Interfacing Science and Management for the Nylsvley Nature Reserve

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DECLARATION

I declare that this dissertation is my own, unaided work. It is being submitted for the degree of Master of Science at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

Regina Xavier Bestbier

11th day of August, 1998

ABSTRACT

Scientists possess knowledge and access to information that is critical to the management of natural resources, yet all too often this information is not effectively transferred and integrated into the management process. This lack of integration of scientific information into conservation management is a result of the barriers that exist between scientists and managers. Differences in the goals and reward systems of managers and scientists lead to managers feeling that scientists do not produce the "goods" that they require, while scientists claim that managers do not provide the questions for which they require answers. There is also a lack of forward thinking, goal-orientated management. As a result much of conservation management relies on intuitive, *ad hoc* decision-making which leads to a problem-by-problem curative approach (cf. adaptive management) as well as a lack of accountability and evaluation.

The thesis of this study is that to overcome barriers between scientists and managers an interface must be developed between the two groups based on sound technology transfer principles (product development, transfer processes, consensus building, feedback, form and function) and three primary elements - processes (which regulate the functioning of the interface), products (which are developed within the interface) and people (who 'drive' the interface).

The overall aim of this study was to develop an interface to overcome barriers between scientists and managers at the Nylsvley Nature Reserve, Northern Province. Although much scientific information is available for Nylsvley, it was not being transferred effectively to the managers. There were no explicit protocols in place that identified operational goals to achieve the "vision" for the reserve. Also, there was very little 'organisational memory' to enable decision making at Nylsvley because of high staff turnover and poor information records.

The interface developed in this study took the form of an 'objectives hierarchy'. The objectives hierarchy was developed to enable conservation organisations to translate policy (vision) into focused, purposeful action (operational goals), thus ensuring that the management

is more goal orientated and providing scientists with the managers information requirements. This enables the scientists to provide the information that managers require, in the format that is most useful to them.

Linked to the development of the objectives hierarchy for the Nylsvley Nature Reserve was the need for a mechanism to ensure 'organisational memory'. Organisational memory is necessary to ensure continuity in the conservation management decision making environment. Thus a product from the interface was the Nylsvley Management Information System, a prototype computer program which ensures that the managers have access to information relevant for decision-making.

Fundamental to the development of the interface for Nylsvley was the development of informal collegia (networks), with contact inside and outside the conservation organisation. These informal collegia were necessary for overcoming bureaucratic resistence to change, and for building mutual respect and trust which was imperative for the development of a successful interface.

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"Through wisdom a house is built,
By understanding it is established,
By knowledge the rooms are filled
with all precious and pleasant riches."
Proverbs 24:3-4.

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CHAPTER ONE

Introduction

1.1 Introduction

The science of ecology has great potential for generating broad and fundamental understanding about complex natural phenomena as it is an integrative science (Likens, 1995). This ecological understanding can, in turn, provide relevant and critical guidance to the complex and multidimensional conservation decision-making environment (di Castri *et al*, 1984; Falk, 1992; Pringle and Aumen, 1993; Likens, 1995; Lubchenco, 1995; Mangel *et al*, 1996; Christensen, 1997; Rogers, 1997). Unfortunately, much scientific information is not utilised effectively in conservation decision-making (di Castri *et al*, 1984; Nudds and Morrison, 1991; Pringle and Aumen, 1993; Huenneke, 1995; Underwood, 1995; Mangel *et al*, 1996; Peters *et al*, 1997; Rogers, 1997).

Even when geared toward practical ends, ecological research may not produce applicable results, or products, for several reasons: ecologists may be addressing what the managers consider to be the wrong questions (di Castri *et al*, 1984; Cullen, 1990), ecological research does not take sufficient account of the needs and perceptions of the potential uses of the research findings (di Castri *et al*, 1984; Mangel *et al*, 1996; Rogers, 1997), and evaluation and feedback procedures currently in place may not be adequate for shaping future research (di Castri *et al*, 1984; Cullen, 1990; Underwood, 1995) and its contribution to conservation decision-making. The managers might not have the right questions, or any at all. They may also not know how to ask the right questions. The products of this study help them to do that.

While the above is true in many respects, it is also compounded because conservation managers' activities revolve around solving immediate problems (Meffe and Carroll, 1994) and, as such, managers have seldom been forward thinking or strategic in their management (Rogers, 1997). This preference for solving immediate problems has led to "adaptive" management becoming "reactive" management, resulting in the cut off of feedback loops between scientists, managers and policy makers (Rogers, 1997). Ecological ideas have also not been fully embraced by conservation managers as a result of bureaucratic resistance to new ideas and change, and lack of external accountability - which is prevalent in conservation agencies (Underwood, 1995; Peters *et al*, 1997; Rogers, 1997).

There has been increasing recognition that the science of ecology and the processes of management need to be integrated, or serviced by an interface, to overcome the existing "barriers" between scientists and managers. Various strategies have been propounded for overcoming these "barriers" (Cullen, 1990; Pringle *et al*, 1993; Huenneke, 1995) one of which is the development of a structured interface between the two "cultures" (Rogers, 1997).

The managers of the Nylsvley Nature Reserve (24° 39'S, 28° 42'E, Northern Province, South Africa) and the scientists, who have done extensive research on the reserve, have experienced many of these barriers. Thus Nylsvley presented a classical, "text-book" case study for this research into interfacing ecological science and conservation management.

1.2 Objectives and Approach

The overall aim of this research was to develop an interface between scientists and managers to overcome barriers between the two, with specific reference to the Nylsvley Nature Reserve (Figure 1.1). The objectives and approach are presented in a conceptual diagram to facilitate understanding of how the components fit together (Figure 1.1).

It was recognised that to develop an interface between scientists and managers would require the explicit identification of the barriers to linking the processes of ecological scientific endeavour and conservation management. Thus the first objective of this study was to :

1. *Identify barriers between scientists and managers in the general conservation context.*

The barriers identified from the literature review, and the general understanding gained, formed the framework to:

2. *Identify barriers between scientists and managers of Nylsvley Nature Reserve.*

The barriers were identified by means of interviews, informal discussions and personal observations. Once the barriers had been identified, the next objective was to:

3. *Identify strategies to overcome the barriers between scientists and managers.*

Once again a literature review was used to accomplish this objective. During the investigation it was found that managers and scientists need to have direction to interact effectively and a clear set of goals must also be defined for the system under management. Thus the fourth and fifth objectives of the study were to:

4. *Develop a generalised protocol for setting objectives and goals in conservation management*, and then to

5. *Develop an objectives hierarchy for the Nylsvley Nature Reserve.*

An important barrier identified was that there was no explicit mechanism for ensuring organisational memory to ensure continuity of management decision making. To overcome it organisational memory had to be developed thus the sixth objective was to:

6. *Develop a mechanism to ensure organisational memory in the management of the Nylsvley Nature Reserve.*

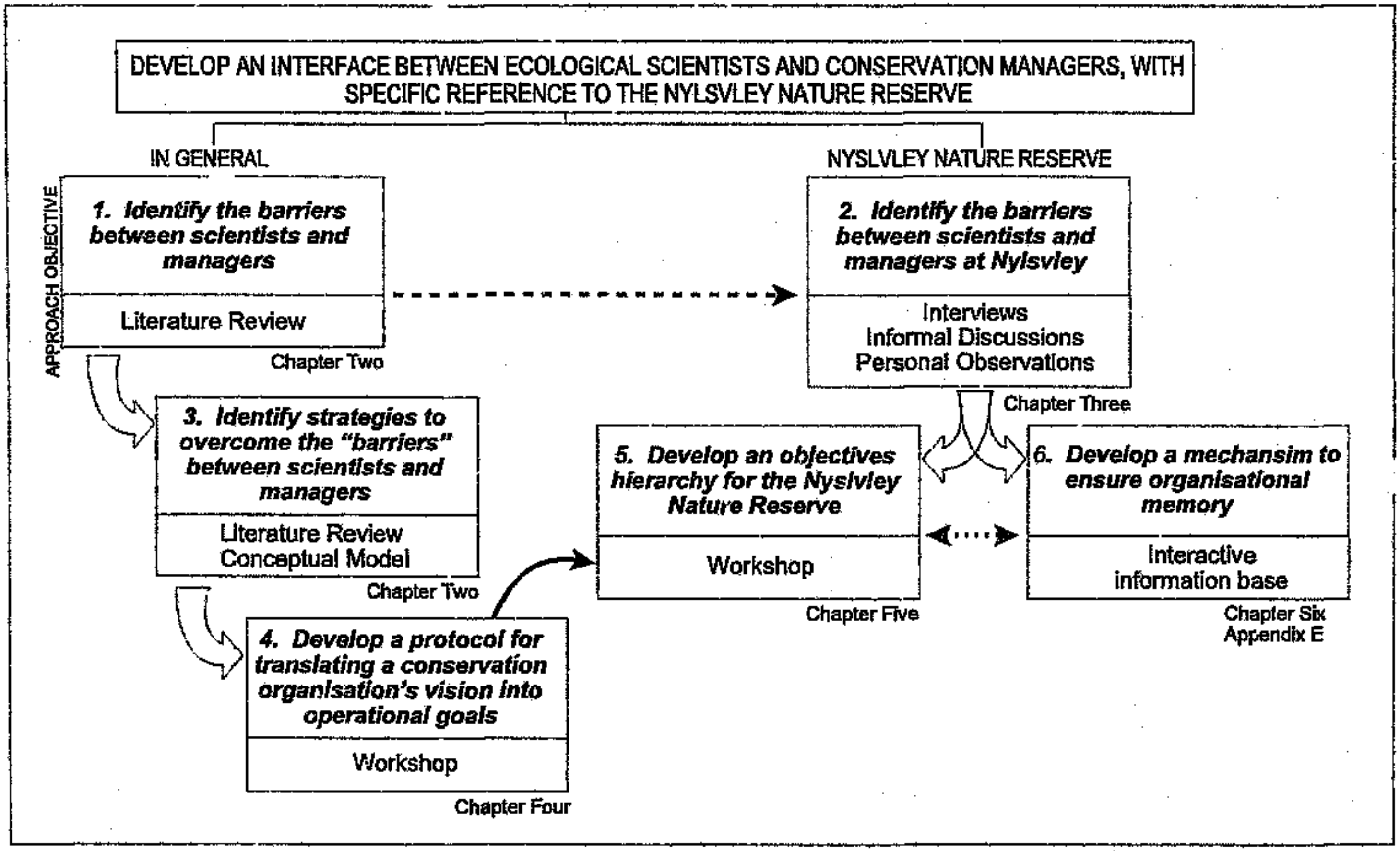

Figure 1.1 The objectives, their relationships to each other and the approaches taken to achieve them in this study. Chapt~ in which each objective is addressed are indicated.

