICULTURE?

Many biologists have previously taken the view that agricultural systems are of low biodiversity which has tended to limit the level of scientific interest that they hold. However, research and reviews are showing that biodiversity in some agricultural systems is higher than previously thought. As a result, there is a move towards looking at how conservation concerns can be accommodated within agricultural work and also how agricultural practice and theory can benefit from lessons learnt in natural systems (Vandermeer & Perfecto, 1997).

The reasons why biodiversity in agricultural systems is of interest come from two main arguments:

- globally, 'managed' land covers 95% of the land surface, compared to 3.2% remaining as natural habitats (Pimentel *et al*, 1992): the level of biodiversity within these artificial landscapes is therefore important from a land cover viewpoint; and
- where agricultural practices are not monocultures, dependent on external support from mechanisation and chemicals, the support base for agriculture is essentially the existing natural system, so the health of this system is important for the sustainability of agriculture.

There is a wealth of research in biodiversity which is potentially useful to agricultural programmes, though few studies have been undertaken specifically with an agricultural objective. Whenever disciplines work in parallel, rather than in concert, there is always a risk that lessons from one will not be incorporated into the other. The aim here is to point to how work in biodiversity can be valuable for agricultural work and not just for considering conservation issues. It needs to be emphasised therefore that:

> **Assessment of biodiversity is not synonymous with nature conservation but is a broader-based field of study with relevance to most practices dealing with natural or semi-natural systems.**

Biodiversity in sustainable agriculture

The importance of biodiversity assessment is increasing as concepts of sustainable development become ever more prominent.

> **The assessment of biodiversity should be an integral part of developing sustainable agricultural practices as it enables changes in the natural system to be monitored and the risk of pest outbreaks to be assessed.**

While highly mechanised agriculture essentially seeks to remove dependency on the natural processes normally required for plant production, low technology methods require that beneficial natural processes be retained. However, such processes are invariably complex. They involve a wide range of organisms and non-living materials and changes to such systems can lead to highly undesirable changes in conditions (e.g. loss of the organic component of soils leading to a breakdown in structure). The role of biodiversity assessment is to help find ways of observing the impacts of changes brought about by agriculture in time to allow for remedial action to be taken.

There are a number of areas where a greater understanding of the role of biodiversity could feed into the evolution of policies for sustainable agriculture. Of the many reviews of this field, the proposal submitted by the Brazilian government to SBSTTA is indicative[1]. This proposal highlighted:

- reservoirs of natural biological control organisms;
- maintenance of natural cycles;
- pollination;
- symbiotic associations;
- genetic resistance;
- new species of economic importance.

This list covers the main areas where assemblages of species play a vital role.

Agricultural intensification and extensification

It is too simplistic to suggest that sustainable agricultural practices are always preferable to highly mechanised forms, from a conservation viewpoint. Where there is a need rapidly to improve agricultural production, intensification over existing farmed land may result in lower demand for development of marginal, more species-rich areas (so helping to preserve biodiversity). In such species-rich areas, the move towards mechanised systems generally results in a marked reduction in species diversity, because mechanised culture inevitably pressures farmers towards monoculture or simple mixed-cropping systems. These, in turn, provide a very uniform range of habitats which can only be colonised by a limited range of species. As a consequence monoculture systems are often highly susceptible to destructive pests; since only very few species have the capacity to exploit a highly specialised habitat (the farm) they are usually without competitors or predators and can multiply excessively, becoming a pest on specific crops.

Biodiversity counts on Javanese 'forest farms' have found that the mosaic of habitats created by the very large number of cultivated plants used by farmers actually increases biodiversity in the farm (Christanty *et al*, 1986). Studies in Central America on coffee plantations provide quantitative data that biodiversity of some insect groups (ants and beetles) in traditional, mixed plantations incorporating shade trees is not very different from that found in tropical forests. However where there was a shift to coffee monoculture, biodiversity in these groups was dramatically reduced (Perfecto *et al*, 1997).

Extensification and its effects on biodiversity

These results do not conform to an established view that biodiversity will inevitably decline when land is converted to other uses. This view stems largely from a stereotype that primarily associates biodiversity with tree canopies in forest systems. Even this seems to be contradicted by recent research. Studies in Southeast Asia, involving detailed assessments of the most species-rich group, the beetles, showed that less than half the species were true canopy species (Holloway & Stork, 1991). Species associated more with ground cover plants and the soil system may have some survival potential within a managed agricultural system, provided that the system incorporates ideas on sustainable management.

Biodiversity and integrated pest management

One important area of agricultural research and practice which to a large extent includes biodiversity assessment, is in biological control of pests. Here, diversity of habitats is possibly the main area of interest, as it is the ecosystem structure which contributes to finding bases for the natural enemy species as they are often species most affected by control chemicals. Natural enemies (especially arthropod species) are often highly affected by agricultural practice and need the diversity of structure found in a heterogeneous environment if they are to prosper.

4 BIODIVERSITY AND BIOLOGICAL INDICATORS

The measurement of biodiversity

Calculating the precise number of species in an area is irrelevant for many practical purposes. What are important are relative changes in species diversity between natural and cultivated areas. A distinction must be drawn between reduction in abundance of a particular species or the local loss of a species (which may be recoverable) and the extinction of a species from the natural system, which is final (Sperling, 1997).

Essentially, the core of biodiversity is the identification and enumeration of species within a given area. This is the baseline set of information from which ecologists and others can begin to develop models of how the ecosystem functions. It also allows linkages to literature to be developed and knowledge on the same species from other sites to be drawn in. So the first biodiversity assessment product is usually a *checklist* of species, prepared by biologists, usually in conjunction with indigenous specialists, such as hunters or herbalists.