1.3 Structure of thesis

This thesis has two components. The first is this dissertation of the research and the second is an executable computer program. It is recommended that you install the program which is provided on 1.44M disks, and refer to it while reading this thesis to fully understand and appreciate how it fits into the thesis (see instructions in Appendix E).

The dissertation has been structured into eight chapters. Chapters One and Two are the introductory chapters. The study is briefly placed in context and the objectives are stated in Chapter One. Chapter Two is a literatu.. review exploring the relationship between scientists and managers, the barriers between them and strategies to overcome these barriers, with an emphasis on the need for a structured interface. The case study, Nylsvley Nature Reserve, is introduced and described in Chapter Three, highlighting the barriers between scientists and managers in that context.

Chapters Four, Five and Six are the materials and results sections. The interface between scientists and managers is presented and the products, processes and people discussed. The general protocol developed for setting an "objectives hierarchy" in a conservation management context is presented in Chapter Four, while in Chapter Five the specifics of the "objectives hierarchy" for the Nylsvley Nature Reserve are detailed. Chapter Six is an explanation of how a computer program (Nylsvley Management Information System) was developed to service the interface between scientists and managers in the Nylsvley context.

The dissertation ends in Chapter Seven with a discussion of the interface and its potential for wider application.

CHAPTER TWO

Barriers and Bridges Between Scientists and Managers in Conservation

2.1 Introduction

"(Scientists) tend to believe that an understanding of the environment, and the processes going on in it, are fundamental prerequisites to the effective, sustainable management of a natural resource. It disturbs such scientists to find that those charged with managing the resource often do not share this simple act of faith." Cullen, 1990

"Managers often misunderstand science and expect it to deliver a truth that is non-arguable. They fail to understand the very process of science demands no such truths, so assumptions, methods and conclusions can always be challenged." Cullen, 1990

"Managers have much to learn with regard to setting goals and expectations, monitoring and handling data, and scientists require greater understanding of the priorities of, and challenges, to ecosystem managers." Christensen, 1997

"If we as scientists do not use our available energies to bring scientific knowledge to bear on environmental problems - who will?" Pringle, 1997

"It is sobering to contrast the many components and complex interactive processes that ecology has unravelled with the small number and simplicity of the tools (fire, a gun/trap, food, water, earth moving equipment, occasionally money, etc) available to the manager. We face an enormous challenge to convert the complex products of science into achievable goals and implement solutions for pratical conservation." Rogers, 1997

These quotes highlight that, in general, there has been insufficient interaction between scientists and managers, and that ecology has not always been a consistent or major driving force in conservation decision making (Rogers, 1997). Barriers exist between scientists and managers which may have been erected unintentionally (Bennet, 1983), but which are real and have an impact on the way in which natural systems are managed. If scientists and managers are to overcome these barriers they must reach a mutual understanding of their respective roles and operating procedures (Rogers, 1997). If they do not, they will remain isolated in their own "worlds".

Two objectives of this study,

(1) Identify the "barriers" between scientists and managers, and

(3) Identify the strategies to overcome the "barriers" between scientists and managers,

were met by conducting a review of the literature (Figure 1.1). This Chapter presents the pertinent literature. It begins with a contrast of the scientists' world of research and the managers' world of decision-making (section 2.2). Specific "barriers" to developing an effective interface between scientists and managers were identified from this contrast (section 2.3) and then strategies for overcoming the barriers were explored (section 2.4).

2.2 A contrast of the different "worlds" of science and management

Lack of communication and fruitful interaction between scientists and conservation managers can be attributed largely to differences in their culture, mode of operation, goals and reward systems (Table 2.1) (Cullen, 1990; Huenneke, 1995; Mangel *et al*, 1996; Rogers, 1997). To quote Cullen (1990): "without appreciating cultural differences we will continue to be frustrated at the inadequate communication in both directions" and continue operating in different worlds with little satisfactory interaction between the two.

2.2.1. The different cultures

Science is a branch of knowledge conducted on objective principles involving the systematic observation of, and experiment with, phenomena. It is especially concerned with the material and functions of the physical universe (Oxford Dictionary, 1993). Management is essentially about deciding what to do and then getting it done through the effective use of resources (Armstrong, 1990; Coombes and Mentis, 1992; Keeney, 1992). Management is related to, and fuelled by, many disciplines in the social sciences, but it differs from the social sciences in its overarching drive towards practice and its concern with technical knowledge in the widest sense of the word (Westley, 1995).

The goals of science are understanding and, ultimately, prediction through understanding (Popper, 1968; Pickett and Kolasa, 1989), whereas the overall goal of management is the delivery of benefits to some group (Cullen, 1990; Pulliam, 1997a). Management goals might be abstract or generalised (eg. policy) or specific (service delivery) (Cullen, 1990). Scientists and managers operate under different operational modes to attain their respective goals and they have different reward systems for achieving those goals (Table 2.1).

Ecological scientists, in their quest for understanding, generally use the hypothetico-deductive method (cf. inductive method, Kuhn, 1970) (Figure 2.1; Table 2.1) (Popper, 1968; Mentis, 1988; Nudds and Morrison, 1991; Sinclair, 1991; Rogers, 1997). The hypothetico-deductive method uses a strict logical procedure involving three basic steps: 1) observation or induction, 2) hypothesis formation, and 3) experimentation, involving prediction and testing (Mentis, 1988; Pickett and Kolasa, 1989; Nudds and Morrison, 1991; Sinclair, 1991; Rogers, 1997). This method is designed to ensure a highly structured, repeatable search for understanding about nature which periodically overthrows established theories (Mentis, 1988). Thus, although the method is highly conservative, the philosophy behind it is revolutionary (Sinclair, 1991; Rogers, 1997).

Table 2.1 Contrasting the cultures of ecologists and conservation managers (Cullen, 1990; Huenneke, 1995; Lubchenco, 1995; Rogers, 1997).

Component	Ecologist	Conservation manager
Motivation	Search for understanding Questions driven by theory and curiosity	Delivery of benefits to some group
Goals/reward systems	Publishing in reputable peer-reviewed journals Conference presentations Analysis of results Quality of insights Competing for research funding Training students	Adherence to rules and procedure Conformity, error avoidance and attention to detail Achieving goals Problem solving
Financial constraints	Grant funds	Need to accomplish as much as cost-effectively as possible
Time frame/Work schedule	Conform to academic schedules and funding periods	Work quickly Short time frames
Mode of operation	Hypothetico-deductive search for truth about the physical universe Conservatively revolutionary	Pragmatically responsive Passive or adaptive approach Trial and error Reactive

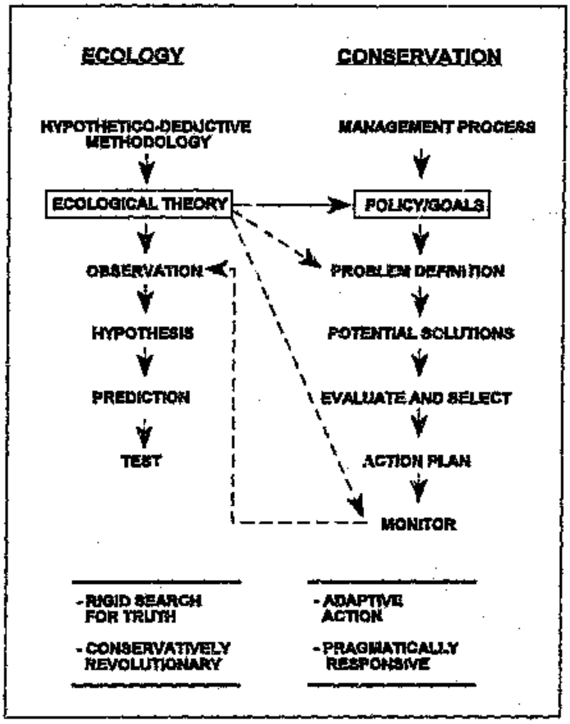

Figure 2.1 A contrast of the modes of operation in the science of ecology and the practice of conservation (After Rogers, 1997). Dotted lines represent information exchanges that must be formalized to promote effective dialogue and technology transfer.

The scientific process involves ongoing testing and self-correction over a long time span (Cullen, 1990). Research findings take a long time to become known and accepted. It takes several years before they are published and often several more years before the findings become part of the body of accepted theory (Bennet, 1983). Conservation managers, on the other hand, must act decisively, and with assurance, within short time frames (Cullen, 1990; Huenneke, 1995; Parrish *et al*, 1995). Most of the managers' day-to-day work is adaptive action and requires highly pragmatic responses to the vast array of events and processes in the systems they must manage (Cullen, 1990; Rogers, 1997).

The prevailing system of rewards (Table 2.1) (Cullen, 1990; Huenneke, 1995; Lubchenco, 1995; Rogers, 1997) is also a consequence of, and reinforces, the different cultures. Research that is immediately useful for management is not usually highly valued in the academic world (Cullen, 1990; Dewberry and Pringle, 1994; Rogers, 1997). Peer rewards, such as funding and publications in reputable journals, are awarded for the ability to select problems that have intellectual difficulty rather than immediate usefulness (Cullen, 1990; Lubchenco, 1995; Parrish *et al*, 1995). Research is an end in itself - a vocation (Bennet, 1983). Data collection has a lower status in science, unless it is to test some hypothesis. Also, higher status and rewards are granted to explanatory theories over empirical models (Cullen, 1990).

Conservation managers, in managing consumptive and non-consumptive use of resources and preserving critical resources (Mangel *et al*, 1996), are rewarded according to the type of management model they follow. Currently conservation management is undergoing a paradigm shift; from a bureaucratic model to a managerial model (Cullen, 1990; Rogers and Bestbier, 1997). Adherence to rules and procedures is more important than the outcomes of management in the traditional bureaucratic model . Thus, rule conformity, error avoidance and attention to detail are rewarded (Cullen, 1990). The managerial model, on the other hand, is characterised by quantifiable outcomes that are more important than following procedure. Goal achievement and problem solving are rewarded in the managerial model (Cullen, 1990; Rogers, 1997).