Attempts are also being made to develop methods of *Rapid Biodiversity Assessment* (RBA) on the model of Rapid Rural Appraisal. It is cost-effective to concentrate on particular groups of organisms, where it has been determined that they can act as indicators for the overall biodiversity of a habitat or niche. Originally used for environmental impact assessments performed under tight timescales, RBA is being further developed to become integrated with agricultural development programmes.

Elephants or insects: choosing appropriate indicators

Perhaps the most valuable contribution that biodiversity work can make is to help in the selection of appropriate biological indicators. An indicator is a species or a set of species whose abundance can be relatively easily assessed and whose presence or absence marks the health of the environment as a whole. For example, a type of frog or bird may indicate the persistence of a whole range of species that are somehow linked to it. A particularly important indicator is the 'keystone' species, which can determine an ecological system by its presence. Such keystone species may be certain types of trees that host entire distinct communities in their canopies, on their bark and in their root system, or large mammals such as elephants. They may also be smaller invertebrate animals such as ants or termites where sheer numbers mean that the whole system is dominated by their activity.

Termites are well-known as a 'keystone' species as they often play a dominant role in the way that semi-arid ecosystems function, especially in Africa and Australia. Typically they are regarded as pests due the damage they cause to wood-based products and crops. However, this has tended to mask their positive role in maintaining essential ecosystems (Black & Okwakol, 1997). Important functions fulfilled by them include soil turnover, detritus removal and wood recycling. These are often crucial to continued productivity within agricultural systems and in particular to the maintenance of soil fertility. Changes in the composition of termite species diversity can therefore provide a promising indicator of the changes that have taken place within a farming system.

The concept of a 'keystone' species is frequently used in conservation, where public perceptions are often as important as purely scientific ones. It is often easier to attract support for one large, well-recognised species than for the maintenance of the complex species assemblage usually needed to sustain it. However, the approach also has drawbacks, not least because it moves the focus away from the importance of the ecosystem and the role of the totality of organisms involved. Such ‘keystone’ or ‘headline’ species (pandas, elephants, whales) are not generally found on agricultural land, and have been responsible for the public perception that biodiversity is somehow irrelevant in the agricultural context.

Use of indicators

Use of indicators is important for several reasons:

- a simple presence/absence test need not require sophisticated equipment and can be important in assessing success or failure of different agricultural policies;
- identifying the presence (or absence) of indicators reduces the amount of work required for monitoring;
- behaviour and abundance of other species may be inferred from changes in population states of the indicators.

The more habitat-specific the species, the more precise the level of information on environmental quality and conditions that will be gained. The hardest part is usually the choice of indicators. There is no ideal animal or plant species which can provide a overview of natural conditions, though different species can be used within one system to highlight one or more of its aspects.

Biodiversity is far from a unitary concept; zoologists may wish to highlight different aspects of a system in contrast to agronomists. If, however, we are able to identify assemblages of species that mirror the complexity of agricultural productivity, it is possible to explain and eventually predict production. Several biodiversity indices have been developed primarily for use in conservation but they may also provide insights into subtle changes in environments within farm-based systems. This is not so much an indicator *species* as an *index of biodiversity*.

5 THE ROLE OF PARTICIPATORY APPROACHES IN BIODIVERSITY ASSESSMENT

A central tenet of sustainable approaches is the need to listen to stakeholders and learn to understand the basis of traditional practices. While these practices may not be related overtly to biodiversity, they may be built around an extensive knowledge base of how local populations of animal and plant species change and respond to climatic conditions and types of tillage practice. In tropical areas in particular, it is likely that the sum of knowledge about key species held locally may well be greater than that which can be provided by outside workers, such is the diversity of species.

Farmers’ knowledge must be combined with more generic knowledge about biodiversity and the functioning of the natural systems. This need is not confined to tropical areas: there are efforts underway, for example in the United Kingdom, to introduce biodiversity as a concept into agricultural practice. The primary reason for the need to look for new sources of information is that while local knowledge may outweigh other sources while the environment is stable, once changes are made (whether deliberate or not), responses by ‘alien’ species may not form part of the local knowledge base.

The level of expertise on species diversity varies considerably around the world. Typically, countries that earn a significant income from wildlife tourism also have a much larger base of zoological knowledge than those that do not. Although Zimbabwe has substantial resources in terms of biological collections, this is not the case in many other countries in sub-Saharan Africa. To balance this, there are now greater efforts to incorporate local knowledge of farming systems into external biodiversity estimates using participatory approaches, notably PRA or similar village-based exercises (Altieri, 1991).

Intellectual property rights

The protection of intellectual property rights (IPR) is an important issue that lies at the heart of the CBD. Local knowledge on biodiversity can be a valuable asset, with an economic value, and so cannot be taken for granted as a free information resource. Discussion on this topic has revolved around areas of bioprospecting (the identification of sources of new products) but implicitly could be relevant to any biological agent. For example, a biological control agent, particularly one with a highly restricted distribution, may confer economic benefits to countries other than the original source. Countries that are signatories of the Convention have undertaken implicitly to safeguard IPR for this kind of use; indeed many conservation organisations see this kind of ‘selling of information’ as having a potential to generate revenue for locally managed conservation activities. In reality, this has proved very difficult to actualise, because the enterprises with the resources to produce a commercial product from its source in indigenous ethnobotanical knowledge are large multinationals, which also have the resources to defend their investment from claims by developing countries.

Enabling local skills: data sharing

The basis for biodiversity assessment is the correct identification of species. Indeed this skill is a requisite for dealing with any interaction of natural species with agriculture, whether pollinators or pests. However, there is a major dichotomy here: the majority of taxonomists are in the developed world, whereas the greatest need for fundamental biodiversity assessments lies in the tropics. Not only do the tropics contain by far the greatest number of species but many of these are as yet undescribed. Describing a species is a crucial stage; the application of a (hopefully) unique label allows experiences and knowledge gained through multiple sources to be readily shared and compared. Unless this is done in a systematic way, uncertainty over the identities of important agricultural species will remain. For example, a common problem in tropical agriculture is the transfer of insect or crustacean species that may be relatively harmless in one continent to a location where they are extremely dangerous (e.g. from South America to Africa). Without effective taxonomic services it may be a long time before such adventives (imported biological organisms) are correctly identified and appropriate remedial action is taken, simply because the affected developing country cannot access the existing knowledge base.

Even for countries where there is a comprehensive central facility for the identification and maintenance of reference collections, the number of specialists can be inadequate to meet the task. Sharing of information and collections, particularly through modern data management systems and networks provides one way of improving knowledge without necessitating the establishment of entire new institutions. A central facility will not be useful unless it can be ensured that this specialist knowledge is accessible to field workers (whatever their backgrounds) without the need to travel to sometimes remote central facilities. Again, computerised identification guides can play a significant role here, especially if they can be attached to existing or planned agricultural support centres.

Enabling local skills: the parataxonomists

A further development of the theme on enabling better identification is one which has been used in several countries now. This is the idea of training *parataxonomists*, field workers who already have some appreciation of biological diversity in a particular area. They undertake specialised training courses and in turn help local farmers and others to make correct identifications of potentially significant species. The Natural History Museum in the UK has now been involved in training parataxonomists in Costa Rica, Paraguay and Indonesia; the reaction has been very positive, not least because it is easier to see the benefits of helping to develop local expertise where it can be most effective.

6 CONCLUSIONS

The past

Biodiversity is a recent term but the topic has a long history within the realms of ecology, taxonomy and conservation. It has often been translated into practical applications oriented towards conservation with much less emphasis being placed on its applicability in other areas, particularly agricultural production. Equally, there is a wealth of research on agricultural ecology that incorporates ideas developed for ‘pure’ biodiversity studies. The flow of information between the two disciplines is inadequate.

The present

Biodiversity has not been given much prominence in agricultural development programmes to date. Most conservationists have regarded agricultural systems as biodiversity deserts by comparison with the primary protected areas such as equatorial forests. However, this is changing as more research indicates that in sustainable agricultural systems levels of biodiversity for some major animal groups are higher than once thought. An increasing amount of attention is also being paid to role of biodiversity in maintaining production in managed habitats.

The future

If sustainable development is to have any real meaning, it must incorporate recognition and understanding of natural processes which help to sustain human activities. This does not mean starting afresh: there is a huge reservoir of knowledge gained through studies of biodiversity in natural areas and this knowledge can often be used to form the sort of baseline needed to monitor changes in an environmental system. The main task is to synthesise what is known and to make this synthesis available to non-specialists. Above all there is a great need for more dialogue between specialists to understand what specific benefits can be gained from an integration of different types of ideas.

A frequently expressed view in developing countries is that biodiversity represents biological resources and hence may be expected to contribute to the economic and social growth of a country. Sustainable agriculture is indeed one expression of that view, where biodiversity is a resource that should be managed.

When the roles of extinct species are not fully understood, there is a real risk that key components of natural cycles will be lost. In many ways the most disturbing aspect of this is that species are disappearing before their role (or even their identities) have been recognised – a situation akin to throwing out parts of a motor car engine without referring to a manual. If it transpires that the role of these lost species was important, the only remedy is to replace their function in the production cycle by human intervention. Whether this is technically possible will vary; whatever the options, any solution will certainly involve greater financial or social expenditure than would have been required to maintain the existing natural system in place.

ENDNOTE

1. Technical submission by EMBRAPA in Brazil, no author. UNEP/CBD/SBSTTA/Inf. 18, Scientific Technical & Technological Advice of the Convention of Biological Diversity (SBSTTA) Agricultural Biological Diversity, Proposal to the Subsidiary Body on Scientific Technical & Technological Advice of the Convention of Biological Diversity, September 1996.

CONFLICTS IN PROTECTED AREAS IN AFRICA: LIVESTOCK AND THE CONSERVATION OF THE RWENYA WILDLIFE MANAGEMENT AREA, NORTH EAST ZIMBABWE

Stephen Hall and Roger Blench

ABSTRACT

Protected areas will only be adequately conserved if the conflicting demands of environmental managers and the people who exploit the resources of the area are resolved. In much of Africa, it is the demands of livestock owners for water and feed that are often seen as being particularly at variance with environmental protection and the conservation of biodiversity and natural resources. Hunters, also, will need to be persuaded to accept controls on their activities. Provision of alternative sources of income and subsistence, such as small scale livestock enterprises, may help to secure this. Background information on livestock systems is therefore needed and this paper reports on a field study, made in May 1997, of the livestock systems of the areas immediately north and south of the Rwenya Wildlife Management Area in north east Zimbabwe.

Farmers currently use the Rwenya Wildlife Management Area for grazing and watering their cattle. There is little control and no monitoring of the impact on the environment. The minefield running along the border with Mozambique acts to deter itinerant herds from entering the reserve. This is believed to lower disease and tsetse challenge and farmers express no desire for removal of the landmines. Major constraints on the development of livestock would be removed if there were improvements in water and feed resources, veterinary and extension services, and marketing.

Enhancing the value of the Rwenya Wildlife Management Area for conservation of wildlife will curtail the freedom of cattle owners to exploit its water and pasture resources. However in view of the rather low level of input of veterinary, extension and marketing services, it seems possible that herd owners would accept this new constraint in return for improvements in such services, together with the provision of more dams and boreholes.