The above discussion illustrates that the cultures pervading science and management are different. This can, and does, lead to misunderstanding and mistrust between scientists and managers. The generally informal lines of communication are distinguished by a lack of recognisable feedback loops between scientists and conservation managers (Parrish *et al*, 1995; Christensen, 1997; Rogers, 1997). This lack of recognisable feedback loops must be overcome if we are to ensure information transfer between managers and scientists. Furthermore, protocols and procedures must be put into place to make the linkages between the two explicit.

This state of affairs is reinforced by the "strategy of hope" under which many scientists and managers operate. Many scientists work under the assumption that their latest research results will be quickly incorporated into changes in management practices (Bennet, 1983; Peterson *et al*, 1997; Pulliam, 1997b; Rogers, 1997). Realistically, it often takes decades for new scientific information/paradigms to be translated into useful management tools (Pulliam, 1997). Scientists also assume that making information available as reports or journal publications also makes it useful (to managers) (Holdgate, 1984; Underwood, 1995; Seasteadt, 1996; Rogers, 1997). However, to be applied in conservation the results of peer-reviewed publications often need major transformation (Peterson *et al*, 1997; Rogers, 1997) and mechanisms must be formalised to identify and modify research to make it relevant to managers (Bennet, 1983).

Managers, on the other hand, even if they are familiar with the recent literature, may not see how new paradigms will help them manage. Managers are rewarded for achieving results, not for testing new theories, therefore they are often unwilling to give up a proven method to try a new unproven one (Pulliam, 1997b). Often managers assume that the decisions they make with imperfect, incomplete and unscientific information are generally acceptable, indeed they take pride in doing so! The conservation management culture is one which does not encourage quantitative evaluation and accountability (Cullen, 1990; Peters *et al*, 1997; Rogers and Bestbier, 1997). Some authors feel that the poor use of scientific information in conservation management often results from a lack of interest or unwillingness (Franklin, 1997), however suitable communication and exposure to researchers' work can awaken interest (Bennet, 1983). Although some managers may be keen to incorporate research findings into their work they make little progress as they do not know where to search for and find the information (Bennet, 1983), or they lack the time to read research reports and journals (Bennet, 1983; Kruger, pers comm). Day-to-day problems are seen as so pressing that reading research reports or journals is regarded a luxury (Bennet, 1983).

In summary, the differences in the "worlds" of managers and scientists have led to the following barriers: poor communication, mistrust, a lack of or inappropriate mechanisms for using and driving research relevant to management, and the inability to locate relevant research. All these can be couched in the term "strategy of hope" - the hope that "things will happen" without the appropriate investment of time and effort to ensure that they do happen. Conscious effort must be put into developing and sustaining an exchange of information which both groups recognise as having value to overcome the "strategy of hope", (Breen *et al*, 1994; Barrett and Barrett, 1997; Rogers, 1997). This may require breaking down long standing and rigid organisational, professional and personal barriers (Mangel *et al*, 1996; Christensen, 1997), as well as changes in the modes of communication and changes in the reward systems of managers and scientists (Christensen, 1997).

In the past, ecologists' efforts were concentrated on research for the purpose of providing a sound scientific base (understanding) for informed decision making. Less attention has been directed towards ensuring the transformation and exchange of information between scientists and managers. The result has been an unsatisfactory level of incorporation of research findings into management, and of management realities and needs into research (Cullen, 1990; Breen *et al*, 1994; Underwood, 1995; Mangel *et al*, 1996). Good research and development organisations know that to avoid this, vigorous and often structured information (technology) transfer systems must be instituted (Van Vliet and Gerber, 1992; Rogers, 1997). If ecology is to move beyond the "strategy of hope" it too must have an explicit avenue for information transfer to, and from, conservation managers (Rogers, 1997).

Ecological research and conservation management are two distinct processes which have their own identities, therefore a pragmatic interface to link the two is needed (Rogers, 1997). The development of an effective interface between scientists and managers is necessary to overcome the existing impasse between scientists and managers (Pringle *et al*, 1993; Christensen, 1997; Rogers, 1997). However, if an effective interface between the two is to be developed, an understanding of how the science of ecology can contribute to conservation management (section 2.2.2) is necessary, as well as an understanding of the conservation management context (section 2.2.3).

2.2.2 How can science contribute to conservation management?

It is increasingly being recognised that all conservation problems have scientific, social and economic aspects. Science is therefore only one part of conservation and is limited in what it can contribute (Thomson, 1986; Cullen, 1990; Brussard, 1991; Schrader-Frechette and McCoy, 1993; Gunderson *et al*, 1995; Huenneke, 1995; Parrish *et al*, 1995; Underwood, 1995; Adams and Hariston, 1996, Mangel *et al*, 1996; Rogers, 1997). Science provides basic knowledge about the world and offers ways to gain additional information and insight. What science can, and cannot, do must be clearly communicated to managers. Ecological science, for example, can be used to set boundaries of activities consistent with conservation goals, including the uncertainty of those boundaries (Christensen, 1997), but science cannot dictate where society should operate in the structure. Science can tell us about the likely biological outcomes of a management decision or action, but not which outcome we should value more highly (Adams and Hariston, 1996; Mangel *et al*, 1996).

Science can contribute towards conservation management in five main areas (Cullen, 1990):

Description — Inventory of what exists in the system and identification of the key processes and functions (Cullen, 1990; Sutherland and Adams, 1992; Breen *et al*, 1994; Underwood, 1995; Peters *et al*, 1997).

Diagnosis — Analysis of past environmental damage and the present condition of the resource/system. Identification of environmental and conservation problems, including causes and consequences of ecological disturbance (Cullen, 1990; Pringle *et al*, 1993; Breen *et al*, 1994; Underwood, 1995).

Prediction — Assessment of the capability of the resource/system to support various functions. Identification of possible hazards, special values and probable ecological effects of specific resource uses (Cullen, 1990; Pringle *et al*, 1993; Breen *et al*, 1994; Underwood, 1995; Christensen, 1997).

Prescription — Recommendations on the requirements to maintain the resource within acceptable limits of change (Bell, 1983; Cullen, 1990; Pringle *et al*, 1993; Breen *et al*, 1994; Underwood, 1995; Christensen, 1997).

Implementation — Advice in formulating management actions. Routine measurements or monitoring to provide a feedback loop for management in evaluating the efficacy of management actions (Bell, 1983; Miller and Child, 1983; Cullen, 1990; Breen *et al*, 1994; Underwood, 1995; Adams and Hariston, 1996; Christensen, 1997; Peters *et al*, 1997).

These scientific inputs are necessary for effective conservation management (Adams, 1993; Breen *et al*, 1994; Parrish *et al*, 1995; Rogers, 1997), but they in themselves are not enough. Scientists must understand what ecological paradigms influence conservation management, what management approaches and processes are being used in conservation management as well as the organisational dynamics of conservation organisations for ecological science to become more relevant to conservation management and for scientists to participate more effectively (Pringle *et al*, 1993; Underwood, 1995; Adams and Hariston, 1996; Mangel *et al*, 1996). Such an understanding will enable the development of an interface that is based on sound management practices and solid scientific information.

2.2.3 Conservation management context

Investigating the conservation management context reveals other barriers, other than that of the "strategy of hope", that must be overcome to ensure that managers and scientists interact effectively.

- **Ecological paradigms and management approaches**

Historically, and to a large extent today, conservation has been based on the "balance-of-nature" ecological paradigm (Pickett *et al*, 1997). According to this classical equilibrium view point any object or unit of nature of ecological interest was considered worth conserving because natural systems were assumed to be closed, static and fixed (Barrett and Barrett, 1997). Conservation under this equilibrium paradigm typically required an appreciation of nature, but little or no ecological understanding.

Valued objects of our ecological heritage were, and are, enclosed within separate and often arbitrarily defined "natural" areas (Barrett and Barrett, 1997). The belief was that such natural areas, if left alone, could persist indefinitely (Meffe and Carroll, 1994; Lajeunesse *et al*, 1995; Rogers, 1997). This passive management involved the protection and preservation of these natural areas with minimal human intervention (Miller and Child, 1983; Roger , 1997).

Ecologists soon realised that such simple conservation measures were not always adequate (Barrett and Barrett, 1997). Most protected areas are "wilderness islands" in a strongly human-modified environment. Their boundaries cannot protect them from threats originating outside, such as pollution and conversion of adjacent lands for development, among others (Meffe and Carroll, 1994; Lajeunesse *et al*, 1995; Barrett and Barrett, 1997). Even natural changes (i.e. succession and natural disturbances) invariably impacted the preservation status of the conserved elements of interest, be it a species or an ecosystem (Barrett and Barrett, 1997). A strictly hands-off management approach amounted to no less than benign neglect in such cases. Conversely, as Barrett and Barrett (1997) express it "attempts to manage for biological diversity by isolation amounted to no more than managing for biological antiquity".

Where there has been some "active", as opposed to passive, management it has focused almost exclusively on controlling species populations to preserve the state of the conserved area or a single species (Smith *et al*, 1993; Cortner and Moote, 1994; Meffe and Carroll, 1994; Rogers, 1997). Active management is often concerned with the enhancement, use and manipulation of the system (Miller and Child, 1983; Rogers, 1997) to keep it in "balance". Sometimes active management has been so successful in controlling an ecological variable that normally fluctuated that it has led to more spatially homogenised ecosystems over landscape scales (Holling, 1995). This can led to systems changing into a persistent degraded state, triggered by disturbances that previously could be absorbed.

Traditionally, much of conservation management has relied on intuitive and *ad hoc* decisions (Steedman and Haider, 1993; Meffe and Carroll, 1994) simply because of the multiplicity of decisions conservation managers make in a single day, ranging from preventing trail erosion to resolving conflicts with neighbouring landowners (Meffe and Carroll, 1994). This problem-by-problem curative approach (Lajeunesse *et al*, 1995) is highly reactive and often leads to the mismanagement of resources (Lajeunesse *et al*, 1995; Parrish *et al*, 1995). For example, in many cases the suppression of fire in nature reserves has changed the relative abundances of plant species, increased their densities, or caused other structural and compositional changes that increase the probability of disease, fire and loss of indigenous species (Peters *et al*, 1997).

Accumulating ecological evidence at odds with the traditional equilibrium paradigm is beginning to dispel the notion of the "balance-of-nature" as a justifiable foundation for conservation practice (Barrett and Barrett, 1997; Pickett *et al*, 1997; Rogers, 1997). The recognition that ecological systems are often open to external control, non-deterministic, rarely at equilibrium (Allen and Hoekstra, 1992; Holling, 1995; Ostfeld *et al*, 1997) and heterogenous in nature (Kotliar and Wiens, 1990; Wu and Loucks, 1996) has precipitated a shift in ecological paradigms (Figure 2.2) (Pickett *et al*, 1997). This non-equilibrium viewpoint, typified as the "flux-of-nature" (Fiedler and Jain, 1992; Wu and Loucks, 1996; Pickett *et al*, 1997) paradigm, offers a prospective basis for contemporary conservation management.