1 INTRODUCTION

There are many examples in Africa of national parks and other protected areas being compromised through the existence or establishment of villages and cultivation within them, through incursions by hunters, and through more or less intensive exploitation by livestock owners. To resolve these conflicts, in many areas the management philosophy promoted by the World Bank known as *l'approche terroir*, may be favoured (Lusigi, 1994; see also references in Child, 1995). This involves designation of different areas for different uses, and their management with local consent for local benefit, with multiple use of reserved areas being permitted. Under such a consent-based management philosophy, livestock producers in the area around a reserve must accept restrictions on their access to water and grazing. The consequent increase in animal populations in the reserve will, however, make their livestock more liable to predation and to attack by tsetse flies. If producers were adequately compensated, for example by more generous provision of veterinary, extension and marketing services, they might accept these penalties. This study investigates the livestock production systems in the region surrounding a protected area in semi-arid Zimbabwe to ask whether such compensation is required and is feasible.

Livestock production in the communal lands of Zimbabwe has been described for various regions (see, for example, Holness, 1974; Sandford, 1982; Shumba, 1984; Barnes, 1987; Cousins, Jackson & Scoones,1988; Barrett, 1991; Scoones, 1992, 1995; Cousins, 1993). Any full study would require that all socio-economic groups of livestock owners be considered, but in practice it is those who own cattle that are most likely to exert pressure on protected areas such as the one considered here, hence the focus of this paper on these people and their activities.

2 STUDY AREA

In north east Zimbabwe (33E, 17°S) the Rwenya River flows approximately north eastwards to meet the frontier with Mozambique about 30 km south of Nyamapanda. The riparian lands with a total area of about 500 km^2 bordering the last 30 km of the river's course to the border were gazetted in 1987 as a Wildlife Management Area, the Rwenya Wildlife Management Area (RWMA).

The RWMA and its surrounding area is considered poor land from an agricultural viewpoint, and its potential for development is further reduced because of its remoteness (Whitlow, 1980, 1982). It is classified as agro-ecological region IV. As land of this type covers 12.84 million ha (33% of the total land area of Zimbabwe), understanding of the livestock systems that operate there is of wide applicability. Region IV is characterised as a 'semi-extensive

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farming region: annual rainfall 450–600 mm, subject to seasonal droughts and severe dry spells during the rainy season; found in hot, low-lying land; marginal for rain-fed maize. Ideal for drought-resistant fodder crops' (IIED, 1992).

The drainage systems flow approximately west-east across the region with the Rwenya river and its tributaries at the centre. The Rwenya flows perennially, although many watercourses are ephemeral. The natural vegetation is dryland forest, consisting of a mixture of mopane and miombo woodland. The granitic sandy soils underlying the forest are infertile, highly leached and with low mineral reserves. The region is quite mountainous, with rocky outcrops and inselbergs dotting the landscape, especially south of the river. Most of the rivers have deposits of alluvial gold.

The region is divided between two provinces, Mashonaland East and Manicaland and on both sides there are three wards bordering the RWMA. This arrangement is shown in the table:

Province	District	Wards	Acronym
Mashonaland East	Mudzi	Makaha A, Chikwizo A,B	RN
Manicaland	Nyanga	Wards I, II, III (formerly Marowo, Sanhani, Mutambwe)	RS

Map 2 in Blench (1998, this issue) shows the geography of the RWMA and the administrative boundaries in more detail.

3 METHODS

Fieldwork was conducted from 2–10 May 1997, in Rwenya South and 13–17 May in Rwenya North. Visits were paid to the ward councillor and then to the principal villages in each ward, where the local chief (the 'kraal head') was interviewed. With his guidance, neighbouring farmers with ruminant livestock were selected and visited (these were usually farmers located near to the chief's residence). A larger-scale socio-economic survey recording the incidence of livestock ownership throughout the region is described in Blench (1998, this issue).

Two questionnaires were compiled, one for village chiefs and the other for owners of livestock. Respectively, these took about 15 minutes and 60 minutes to administer. Village chiefs were asked:

- which species were kept in the village;
- what the problems of keeping each species were;
- what could be done to help with animal husbandry and marketing;
- whether livestock owners encountered any government restrictions; and
- what the effect of the closure of the border with Mozambique and of the 1991–92 drought had been.

Livestock owners were asked:

- which species they kept;
- whether and how they used animal traction;
- how they kept and fed their livestock, why they kept each species;
- what the problems associated with each species were;
- what the best months for the different species to give birth were;
- when and to whom they had last sold animals;
- what the current local sale prices were;
- when they used veterinary services; and
- when they had last purchased drugs.

Discursive answers were encouraged and further information was sought opportunistically from other local people.

In Rwenya South, five men were interviewed in their capacity as village chiefs. They and a further three women and six men were interviewed as owners of livestock. In Rwenya North, six chiefs and a further five livestock owners (four men and one woman) were interviewed (Table 1).

Table 1. Number of respondents to livestock questionnaire survey

Region	Ward	Respondents
RS	Ward 1	8
	Ward 2	3
	Ward 3	3
RN	Chikwizo A	11
	Chikwizo B	6

Full details of the survey of livestock productivity and of body measurements made on cattle, sheep and goats are given by Hall (submitted a,b).