Ecological heterogeneity over spatial and temporal scales forms the basis of the new paradigm of "flux-of-nature" (Pickett *et al*, 1997; Rogers, 1997). If we accept this, it demands a change in focus from species management to providing context for the interactions of species with all the components of the landscape i.e. "ecosystem" management (Grumbine, 1994;

ECOLOGICAL PARADIGMS

THE OLD	THE NEW
BALANCE OF NATURE	FLUX OF NATURE
HOMOGENEITY	HETEROGENEITY
SPECIES FOCUS	LANDSCAPES → GENES
ECOSYSTEM FUNCTIONING IMPLICIT CONSEQUENCE OF POPULATION CONTROL	ECOSYSTEMS, HETEROGENEITY AND FLUX TO BECOME EXPLICIT AND ACHIEVABLE GOALS

Figure 2.2 A contrast of the "old" and "new" ecological paradigms (After Rogers, 1997).

Ecological heterogeneity over spatial and temporal scales forms the basis of the new paradigm of "flux-of-nature" (Pickett *et al*, 1997; Rogers, 1997). If we accept this, it demands a change in focus from species management to providing context for the interactions of species with all the components of the landscape i.e. "ecosystem" management (Grumbine, 1994; Christensen, 1997; Rogers, 1997). This change in focus also recognises that ecological and social systems are inherently more dynamic and unpredictable than was first imagined. Surprise is inevitable as the system itself is a moving target (Holling, 1995; Gunderson *et al*, 1995; Christensen, 1997).

Ecosystem management involves the maintenance or recovery of biological diversity and places greater emphasis on conserving fundamental ecosystem processes (Smith *et al*, 1993; Cortner and Moote, 1994; Grumbine, 1994; Czech, 1995; Galindo-Leal and Bunnell, 1995; Lajeunesse *et al*, 1995; Sparks, 1995, Wear *et al*, 1996; Christensen, 1997). Ecosystem management is not a strategy for eliminating uncertainty, which is inevitable in managing ecosystems, instead it acknowledges its inevitability and accommodates it (Christensen, 1997). Given the uncertainties, it is essential that the management systems be adaptable (Holling, 1995; Gunderson *et al*, 1995). As Holling (1995) expresses it "learn to manage by change, rather than simply to react to it". This approach to conservation management has been widely advocated for the last two decades and is known as "adaptive management" (Holling, 1978; Walters, 1986).

■ Adaptive management

Originally adaptive management was intended to be an inductive approach utilising comparative studies that blend ecological theory with observation, with the design of planned interventions in nature and with human response systems (Holling, 1978; Walters, 1986). Adaptive management has been adopted in theory throughout the world for nearly 20 years, however it has seldom been successfully translated into practice in the form originally intended by its early proponents (McLain and Lee, 1996; Walters, 1997) - this is especially so in Africa (Rogers and Bestbier, 1997).

Although adaptive management systems should be adaptable to variation in the environment (including impacts and needs of humans) from location to location, they should also be adaptable to inevitable changes in those environments through time (Walters and Holling, 1990; Haney and Power, 1996; C istensen, 1997). These management systems should acknowledge the provisional nature of existing models and information bases and be adaptable to new information and understanding.

The realisation is growing that to be adaptable and accountable, management goals must be stated in explicit operational terms (Coombes and Mentis, 1992; Christensen, 1997; Rogers, 1997), informed by the best available models and understanding of ecosystem function, and tested by carefully designed monitoring programs that provide accessible and timely feedback to managers (Haney and Power, 1996; Christensen, 1997; Rogers, 1997). Conservation management must have organisational structures and processes which can be adapted in the face of changing information about how the organisation and ecosystems operate to ensure that this happens (Christensen, 1997; Rogers, 1997). Managers cannot defend their actions in open, transparent governance systems (Rogers and Bestbier, 1997), and it is difficult to incorporate research into the management context without explicit goals. Thus, a forward planning, strategic component must be more formally incorporated into adaptive management systems to ensure acceptability and accountability (Parrish *et al*, 1995; Rogers and Bestbier, 1997).

The concept of setting goals is explored further here, before the organisational dynamics which operate in conservation organisations are discussed.

Setting goals. A central principle or theme of ecosystem management is that it requires explicit operational goals to be set (Haney and Power, 1996; Christensen, 1997; Rogers, 1997). Identification of the vision and objectives should be the first step in the decision framework (Ackoff, 1970; Armstrong, 1990; Coombes and Mentis, 1992; Keeney 1992). Apparently, this is obvious, yet observation of the current practice in conservation management indicates otherwise (Coombes and Mentis, 1992; Reckhow, 1994; Christensen, 1997). Currently too little time is spent identifying and agreeing on objectives and goals (Reckhow, 1994).

Goals must be well defined because they influence the way information is organised and how problems and potentials associated with ecosystem management are perceived (Haney and Power, 1996). Therefore, it seems that emphasising the need for an effective interface between scientists and managers without considering well defined goals for management would be counterproductive (Angermeier and Karr, 1994). The managers' clarity of vision for the managed system is critical for the success of the interface between scientists and managers because if managers do not have a clear vision and operational goals, how can the scientists contribute effectively to the conservation decision making process? Clearly stated objectives and goals for conservation management enable scientists and managers to interact effectively in defining the information required to achieve those objectives and goals.

Goals cannot be set in isolation as they are dependent on the vision and objectives of the management body (Blackmore, 1995) and other stakeholders. They should reflect the information gathered during exchanges with stakeholders, including socioeconomic and cultural considerations (Haney and Power, 1996). The business literature abounds with methods for setting goals (Ackoff, 1970; Keeney, 1992; Kaplan and Norton, 1996; Maser, 1996) ranging from informal approaches (Maser, 1996) to more formal one such as Keeney's (1992) value focused approach. A common thread is their hierarchical nature, with the broader, more strategic statements of intent at the top and the operational end-points at the bottom of the hierarchy.

Different disciplines and people use terms such as objectives, goals, mission or vision differently (Ackoff, 1970; Keeney, 1992; Maser, 1996). Goals, to some, are the broadest category at the top of the hierarchy but to others goals are tightly defined at the bottom of the hierarchy. The Harvard school of thought (Keeney, 1992; Kaplan and Norton, 1996) which is prominent in the business world places objectives at a higher level than goals.

Conservation goals. The central or general goal of conservation, if one accepts the ecosystem-based approach to management is one of maintaining ecosystem integrity (McNeely *et al*, 1990; Grumbine, 1994, Mangel *et al*, 1996). Other more specific goals are maintaining viable populations, ecosystem representation, maintaining ecological processes (i.e. natural disturbance regimes), protecting evolutionary potential of species and ecosystems, and accommodating human use in light of these (Owen-Smith, 1988; McNeely *et al*, 1990; Smith *et al*, 1993; Grumbine, 1994, Mangel *et al*, 1996).

Conservation goals should be defined for structural, compositional and functional criteria (Rogers and Bestbier, 1997), which have implications for the spatial, temporal and qualitative/quantitative resolution. Implicit in these criteria are confidence limits, i.e. an expected range of values which must be achievable and therefore testable (Ackoff, 1970; Bartol and Martin, 1991; Maser, 1996; Rogers and Bestbier, 1997).

■ Organisational dynamics of conservation organisations

Apart from operational issues like setting goals, one also needs to consider the organisational dynamics within the conservation organisations. Holling's (1995) four-phase conceptual model of an adaptive system cycle (Figure 2.3) provides useful insight into the organisational dynamics of conservation organisations.

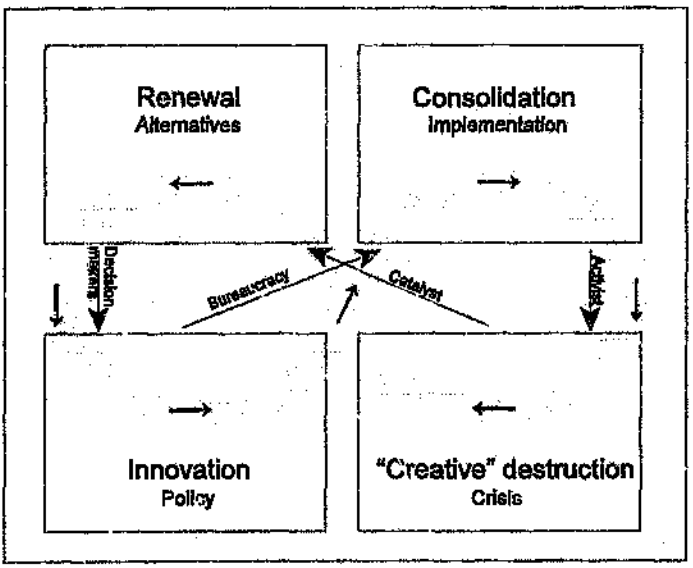

Figure 2.3. Holling's (1995) four-phase adaptive cycle that typify human organisations established to manage resources. The cycle emphasises a loop from consolidation to two phases of destruction and reorganisation, where innovation and change assume a dominant role.

This model is based on an adaptive approach that conservation organisations should adopt if they are to survive crises, learn from them and be successful in achieving their directives (Gunderson *et al*, 1995). According to Gunderson *et al* (1995) adaptive, viable organisations show periods of innovation, consolidation/stability, creative "destruction" as a result of a crisis and then renewal or reorganisation (Figure 2.3). Those conservation organisations that do not exhibit such a four phase cycle cannot adapt, and become locked into a 'command-and-control' management syndrome (*sensu* Holling and Meffe, 1996) that can be persistent. This has been the case in many South African conservation organisations before 1994 because of the largely patriarchal mind set of the organisations' management.

Most conservation organisations are established to carry out a set of policies, or a mission. During this "innovation" phase, a hierarchical bureaucracy is usually the type of group established to implement the policies (Figure 2.3). However, after the policies are legitimised the adaptive behaviours often cease and the main activities of the bureaucracy revolve around becoming more efficient in implementing those policies (Gunderson, 1995; Holling and Meffe, 1996). As a result, they spend most of their time and energy solving problems which might reduce their operational effectiveness (Gunderson *et al*, 1995). This preference for solving immediate problems has led to "adaptive" management becoming "reactive" management that cuts off the feedback loops (Figure 2.1) to science and internal policy/goal setting structures (Rogers, 1997). This narrowing of attention, between the phases of innovation and consolidation, causes strategic analysis and evaluation to deteriorate in organisations (Gunderson *et al*, 1995). Inevitably, crises occur in management when the original expectations, as determined by the initial policy, are not met or underlying paradigms shift or governance systems change. Consequently, organisations experience a loss of flexibility and adaptability, while the resource loses resilience (*sensu* Holling, 1995). The development, and choice, of alternative plans then takes place during the renewal/reconfiguration phase (Gunderson *et al*, 1995).