4 RESULTS

Incidence of ownership

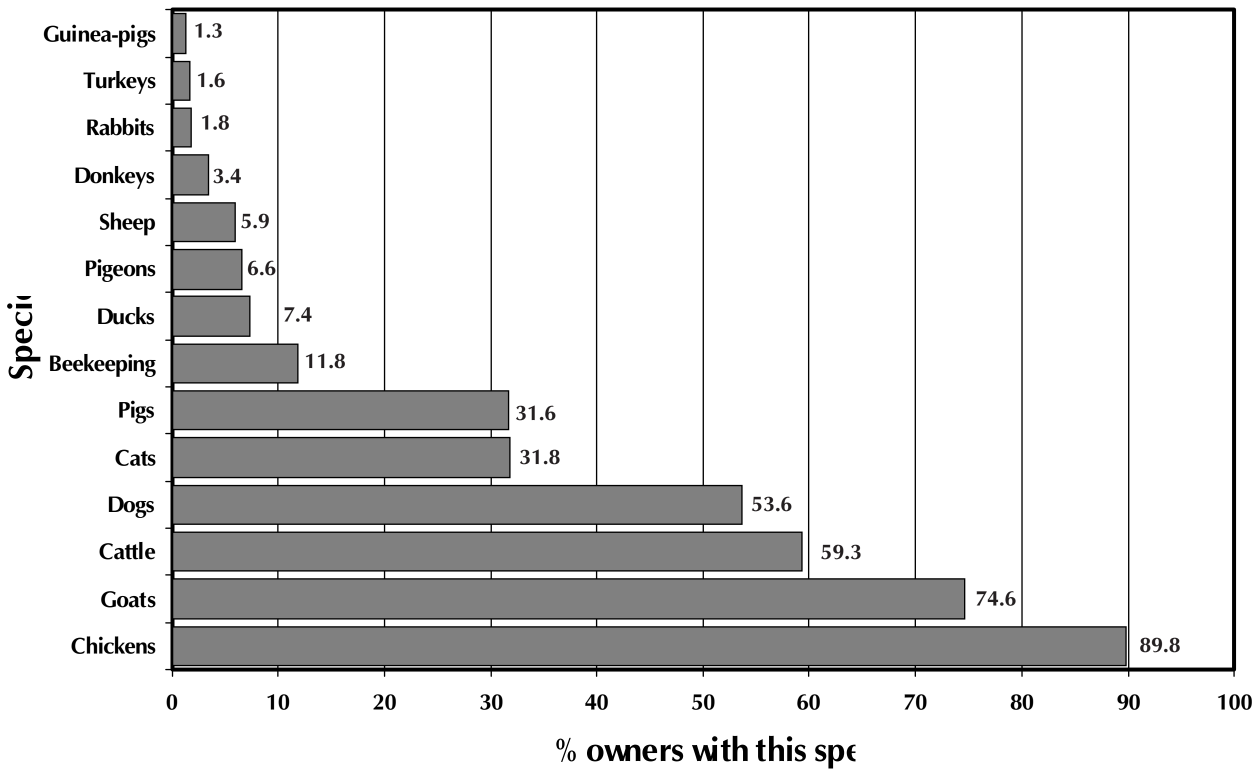
As part of an extensive socio-economic and geographic study of 610 households (Blench, this issue), the percentage of those owning each species was recorded. These are shown in Figure 1.

Functions of livestock

Cattle: All respondents gave draught power as the primary function of cattle. Bride price (the current rate is between four and twelve heifers) and sale for cash were also important. School fees were a major concern; the approximate equation is that two or three cattle will pay for secondary education for one child (i.e. from Form 1 to Form 4, corresponding to education to O-level standard). Provision of manure was also considered important, and of milk, less so.

Goats and sheep: Goats were kept as a source of family meat and of ready cash. A bride price may also include a female goat as a gift for the mother-in-law. No respondent drank goat milk though all were aware of the practice. Sheep were kept primarily for sale.

Figure 1. Frequency of ownership of livestock species in the Rwenya Basin, May–June 1997



Donkeys: Donkeys were kept by one respondent in Rwenya South, and they were kept in five of the six villages visited in Rwenya North (in one of them, since 1942). Generally donkeys were used to pull carts or carry panniers and only occasionally for cultivation. In the survey area, the use of donkeys is fairly limited, probably due to the high tsetse challenge in wards close to the RWMA. However, further north, along the Kotwa-Nyamapanda road, donkey-carts are very common, as are pack-donkeys. Donkey-tillage is reported.

Pigs: Primary reasons for keeping pigs were as a supply of meat for the family and as a potential source of ready cash. Respondents stated that in their villages pigs were also kept by women and by people with no other livestock.

Husbandry systems

The husbandry systems are dominated by the requirement to pen the animals in their kraals every night. Kraaling protects animals against predators and makes possible the collection of manure. However, it restricts grazing time (goats: Nyamangara and Ndlovu, 1995; cattle: Scoones, 1995) and confinement often leads to conditions ideal for the spread of disease (Monicat et al, 1992).

Cattle: The same husbandry system applies in both Rwenya South (RS) and Rwenya North (RN); cattle are kept in wood-fenced kraals every night and are taken out to pasture or to the fields every morning, year round. Calves up to the age of 6 months are kept in a hut all day, often with sheep or goats. They are released to suck the dam in the morning and the evening. The dam may then be milked in the presence of the calf and the calf is then returned to the hut. Calves receive neither food nor water during the day. Grazing cattle are supervised by the owner's children (of primary-school age) at weekends and during school holidays. Whether older children look after the cattle depends on whether they are needed for other work. In RS, three respondents each employed a herdsman, two of them all year round. In RN, eight employed herdsmen, all but one of them year-round.

Goats and sheep: One respondent had a special enclosure of about 0.2 ha for sheep where they were kept all year round. They ate the grass growing there and were also brought water in buckets (three times a week), crop residues, crushed maize (on occasion), surplus vegetables, and browse cut from trees. The same owner also kept goats tethered near his grinding mill and fed them on sweepings and waste from it. However all other owners employed the same system, namely the year-round extensive grazing of sheep and goats in company with the cattle.

Pigs: Pigs were kept by nine respondents in RS and by two in RN. Typically they were kept in small thatched huts close to those housing sheep, goats and calves. Three respondents in RS allowed the pigs to roam free after harvest (June-November), but the other three, and both respondents in RN, kept the pigs in confinement all year round. Mating is by boars met opportunistically at pasture, or in the case of pigs kept in confinement, a boar may be borrowed (some respondents had also owned a boar at one time). No pigs had water continuously available. All pigs were fed on maize waste and most were given crushed maize and pumpkins (these items are used for human consumption up to

February and thereafter given to the pigs when no other foodstuffs are available). One respondent in RN owned a piggery in RS which comprised six sties; these pigs were confined all year and were fed on crushed maize, pumpkins and concentrates purchased in Harare. This owner had a very large family and most of the pigs produced were slaughtered for home consumption.

Rabbits and guinea-pigs: Rabbits were kept by several of the farmers interviewed. They are a recent introduction and local schools seem to be the main source of breeding pairs. A few farmers who owned guinea-pigs were also encountered.

Chickens: Chickens are all said to be 'native' breeds, although their phenotypic diversity suggests substantial introgression from exotic strains. There is no large-scale chicken or egg production for lack of a market. Chicken feed is usually heavily supplemented with grain.

Pigeons and other poultry: Keeping domestic pigeons (Columbia livia) is a well-established practice throughout this region. Florcks of up to one hundred are often seen. Columbaria are usually constructed on tall platforms. They resemble small dwellings with entrance and exit holes for the pigeons. The pigeons are fed on sugar-water and grain. They are not usually brought to market. Muscovy ducks and turkeys are kept by some farmers, although not in large numbers. Geese were introduced at some time in the past, but it seems they are not kept today.

Beekeeping: Just over 10% of the households in the region are actively engaged in beekeeping. Beekeeping seems to be a traditional practice in many miombo woodlands in eastern and southern Africa (see Fischer (1993) and references therein). The hives are made from hollowed logs sealed with mud. This practice has declined markedly in the last decades, both for lack of a market for honey and because children going to school have declined to carry on the tradition. Modern beekeeping is little-known, but the NGO BUN-Zimbabwe has carried out training for individuals to spread new systems and practices in Mudzi district.

Feed and water

After August in each year, when grazing becomes scarce, farmers supplement the diet of their cattle with browse or crop residues (maize stover and groundnut straw) or both. In RS, two gave only browse, six only crop residues, and six gave both. In RN, one gave neither, two gave crop residues only and thirteen gave both. The most widely favoured browse species was the sausage tree (*mubvewe* i.e. *Kigelia africana*), but six other species were specified, including *Leucaena* by one farmer in RN. In RS, therefore, 8/14 farmers gave browse to their cattle and in RN, 13/16; these proportions do not differ ($chi^2 = 2.07$, p NS). In RS, 10/12 owners supplemented the diets of goats with crop residues or browse, and in RN, 7/16; these proportions differ significantly ($chi^2 = 4.72$, $p < 0.05$).

Generally, the forage resources available to free-ranging livestock in the communal lands of Zimbabwe are not adequate throughout the year (cattle: Francis and Ndlovu, 1995; goats: Nyamangara and Ndlovu, 1995). While the use of stored crop residues to supplement the diet of cattle is well known, as are their willingness to browse, to eat cut browse and to forage for crop residues in fields (Scoones, 1995), the practice of giving cut browse and crop residues to goats as noted here has not previously been reported.

Work animals

In Rwenya South, seven farmers used their own oxen to meet all their traction requirements and another two used bulls as well as oxen. The remaining seven used a variety of approaches. These comprised hiring a pair (span) of oxen to draw one's own plough, borrowing an ox from neighbours to span with one's own single ox, or spanning one's single ox with a cow, almost always a non-lactating (dry) cow. One farmer had one ox which he spanned with a dry cow to plough, and one male and one female donkey which were occasionally spanned for ploughing but which were more often used to carry produce in panniers. The female donkey did not work when she was lactating. Farmers who had experience of donkeys said that they were as strong as oxen but could not work for as long.

Table 2 shows the incidence of different categories of tillage and draught animal power in the survey area recorded by the large socio-economic survey:

Table 2. Tillage options and draught animal power in Rwenya

		n=610
	No. of farmers	%
Hire tractor?	19	3.1
Hire ox-plough?	199	32.6
Have ox-plough?	3505	7.4
Scotch-cart	62	10.2
Donkey-cart	4	0.7

Current purchase prices for a Scotch cart, (an animal-drawn cart, usually with four wheels and partially factory-made) range up to about Z$2,000 and for a home-made cart Z$1201. Scotch carts are purchased mainly in Harare and are transported, complete with wheels, tyres and pole, on the roof of buses. The hire charge for a cart and oxen is about Z$25 for half a day.

There was a strong disinclination to use lactating cows for work, and also a lack of interest in donkeys which was surprising in view of the accepted resistance of this species to disease and drought. It appears the donkey is not seen as a multiple use animal in that its meat and milk are not valued. Donkeys are not used as currency in bride price transactions.

Marketing

In Rwenya South the parastatal Cold Storage Commission (Colcom) purchases cattle for slaughter elsewhere. Colcom does not purchase in Rwenya North, though private buyers call at farms in search of cattle or may send word round that they will be in attendance at a particular dip tank. They may bring their own lorry or simply hire people locally to herd the cattle away.

In RS, all fourteen respondents could provide details of their most recent sales of animals. For one the most recent sale was that of a cow in 1984. The others gave details of sales back to 1992. These comprised 20 cattle, 14 sheep (including one batch of ten animals), 17 goats, one boar and one old sow. In RN, sales were of 23 cattle, 6 sheep, 30 goats and 8 pigs (three for slaughter and five for breeding). Of the cattle sales in RN, ten were to Colcom, six to private buyers and four (all heifers) were to local people for breeding. Of the cattle sales in RN, 21 were to private buyers and two (one bull for breeding and one cow for slaughter) were to local people.