A lack of understanding is prevalent in conservation circles of how to initiate and institutionalise such an adaptive approach to management, yet it is absolutely fundamental to effective conservation. In particular, the capacity must be developed to ensure that the "destruction" (*sensu* Gunderson *et al*, 1995) of established organisational structures or processes that have failed to respond adequately to a crisis remains creative and does not degenerate. Gunderson *et al* (1995) and Rogers and Bestbier (1997) have proposed that the "renewal" phase must be based on sound scientific foundations, and must produce an acceptable, achievable and auditable set of goals. These goals must provide the basis of operations in the next "consolidation/stable" phase but not be so rigid as to lock the organisation into a 'command-and-control' (*sensu* Holling and Meffe, 1996) management style (Rogers and Bestbier, 1997). The successful conservation organisation would therefore adopt a strategic and goal directed, yet adaptive, management *modus operandi*.

Strategic management explicitly requires forward planning and therefore demands a structured system to maintain "organisational memory" (Rogers and Bestbier, 1997), since future managers must be fully aware of how and why their predecessors set the path they did. All the reasoning and the decisions taken must be recorded, and a process set up whereby they are frequently revisited. If not, management becomes subverted by personal agendas and the "pseudo-facts" (*sensu* Holling, 1995) generated by deductive reasoning (Gunderson *et al*, 1995). Unfortunately, many conservation organisations do not maintain or cultivate organisational memory because of their lack of direction and reactive management style, as well as a high turnover of staff. This is a major reason why the organisations are reactive and why science often is not incorporated into management.

■ The role of individuals in management

Particular groups, or types, of people emerge and appear to dominate in the transition among the four phases of organisational change (Gunderson *et al*, 1995). Four types or groups appear: bureaucrats, activists, catalysts and formal decision makers (Gunderson *et al*, 1995).

Bureaucrats carry out activities from the innovative/exploitative to the consolidation phase in the process of implementing policies (Gunderson *et al*, 1995). Bureaucrats focus on increasing efficiency and ask such questions as "are we doing things right?", instead of "are we doing the right things?" (Gunderson *et al*, 1995; Walters, 1997). The insular nature of their operations contributes to their surprise in the face of inevitable future crisis.

Activists are critical for the"creation" of the crises that can cause a shift from the consolidation to the "creative" destructive phase (Figure 2.3) (Gunderson *et al*, 1995). They identify issues that they perceive as inadequately addressed by the organisations, and they then arouse the public and expose organisational vulnerabilities. If they succeed, a period of crisis can occur that exposes the inadequacy of the existing management and creates a demand for new approaches and ideas.

At this point a new set of 'actors' emerge. They provide the initial foundation for effective adaptation by developing an integrated understanding of the system and by defining alternative policies and possible futures (Gunderson *et al*, 1995). Typically, alternatives are created by a group of technical, yet visionary, people called the "shadow network"(Gunderson *et al*, 1995), who function outside the organisations but who have contacts within them. These groups are in many cases academics or scientists, who act as catalysts by facilitating the transition from crisis to reorganisation by developing new learning, transforming strategies and establishing new goals (Gunderson *et al*, 1995).

The second set of activities that can then actually "launch an adaptive lurch into a new regime" requires "alpha" groups that are more formally empowered than the self organised "shadow network" (Gunderson *et al*, 1995). A key ingredient to success of these alpha groups is the ability to create credible futures while resolving issues of the past. The alpha groups come in a variety of configurations - they range from alliances among provinces or nations, to elected groups to appointed commissions or boards.

Three types of individuals play key roles - visionaries, respected integrators and loyal heretics (Gunderson *et al*, 1995). Visionaries appear to span multiple group activities for example as an activist, by injecting conflict, and as an alpha person, who reframes new strategies. The wise integrator is respected by those on the inside and outside of the system and is able to use traits of honesty to connect knowledge to power while countering political winds. The loyal heretic, or rebel bureaucrat, is critically important in preparing bureaucracies and other organisations for change by maintaining strong personal contacts inside and outside the organisation.

These groupings can be helpful for pragmatic managers who would like to translate the concepts of an adaptive organisation into practice. An adaptive organisation would likely have these functional roles filled by a variety of individuals. Thus the development of an effective interface between scientists and managers must take cognisance of the adaptive cycle (Figure 2.3) and of the extraordinary influence that individuals, within the organisation and without, exert on organisations. While Gunderson *et al* (1995) have focused on the roles that individuals play mostly outside the organisation (except the loyal heretic) many of these roles could be played within the organisation to make it adaptable from within.

2.3 What are the "barriers" between scientists and managers?

A contrast of the different cultures of science and management, as well as a basic understanding of what science can contribute to conservation management a (section 2.2.2) and of the conservation management context (section 2.2.3) provides the basis for identifying the following barriers to communication and information transfer between scientists and managers (and hence to developing an interface between the two):

i Differences in "cultural" goals of managers and scientists i.e. the delivery of benefits by managers versus understanding by scientists, leading to poor communication and mistrust.

ii Scientists and managers operate under a "strategy of hope". Scientists "hope" that their research results, as they stand, will be incorporated into the management process, while managers assume that the decisions they make are right.

iii Managers feel that scientists do not produce the products that they require for effective management. Managers do not know how to ask the right questions of scientists.

iv A lack of accountability and quantitative evaluation in conservation management.

v Conservation management has been based on the "balance-of-nature" paradigm; therefore it is species-focused, which is in sharp contrast with the ecosystem, "nature-in-flux" paradigm that the scientists accept.

vi Conservation management has relied on intuitive, *ad hoc* decision-making resulting in a problem-by-problem curative approach. Lack of adaptive management and a lack of forward thinking, goal-orientated management.

vii Lack of understanding of organisational dynamics and how scientists and managers can interact effectively.

vii Lack of organisational memory.

These barriers can be grouped into three main types for the purposes of this study, namely:

1. *"Strategy of hope".* (Barriers i, ii, iii). In the past, efforts were concentrated on research for the purpose of providing a sound scientific base (understanding) for informed decision making. Less attention has been directed towards ensuring the exchange of information between researchers and managers. Together with cultural differences, the result has been an unsatisfactory level of incorporation of research findings into management, and of management realities and needs into research (Cullen, 1990; Breen *et al*, 1994; Underwood, 1995; Mangel *et al*, 1996). Good research and development organisations know that to avoid this, vigorous and often structured information (technology) transfer systems must be instituted (Van Vliet and Gertzer, 1992; Rogers, 1997). If ecology is to move beyond the "strategy of hope" it too must have an explicit avenue and process for information transformation and transfer to, and from, conservation managers (Rogers, 1997).

2. *No explicit protocols for defining scientifically-based operational goals in conservation.* (Barriers iii, iv, v). Conservation management is shifting the emphasis from managing species for their intrinsic value, to managing them for their interactive roles in ecosystem functioning, and for their role in promoting heterogeneity in system structure, composition and functioning, in time and space (Pickett *et al*, 1992; Rogers, 1997). A purely custodial, wait-and-see, *ad hoc* approach to conservation management must give way to a more auditable goal-orientated, strategic approach (Rogers and Bestbier, 1997). Conservation management must adapt from reacting to surprise events of nature, to pro-actively providing accountable, strategic management (section 2.2.3). Such an adaptation will require of many conservation

managers a revolution in thinking and *modus operandi*. Therefore, general protocols to help managers in generating goals and initiating a strategic management style must be developed.

3. *No explicit mechanism or tool for ensuring organisational memory.* (Barriers vii, viii). Strategic management explicitly requires forward planning and therefore demands a structured system to maintain "organisational memory", since future managers must be fully appraised of how and why their predecessors set the path they did. All the reasoning and the decisions taken must be recorded, and a process set up whereby they are frequently revisited. If not, management soon becomes highjacked by personal agendas and the "pseudo-facts" generated by deductive reasoning (Gunderson *et al*, 1995).

Conscious effort must be put into developing and sustaining an exchange of information (in various formats) which both groups recognise as having value to break down or, at least, to overcome the barriers between scientists and managers (Breen *et al*, 1994; Barret and Barrett, 1997; Rogers, 1997). This may require breaking down long standing and rigid organisational, professional and personal barriers (Mangel *et al*, 1996; Christensen, 1997), as well as changes in the modes of communication and changes in the reward systems of managers and scientists (Christensen, 1997; Rogers, 1997) The rest of this chapter explores various strategies for overcoming these barriers.

2.4 Creating bridges to overcome the "barriers" between scientists and managers

Various strategies for overcoming the barri . have been suggested in the literature or are currently in place. The ability of the particular strategies to address and overcome the identified barriers (section 2.3) is explored below.

2.4.1 Scientific brokers

Scientific information brokers or, as Cullen (1990) refers to them, "purveyors of fine ideas" could be mediators between managers and scientists, transferring information among scientists and between scientists and managers. Although the broking function is becoming more established in the more general field of environmental management, where consulting companies act as "linkage agents" between scientists and managers (Cullen, 1990), there is not the equivalent service industry in conservation management (Rogers, 1997). Although Cullen (1990) proposed scientific broking as a strategy for the transfer of information, he does not suggest how it would transfer information across and in what format, thus scientific broking falls foul of the "strategy of hope". Clearly there is a need for an explicit interface between scientists and managers which allows for the effective transfer of relevant information.

Although scientific brokers may act as linkage agents between scientists and managers, they cannot effectively perform their function of transferring relevant information if management does not have a set of operational goals and clear information requirements to achieve those goals. Transferring information just for the sake of it falls foul of the 'strategy of hope' as well.

Note that the function of scientific brokers does not include that of ensuring organisational memory, that must remain the responsibility of the conservation organisation, although the scientific broker can aid the process. The wise integrator (*sensu* Gunderson *et al*, 1995) can assume the role of the scientific broker as he is a respected individual who synthesises, integrates and communicates information to managers and scientists.