There was no difference in the price of goats between Rwenya South and Rwenya North. Goat sales are reported in Table 3.

Table 3. Purchasers of goats sold by respondents in recent years

	Rwenya South	Rwenya North
Private buyers	9	4
Local people	8[1]	26[2]

[1]of which 4 for slaughter and 4 for breeding

[2]of which 17 for slaughter and 9 for breeding

The proportion of sales of goats which were to private buyers was significantly ($chi^2 = 8.51$, $p < 0.01$) higher in RS than in RN.

Tables 4a and 4b show the prices of various livestock. In the case of the more minor livestock, the number of responses was small.

The differences in price within and between species are of especial interest, and it is striking how variable some prices were (shown by a high coefficient of variation). This variability implies an uncertainty as to how much animals other than cattle, goats and probably chickens are worth, which is consistent with the finding from other evidence that marketing is not well developed. The normal price for donkeys, Z$300 in May 1997, can be compared with prices in 1992/93 (Hagmann and Prasad, 1995) when 'prices tripled ... from approximately Z$100 to Z$300 to 400' after the drought. Again, that such a fluctuation should be observed is evidence of a lack of close coupling between supply and demand.

Table 4b. Current local prices (Z$) of other livestock, May 1997

	mean Z$ (CV when calculated)
Pigs	
Adult male	338 (62)
Adult female	205 (100)
Young pig	49 (32)
Donkeys	
For work	300
Rabbits	
Per adult	25–30
Chickens	
For meat	15–30 (5 estimates)
Pigeons	
Per pair of adults	10 (2 estimates)
Turkeys	
For breeding or slaughter	85,150 (2 estimates)

Government services

The general impression was that government support for livestock in the Rwenya area was not generous, although the services that were provided were efficiently performed. The dipping of cattle was clearly an established routine and there were no reports of any shortcomings. The personnel who staff the dip tanks, and the veterinary officers, were well spoken of.

Marketing services: In Rwenya North, fourteen of the sixteen respondents (87.5%) said that for Colcom to extend its activities into this area would be of benefit; in contrast in Rwenya South six of the fourteen respondents (43%) said that further help with marketing was needed. Livestock owners would clearly welcome an extension of the activities of Colcom. Sikosana (1992) described how in 1986 Colcom did start buying goats from the Communal Lands, one reason being to encourage farmers there into the cash economy. It seems as though this was not done in the Rwenya area.

Veterinary services: All livestock owners took their cattle to the local dip tank where up to 2,000 cattle per day are dipped in Decatix solution which kills ectoparasites

Table 4a. Current local prices (Z$) of goat, sheep and cattle in May 1997

	Goats		Sheep			Cattle RS		Cattle RN	
	mean Z$	CV*	mean Z$	CV*		mean Z$	CV*	mean Z$	CV*
Adult male	127	21	199	41	Bull	2267	34	1650	41
Breeding female	125	22	139	31	Ox	2796	35	2042	21
Old female	127	18	159	37	Old cow	1291	32	1678	27
Young female	90	22	92	19	Heifer	1570	30	1573	22
Young male	88	15	98	21	Young bull	1414	30	1388	22

* coefficient of variation

and is believed to repel tsetse flies. Dipping is weekly from December to March, then fortnightly until August, then monthly until December. It is under the supervision of a dip tank attendant and, periodically in Rwenya South, the veterinary officer who is based in Ruangwe is in attendance although this is difficult because he has no personal transport. It was not clear which, if any, veterinary staff visited dip tanks in Rwenya North. Other veterinary staff may attend occasionally to collect blood samples. Until about 1980 the government levied a poll tax on cattle (Z$3.50 per head); this was abolished but reinstituted in 1996 avowedly to defray the costs of dipping. The dip tank assistant is the main source of advice on veterinary problems and drugs can be purchased from the veterinary officer, and from general stores in Kotwa or other towns. Village shops in Gozi, Fombe and Nyamande did not stock veterinary drugs. The veterinary service generally operates on a partially privatised basis. Whether dip tank attendants are expected to notify higher authority of any cases of serious infectious disease such as foot and mouth or rinderpest was not clear; the impression was received that notification usually does not occur, at least in Rwenya North.

Extension services: The Zimbabwe Agricultural Technical and Extension Services Department (AGRITEX) is active in Ruangwe but only concerns itself with crops. No respondents mentioned any provision of livestock extension services in the area, although the deceased husband of one respondent had attended courses in Nyanga. Dip tank attendants had been on training courses.

Constraints on production

The most frequently cited problems with the five principal livestock species were disease generally or specifically, water supplies, tsetse flies and distance to pastures.

Government restrictions: No government restrictions hampering livestock production were mentioned. Although the special status of the RWMA was understood there was no evidence that anyone felt unable to exploit this resource as a result. Arguably the presence of the minefield along the Mozambique border is the responsibility of government, but no-one felt that removal of the minefield would benefit them, as removal would encourage grazers to come from Mozambique and bring diseases from areas where there is no effective veterinary control.

Water resources: There was much variation in the difficulties encountered by herders in getting water for their stock. Some respondents had adequate water locally available all year round while others had to walk their herds up to 15 km each way daily to water at the Rwenya or Gairezi rivers.

Drought of 1991–92: Responses from village chiefs on the mortality of cattle during this drought also revealed considerable local variability. In Rwenya South, the consensus was that everyone lost many cattle; the proportion stated by one chief was 65%. In Rwenya North, there was more variability. One respondent in Chikwizo B had driven his cattle to the Rwenya and had had to leave them there. He lost several, apparently to hyaenas. Conditions seemed to have been less arduous in Chikwizo A where the local ward councillor said that during the drought some herds had come into the area from the vicinity of Mudzi; this did not lead to friction and some of these herds remained in the custodianship of local residents who were allowed to use the manure and draught power of these cattle in payment. Livestock deaths during the drought seemed to have been precipitated not by water shortage or disease but by starvation due to lack of forage, or to exhaustion caused by the long treks. There did not seem to have been a disproportionate loss of any particular class of stock. It was striking how some herds were less affected by the drought than others, although everyone lost some animals. That mortality can show local variation of this kind was also found by Scoones (1992).