2.4.2 The role of scientists within conservation organisations

Many conservation organisations employ staff with scientific training. However, the organisations rarely use them effectively as scientists (Thomson, 1986; Cullen, 1990). All too often they are relegated to management roles, for which they have no training, with little time or reward for finishing scientific work, submitting it for peer review and publication. The organisations often see these as indulgences, so scientists are often swung in and out of problem areas, rarely writing up their findings properly (Cullen, 1990). At the same time many do not keep abreast of the latest developments in the scientific field, because they become caught up in "ad hocracy" (Eidsvik, 1996), so their role in transferring scientific information to managers is impeded. This is often the case in South African conservation organisations where these scientists fall between the cracks of science and management (Kruger, pers comm). These staff are not rewarded as scientists so they are not recognised by their scientific peers. Unfortunately, they are also not rewarded as managers, so they are not accepted into either camp. The conservation organisations must be clear about why they want scientists on their staff (Cullen, 1990) and create appropriate reward systems.

Like scientific brokers, the role of scientists within conservation organisations is often impeded if management does not have a defined direction i.e. a clear set of operational goals. Often these scientists take on the role of loyal heretics (*sensu* Gunderson *et al*, 1995) and can be instrumental in precipitating change within the organisation.

2.4.3 Networking

Numerous people (Cullen, 1990; Pringle *et al*, 1993; Dewberry and Pringle, 1994; Huenneke, 1995; Mangel *et al*, 1996; Holling *et al*, 1997) have advocated the development of formal and informal networks between researchers and managers to develop the interface. These networks would enable the establishment of: (a) strong personal links between scientists and managers (Pringle *et al*, 1993; Dewberry and Pringle, 1994; Huenneke, 1995; Holling *et al*, 1997), based on mutual respect and sound information (Mangel *et al*, 1996), and (b) cooperative arrangements between national scientific organisations and organisations involved in conservation management. Scientists, for instance, can provide their expertise to conservation organisations and this can be facilitated by the creation of resource databases that list the names and addresses of interested scientists (Pringle *et al*, 1993; Dewberry and Pringle, 1994).

Although these networks are important in establishing contact between scientists and managers, they do not provide an explicit mechanism to ensure the transfer of information in a useful format and can once again fall foul of the "strategy of hope". These networks may provide the breeding grounds for developing new products to service the interface, for example protocols for defining operational goals. They may also facilitate the transition of an adaptive organisation from the crisis phase to reorganisation by developing the appropriate strategies and establishing new goals (Gunderson *et al*, 1995) A network is inter-organisational and therefore the "organisational memory" for a particular organisation cannot reside within it, therefore building networks does not overcome the "organisational memory" barrier.

2.4.4 Better science - better impact

Good research serves as the scientific justification of good management (Parrish *et al*, 1995; Wiens, 1997). It has been suggested that for science to be more useful and to enable the transfer of information, it must be better science (Cullen, 1990). However "doing better science" does not ensure that it will be incorporated into the management process or transferred to the managers for that matter! Doping "better science" also does not ensure that it is useful science. Once again the "strategy of hope" is evident here. There seems little point investing in further scientific research if the information that is already available is not better used to manage the system (Cullen, 1990). Also, conducting "better" science does not ensure that "organisational memory" is developed and maintained. Conducting "better" will not result in the development of an explicit protocol for defining goals, however "better" science will ensure that the operational goals that are defined are based on the best available knowledge and therefore may be more accurate and relevant.

2.4.5 Modelling

Models are defined as being "purposeful representations" of systems, be they conceptual models, mathematical simulation models or expert systems. Models, when perceived as quantitative or qualitative (Starfield and Bleloch, 1986) descriptions of current understanding, can be an effective form of communication between scientists and managers, especially when considering alternative management scenarios (Peterson *et al*, 1997; Starfield, 1997; Walters 1997).

Ideally models can be used for projecting and comparing alternatives in a decision making environment (Peterson *et al*, 1997; Starfield, 1997; Walters, 1997). Records can be kept on how the decision was taken and how the projections were used or why they were ignored. The most efficient monitoring scheme for evaluating the decision and the model itself can be determined by using the models, where the decision and the model are reviewed regularly and revised accordingly. This is an adaptive environment with built-in procedures for learning from experience (Walters, 1997). Such an environment can provide continuity in the face of personnel changes (Starfield, 1997) as models, like long-term data sets, become a part of the organisational memory. Unfortunately, many modelling efforts have been plagued by difficulties in representation of cross-scale effects, lack of data on key processes that are difficult to study, and confounding of factor effects in validation data (Walters, 1997). Also, modelling becomes an end in itself instead of the means to an end, often leading to a 'battle of the models' (Walters, 1997).

Although models can be used effectively to overcome two of the three barriers ("strategy of hope" and ensuring organisational memory), there is a major constraint - many conservation managers and even scientists are wary of models as they do not have the expertise required to use models effectively (Ritchie, 1989; Starfield, 1997).

2.4.5 A technological interface

Rogers (1997) has suggested that scientists must formalise their concept of research and its application, if they are to appreciably impact conservation and ensure information transfer. The solution is not a two part process of research and its application, but rather a three part process - research, the transformation of that research into a useful product, and the transfer of the transformed research to managers. Establishment of appropriate infrastructure, standards and routine is needed to ensure successful information/technology transfer (Rogers, 1997). Vigorous and structured information/technology transfer systems must be instituted to achieve this (Van Vleit and Gerber, 1992). The development of these transfer systems or 'technological interfaces' should be guided by a basic set of principles; product development, transfer processes, form and function, feedback, and building consensus (Rogers, 1997). More detail about these is provided in section 2.5.

On the broad scale the interface between scientists and conservation managers could operate in the same way that pharmaceutical companies form the interface between the science of biochemistry and the medical practice, and civil engineering the interface between physics and construction (Rogers, 1997). Although at a smaller scale, for example a national park, the interface could take the form of a decision support system which provides structure and process to the interaction between science and management (Breen *et al*, 1994; Rogers, 1997).

2.5 A structured interface as a bridge

Each of the above strategies has limited value in isolation, however in combination they can be effective in overcoming the barriers between scientists and managers as aspects of each of the strategies can be used to develop and maintain the interface.

Ecological scientific endeavour and conservation management are distinct processes, thus an effective interface must explicitly link the two processes of management and research (Figure 2.1) (Breen *et al*, 1994; Rogers, 1997) to be successful and to ensure that it overcomes the barriers identified (section 2.3).

The following conceptual framework of a structured interface was constructed to aide the general discussion in the thesis and also to provide other researchers who have identified a need to develop similar interfaces between scientists and managers, with a solid starting point.

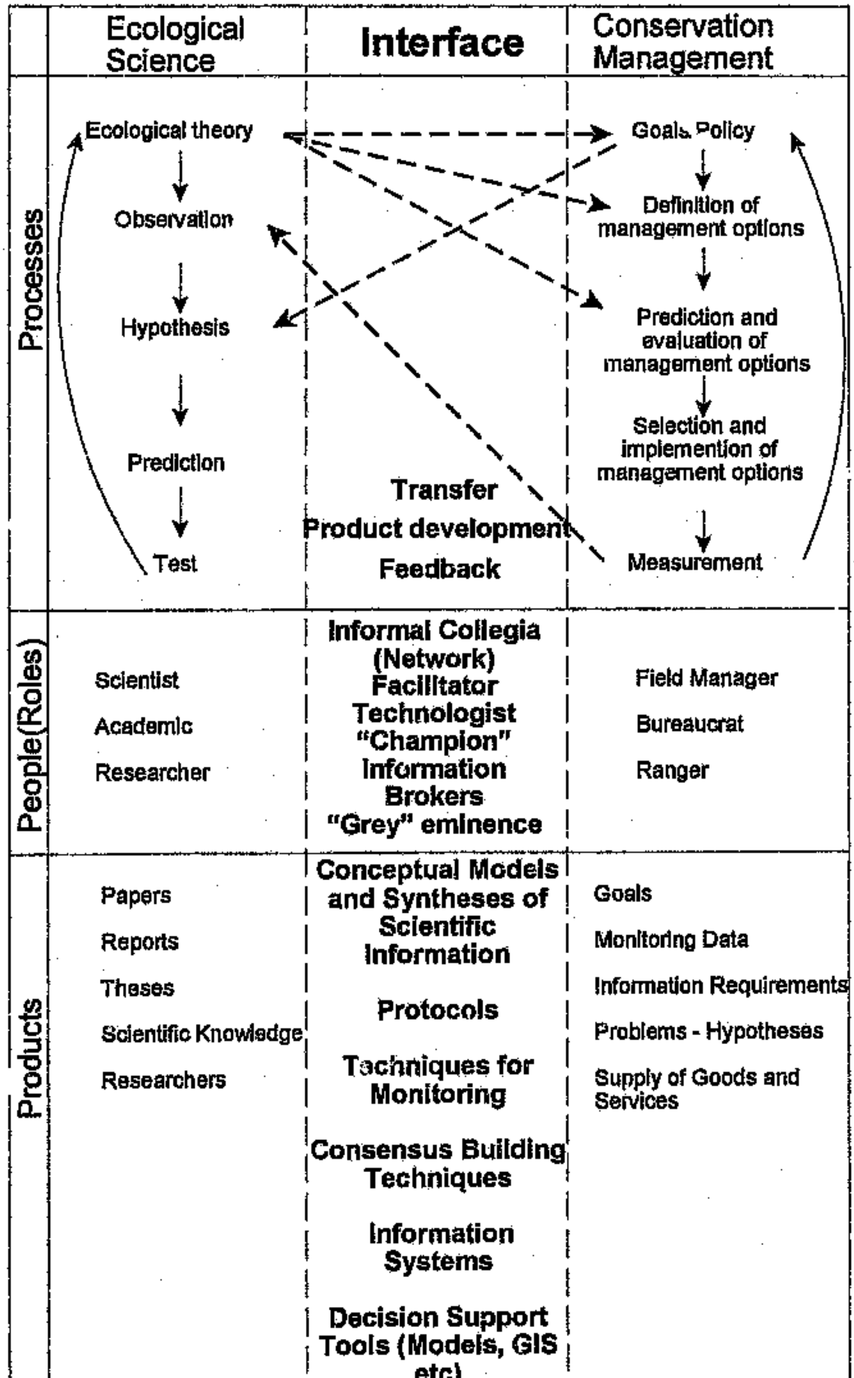

Figure 2.4 A conceptual model of the interface between scientists and managers. The interface consists of three primary elements - processes, people (or the roles they play) and products.

The conceptual framework is based on Roger's (1997) principles of product development, transfer processes, building consensus, feedback, and form and function, and it has three primary elements: Processes, Products and People (Figure 2.4). Each of these elements is crucial to the success of the interface and is dependent upon the others. *Products* that are useful to management may be developed, but if there are no *processes* to ensure that research and management products are transformed into useful products and transferred between scientists and managers the interface will fail. The specific roles that *people* play within the interface ensure that the products are developed, transferred and utilised, and that feedback loops are maintained.

2.5.1 Processes within the interface

Four "interface" processes need to be implemented to ensure that the researchers and managers interact in a fruitful manner. Firstly, transformation processes:- ecological products and management products need to be "translated" or transformed into formats that are useful for input into either the hypothetico-deductive ecological process or the management process. Secondly, product development:- means of developing the products need to be identified and explicitly implemented. Thirdly, transfer processes:- once the products have been developed they must be transferred. Fourthly, feedback processes:- to ensure continuity of communication, understanding and consensus building, feedback processes also need to be put in place. The exact details of these processes will depend on the organisations and individuals involved.

2.5.2 Products of the interface

An interface must develop "products" that can be used by the scientists and/or the managers, to enable the transfer and dissemination of information and thereby overcome some of the barriers between the two.

The products of ecological research are papers, reports, theses. researchers and an expanded base of ecological/scientific knowledge. The products of conservation management tend to be the supply of goods and services, and monitoring data.

The interface transforms these products into other products or tools that can be used either in management or to generate research. For example, problems in management can be transformed into hypotheses that can be tested by ecologists. Monitoring data are also useful for generating hypotheses. Ecological theory, if transformed into syntheses, models or other tools/products provides the scientific basis for defining operational goals in the management process. Other interface products would include monitoring techniques, consensus building techniques, technological tools such as Decision Support Systems, and protocols.

Many products that conservation management needs have already been identified and some have been developed, at least in prototype (Rogers, 1997). Markov decision theory, for example, can be used to choose between management options for a threatened metapopulation (Possingham, 1997), while a rule based model developed from the specialist knowledge of numerous aquatic ecologists can be used for managing salt levels in an estuarine lake (Starfield *et al*, 1989). However, under the new ecological paradigm of "nature in flux" (Pickett *et al*, 1997) conservation management will need new methods for describing system heterogeneity and flux (Rogers, 1997). Dealing with environmental change emphasises the need for predictive models and monitoring procedures to deal with environmental uncertainty (Peters *et al*, 1997; Rogers, 1997).

To ensure that these "interface" products are developed the four interface processes must be in place.

2.5.3 People of the interface

To be successful, the interface must engage the energies and talents of all who have a stake in it. Individuals and small groups of individuals exert extraordinary influence within organisations by performing distinctive roles within, and without, the organisation. It is this influence that provides a partial antidote to the people who perpetuate "command-and-control" (*sensu* Holling and Meffe, 1996) strategies that often permeate bureaucracies.

Certain roles of individuals have been identified (Gunderson *et al*, 1995) which are critical to the success of such an interface:

- The *loyal heretics* or *rebel bureaucrat* is critically important in preparing bureaucracies and agencies for change by maintaining strong personal contacts both inside and outside the organisation, and by "*championing*" the need for or the use of interface products.
- "*Grey eminences*" are respected, wise individuals who synthesise, integrate, and communicate information. The wise integrator is respected by both managers and scientists on the inside and outside of the organisation and is able to utilize traits of honesty while connecting knowledge to power in spite of countervailing political winds.
- *Informal collegia* of academics, researchers and managers are often the breeding grounds for new products to service the interface. People within these networks also assume the role of technologists and facilitators.
- *Technologists* transform the scientific information into a format that is useful for the managers: this may range from a simple conceptual model to complex, highly computerised Decision Support Systems.
- Scientific *information brokers* act as "purveyors of fine ideas" (Cullen, 1990), they are mediators between managers and scientists, transferring information among scientists and between scientists and managers. Very often these people are scientists or managers who recognise the need for this role.
- *Facilitators* build consensus between scientists and managers and where necessary other parties. Facilitators may also be people within the particular organisation who have the particular skills, or independent persons from outside the organisations.

2.6 The next step...

The Nylsvley Nature Reserve was chosen as a case study for this project as many of the barriers and problems described in this Chapter have been, and are being, met there. It thus provided an ideal, "text-book" example for which an interface between science and management could be developed. The lessons, principles and concepts derived from this case study could then be used to guide interfacing science and management in other contexts.

CHAPTER THREE

Nylsvley Nature Reserve: A Case Study

3.1 Introduction

The main purpose of this chapter is to address Objective Two:

> *Identify the barriers between the scientists and managers of Nylsvley Nature Reserve.*

The evolution of the management and science of the reserve provides the context for identifying barriers between the scientists and managers of Nylsvley.

3.2 Approach used to identify barriers at Nylsvley

Information was gathered to determine the barriers between management and science of the Nylsvley Nature Reserve by:

- Conducting interviews with numerous managers from the Northern Province Department of Agriculture, Land and Environment (hereafter referred to as the Department), two landowners on the floodplain and various scientists familiar with the Nylsvley Nature Reserve and the floodplain (see Appendix A).

- Making personal observations as a result of informal interaction with the reserve manager and the other Departmental managers, as well as personal experience as a "scientist" interacting with the reserve's management.

- Reviewing files and management plans held by the reserve's management and at the Department's headquarters in Pietersberg.

- Reviewing published literature on the reserve and the floodplain.

3.3 The Nyl River System

The Nyl River system is located in the semi-arid, bushveld-savanna region of the Northern Province, South Africa (24° 39'S, 28° 42'E) (Figure 3.1). The river drains into the Mogalakwena River, forming a component of the broader Limpopo drainage system (Higgins *et al*, 1996). A key component of the Nyl River System is a 24 000 ha floodplain, characterised by periodically inundated grasslands (Noble and Hemens, 1978). The floodplain system is of considerable value both as a conservation and agricultural asset. The fertile alluvial soils of the floodplain support both crop and livestock farming, as well as a growing eco-tourism industry which is underpinned by a diverse community of waterfowl (Higgins *et al*, 1996). On a sub-continental scale the floodplain, when in flood, provides a waterbird breeding habitat, rivalled only by the Pongolo River floodplain of Zululand, South Africa, and the Okavango Delta, Botswana (Higgins *et al*, 1996).

Less than five percent of the floodplain is under formal government protection. the rest is privately owned (Tarboton, 1987b; De Vos, pers comm; Marneweck, pers comm). Nylsvley Nature Reserve (Figure 3.1) with the recent acquisition of Vogelfontein is now a 5284 ha (De Vos, pers comm) provincially administered Nature Reserve. It forms the core of the growing eco-tourism industry on the floodplain, which in turn is a core element of the regional network of wildlife parks, private reserves and hunting areas (Higgins *et al*, 1996).

Refer to the Information module of the Nylsvley Management Information System (Chapter 6) for more detailed ecological information on the reserve and the floodplain.

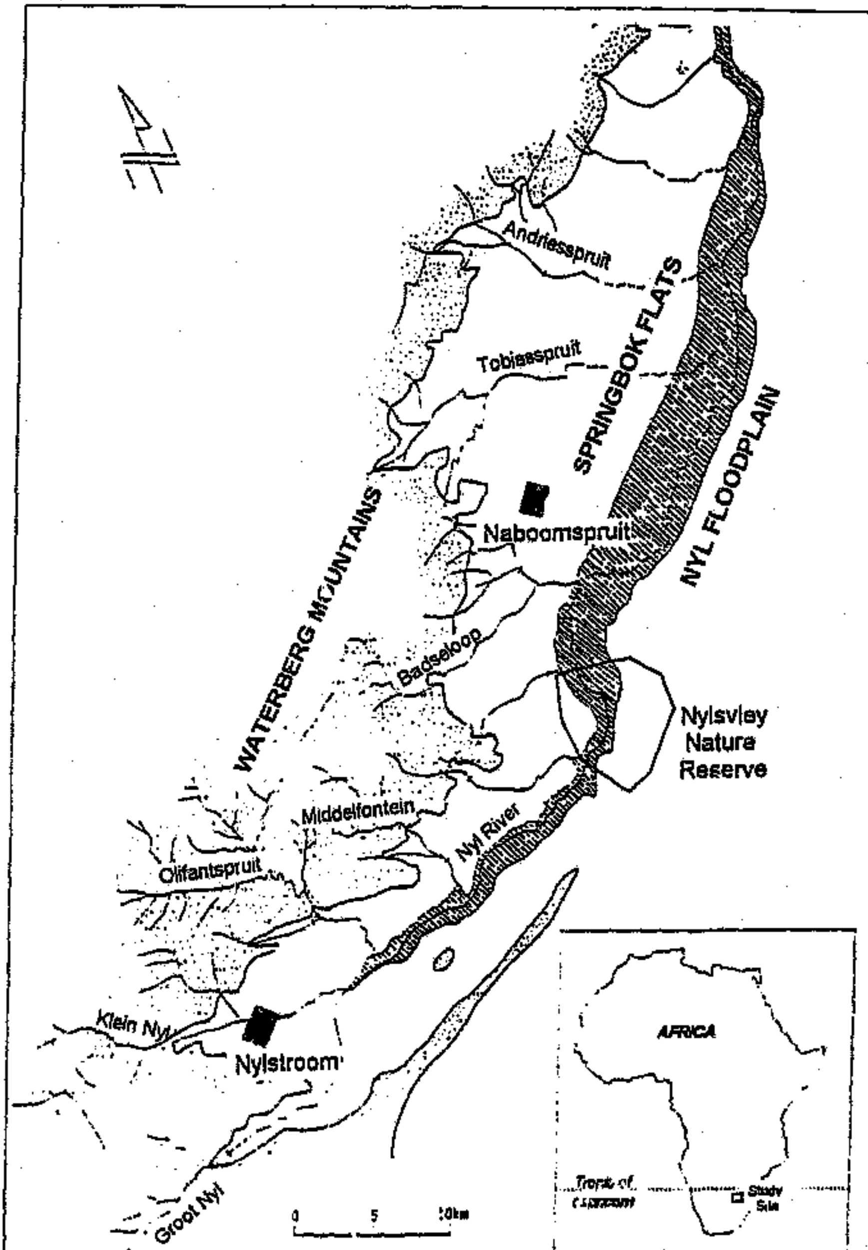

Figure 3.1 The Nyl floodplain, its tributaries, towns and the reserve (modified form Tarboton, 1987b).