Predation: Three respondents in Nyanga Ward 2 specifically mentioned wild animals as a problem. In both areas there is anecdotal evidence of predation on livestock. During the visit crocodile spoor was seen beside a dam in Chikwizo A and very recently a crocodile had been shot there by the wildlife authorities after complaints that it had been eating goats. Also during the visit reports were current of three lions being observed in the middle of Chikwizo A, about 3 km from the village of Gozi. On two occasions during the visit birds of prey were seen to attack poultry. Of the 96 goats and 66 calves whose deaths were reported in female case histories, baboons accounted for five goats and hyaenas for three goats and four calves.

5 DISCUSSION

Many studies (e.g. Scoones, 1992; Muchena *et al*, 1995; Bosman *et al*, 1997) have considered the functional significance and economic value of livestock in non-pastoral economies in sub-Saharan Africa. The present study is in agreement with the thesis that cattle are mainly kept for work purposes and that milk, manure and the possibility of a sale for cash are secondary. Although the sale of milk, whether fresh or soured, is a significant source of income to, for example, pastoralists in West-Central Africa, sale of milk in Zimbabwe seems to be rare (Mutukumira et al, 1995). Perry et al (1987) sampled a total of 222 cattle producers in Mashonaland and found only one farmer in the survey selling milk (hand-milking was practised by 102 farmers; the others did not milk at all). The other outputs from cattle, work and manure, are generally not considered as income-generating, even though ploughs and carts are occasionally hired out.

If the income generated from domestic livestock keeping were to be sufficiently high and reliable, local pople in the Rwenya valley would be less likely to make incursions into the RWMA to hunt (to generate income). It is, however, doubtful that the income generated from livestock keeping or other activities can substitute for hunting income at the present time. Recent studies (for example Campbell *et al*, 1995) have demonstrated the complexity of the trades in non-timber forest products, with commodities being gathered by certain groups of people and marketed by others, and the overall sustainability of the trades being in doubt. It seems unlikely that every hunter will become a rabbit farmer, turkey keeper or milk salesman and perhaps the most that could be achieved is that the traders and middlemen will find the new entrepreneurial activities attractive and the exploitation of non-timber forest resources will revert to being a subsistence activity.

However, the current low level of provision of services to people living near the RWMA may be a hidden advantage. It seems likely that visible and genuine improvement of services to livestock farmers could be linked with a curtailment of access to the RWMA. Some necessary improvements, for example the construction of dams and boreholes, would represent one-off expenses with further maintenance to be covered by a charge levied on the users. Improved veterinary care, within the framework of a veterinary service that is being gradually privatised, might perhaps be financed, in part at least, from the revenues of the RWMA.

A problematic aspect of this potential 'solution' lies in defining the 'catchment' area of the reserve. The proposal is that local people will be persuaded voluntarily to restrict livestock incursions in the RWMA in exchange for improved services. There may be problems, though, if the hinterland of the reserve is not a closed system. In most years, when precipitation is average, the population in the area can be expected to be stable. However, in years of low rainfall, cattle-producers from other communal areas travel long distances with their herds in search of pasture and water. This occurred, for example, during the drought of 1991-92 when large numbers of cattle were driven from other areas to graze in the reserve. As the vegetation and biomass build up in the reserve, these will become increasingly attractive to external livestock owners who are not party to the agreements about non-entry into the RWMA. If the fauna of the RWMA is to be conserved, then some element of policing, at least in the early period of reserve development, would still be necessary.

Consequences of enforcement of restrictions relating to the Rwenya Wildlife Management Area

Currently the RWMA does not function as intended, for the benefit of wildlife. Rather, it serves as a source of water and grazing for neighbouring farmers. If, however, the reintroduction of wildlife into the RWMA is promoted, tsetse control would have to be reviewed as part of the new land use strategy (Koeman *et al*, 1980). Curtailing tsetse control would probably discourage incursions by cattle as the tsetse threat would increase (Reid *et al* (1997). All livestock in the surrounding areas would then be subject to greater challenge from tsetse and this would have to be met by improved provision of veterinary prophylaxis and therapy.

If cattle are excluded from the RWMA, there may be a risk of bush fires until numbers of larger wild mammals have built up. Russell-Smith *et al* (1997) describe how in Australian wooded savanna (rainy season November–March, annual precipitation 1,200–1,500 mm) the removal of water buffalo that have gone back to the wild appeared to lead to an increase in floodplain burning due to the accumulation of litter. Even if the long-term aim is to close the RWMA to domestic livestock, it may be necessary to phase the exclusion of livestock to reduce the risk of the same type of thing happening in RWMA.

As wildlife do build up, there is likely to be increased predation on domestic animals. Stockowners already report kills by baboons, crocodiles and lions; this can be expected to increase if ungulates repopulate the reserve. To a certain extent, the remedy for this is in the hands of producers. They will have to invest more time in preventing attacks during the daytime and strengthening the kraals that protect their stock at night. In the early period of reserve development, as wildlife predation increases, there will be a phase of resentment against the reserve and its philosophy, which will probably lessen as producers take preventive measures (which they are compelled to do in many other locations in Zimbabwe which are adjacent to reserves).

ENDNOTE

1. Z$ = Zimbabwe dollars
(£1 = Z$17; $1 = Z$10 at time of fieldwork)

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