3.4 The evolution of Nylsvley Nature Reserve's management and research

The emphasis of the management and the research conducted at Nylsvley Nature Reserve has undergone numerous changes since its proclamation in 1974. The evolution of the management of the reserve, and the research associated with it, is briefly described to provide the context for identifying barriers between those who manage the reserve and those researching the ecological systems within it.

The "evolution" of management of the Nylsvley Nature Reserve can be depicted by using Holling's four-phase cycle (Figure 2.3). The initial innovative phase was defined by the proclamation of the reserve and the setting up of the appropriate bureaucratic structures. Within a short period management entered into the conservation phase with a strong "command-and control" style of management. Management entered the "creative" destructive phase in the early 1990s because demands on the water resource increased and there were significant country-wide political change. Subsequently in the late 1990s it has entered into a renewal phase. Each of the phases is considered in more detail in the following sections.

3.4.1 The innovative phase

The farm 'Nylsvley' (3120 ha) was purchased by the government in 1974 and proclaimed a Nature Reserve. It was then managed as a Nature Reserve by the Division of Nature Conservation, Transvaal Provincial Administration (TPA).

The reasons for establishing the reserve were primarily to breed rare antelope, namely Roan (*Hippotragus equinus*) and Tsessbe (*Damaliscus lunatus*); protect the bird communities of the floodplain , and provide a savanna research site (Scholes and Walker, 1993).

During this "innovative" phase, many antelope such as Impala (*Aepyceros melampus*), Kudu (*Tragelaphus strepsiceros*) and Giraffe (*Giraffa camelopardalis*) thought to have been indigenous were reintroduced and the populations of the larger herbivores were controlled annually by culling. Fire was also implemented as a management tool, where the reserve is burned in blocks of several hundred hectares each according to the degree of grass moribundity (Scholes and Walker, 1993). During this phase no adaptive policies were implemented and soon the "innovative" became the "conservative". Only two of the three objectives were actively pursued: breeding Roan and Tsessbe, and providing a savanna research site. The protection of bird communities was, and has been to the present, largely ignored.

3.4.2 The consolidation phase - the 70s and the 80s

The management approach of the TPA became rather patriarchal and "command-and-control" (*sensu* Holling and Meffe, 1996) as did most governmental departments during the "apartheid" era. Deeply entrenched bureaucracies are characteristically unresponsive to new challenges because the system discourages innovation and other behavioural variance (Holling and Meffe, 1996). This was evident at Nylsvley with the emphasis on the then popular species-focused management approach (section 2.2.3), rather than the revolutionary or innovative "ecosystem management" approach. The species-focused approach to management at Nylsvley was evident in the introduction of the endangered antelope species, Roan, into the reserve and the initiation of a breeding programme although Roan had never occurred naturally in the region (de Villiers, 1986).

The protection of bird communities on the floodplain however received little, if any, attention. Dam building, for irrigation purposes, proliferated on the farms upstream of the reserve altering the frequency, extent, timing and duration of the flooding events on the floodplain at the reserve and downstream of that (Higgins *et al*, 1996). While this has had significant implications for the bird communities that normally migrate to the floodplain during floods to breed and forage (Tarboton, 1987b), no action was taken by the TPA to address these issues even though they had the explicitly stated objective to protect these bird communities (Scholes and Walker, 1993).

More than a decade after the proclamation of the reserve, a management plan was finally proposed, loosely based on "adaptive" management guidelines (section 2.2.3). Large mammals that could be placed on the reserve with some success were first identified and only then were three objectives defined for the reserve (de Villiers, 1986). According to de Villiers (1986) a management plan could then be drawn up from these objectives. Unfortunately, the proposed management plan for the reserve went no further than highlighting three objectives. No subsequent goals or action plans to explicitly meet the objectives were drawn up . The following were proposed as objectives for the reserve (de Villiers, 1986):

- Conserve a unique natural phenomenon, namely the floodplain, with its associated animals (especially Reedbuck, *Redunca arundinum*) and bird-life (migrants).
- Conserve a rare animal species, namely the Sable antelope (*Hippotragus niger*).
- Promote/advance ecological research.

Although these "official" objectives indicate that the management emphasis was to have embraced a more ecosystem-based approach to managing the reserve with the emphasis on the floodplain, the reality of it was very different.

The breeding success (they were not actively breeding) of Roan continued to be the single most important consideration in managing the reserve and it influenced most management decisions, even though in t' 1986 management plan Sable were targeted as being worthy of conservation, not Roan. Sable, however, were never introduced to the reserve. This indicates a number of problems. Firstly, there may have been bureaucratic resistance to the change in objectives, or it may have been because of a lack of organisational memory. Staff changes may have resulted in the management plan being 'lost' for a while new staff settled in. This also points to a lack of accountability - if the managers were held accountable for their actions and measured according to their performance in attaining objectives the Sable objectives may have been followed through.

The reasons for the lack of follow-up on Sable are unknown, but it points to a lack of "organisational memory" as well as accountability for decisions made.

During the 1970s and 1980s there was a high turnover of staff in the reserve, specifically the reserve manager (ranger). This may be because the reserve was, and is, considered to be a stepping stone to more senior positions within the conservation organisation. This high turnover of staff coupled with the lack of documentation of decisions may be the reason for the low levels of "organisational memory".

While one of the original objectives was to protect the bird communities of the floodplain, and then later to conserve the floodplain, ecological research focused almost exclusively on the savanna areas of the reserve until 1990. This illustrates, yet again, that the objectives did not play a significant role in Nylsvley's management.

The reserve was the principal site for the South African Savanna Biome Programme, which ran from 1974 until 1990 under the auspices of the Council for Scientific Research (CSIR). The programme was intended to be strategic research aimed at ultimately improving savanna management (Scholes and Walker, 1993). The Department of Agriculture, which had the responsibility for the strategic research needs of the cattle industry, was a chief motivator for the research. The TPA's Division for Nature Conservation, which was responsible for wildlife on state land in the Transvaal, managed the reserve and actively participated in the initial research phases. These bodies were represented on the steering committee. However, with time, the "user" organisations became less involved and the crucial task of transferring and interpreting the wealth of information generated from the reserve studies into the management framework has occurred by chance, if at all (Scholes and Walker, 1993). This occurred despite the fact that managers and researchers were domiciled on the reserve and were in daily contact.

3.4.3 "Creative" destruction - the turbulent 90's

Increasing population demands on the very limited water resources of the Waterberg catchment and a constantly changing political environment precipitated changes in the emphasis of the management of the reserve and the type of research conducted on the reserve.

Increasing urbanisation and growth of informal settlements in the Nyl River Catchment is placing considerable strain on the water resources of the Nyl River System, necessitating further water resource exploitation (Higgins *et al*, 1996). The Department of Water Affairs and Forestry (DWAF) now recognises the legitimate claim that the "environment" has to water, along with other users such as industry and agriculture. Under this scenario, an FRD Special Programme was initiated in 1990 entitled "Nylsvley as a functional unit of the landscape" (Higgins *et al*, 1996). This programme which engaged in ecological and hydrological studies of the floodplain (Higgins and Rogers, 1993; Higgins *et al*, 1996) represented a shift in emphasis from savanna research in the reserve to floodplain research. This programme has generated much valuable information in the form of journal papers, reports and theses, that is relevant to management of the floodplain, yet very little of it has been transformed into useful products for the managers.

South Africa has undergone significant changes and has often been thrown into crises since the collapse of apartheid in 1992. One of these changes was the redesignation of the four provinces in 1994 into nine provinces. The reserve and floodplain now fall within the boundaries of the Northern Province, and therefore under the jurisdiction of Department of Agriculture, Land and Environmental Affairs. This department is an amalgamation of the former Transvaal Provincial Administration and the equivalent departments within the previous "homelands".

Much upheaval and stress was created in the lives of the personnel within the Department during the amalgamation of departments. Personnel were transferred on an *ad hoc* basis and after almost three years of continual change, many people did not have permanent posts. This was the environment under which this study was conducted (1995-1997). Although this environment had numerous disadvantages for this study in that one often did not know what to expect nor whom to contact, it was also advantageous in some respects. Continual change within the organisation created a culture receptive to new ideas, which provided the ideal opportunity for the incorporation of the products generated by this study into the organisation.

During this time of change, the management goals for the reserve as stated by the reserve manager and the regional ecologist in 1996 (although there is no official documentation of these), were:

- To maintain the floodplain in a natural state with the associated bird-life, and
- To breed the endangered species Roan and Tsessebe.

The maintenance of the floodplain in a "natural state" was a stated management goal, however such a state has not been defined and there were no management guidelines or options for managing the floodplain to this end. The floodplain was managed as a component of the Roan breeding and conservation program. This conflict in what managers said they would do, and what they actually did, was a source of tension between scientists and managers. Scientific information was communicated to the managers that had implications for their decision making but the information was not incorporated into the decision-making process. Much of this scientific information was either in a report or thesis format and therefore not in a format that may have been of direct use for the managers. There have also been various brokering attempts on the part of the scientists to integrate their information into the managers' decision making process. Numerous discussions and workshops with scientists and managers, some of them mediated by the Foundation for Research Development, were held throughout the early 1990's but they were not very successful in bridging the "gap". The managers felt that the scientists were not producing the products that they required, while scientists claimed that the managers did not have clarity on the questions for which they required answers.

Recently a proposal was accepted to list the floodplain on the International List of Wetlands of International Importance especially for Waterfowl (Ramsar Convention). There are certain floodplain management criteria that the managers will have to meet in terms of the Ramsar Convention, such as wise use of wetlands (Cowan, 1996), which may conflict with their Roan breeding program. However, the managers have not been able to initiate any processes to develop explicit management plans and guidelines for the floodplain.

No clear management approach or process was being followed by the reserve managers, which has resulted in lack of vision in addressing the floodplain issue and management of the reserve in general. Much of the decision making appears to be based on animal census data and political agendas of higher level management, rather than current and past scientific information.

This lack of direction is compounded by the sketchy information of the reserve and floodplain on which the managers base their decisions. They have a series of information documents (called "ecological files") which contain incomplete records of vegetation monitoring programs and animal census details. Other information such as soil types, management blocks and burn blocks are mapped on A4 pieces of paper. Many of the files do not contain recent information, and a disturbing proportion (81%) of them are empty. For example, no information on objectives and policy is available, nor is there any information on aspects such as topography, reptiles, pollution, archeological features, to name a few (Kruger, pers comm).

3.4.4 Renewal into the 21st Century?

Nylsvley's management needs to adopt an adaptive, yet strategic, approach to management to ensure that the changes (section 3.4.3) that have happened are "creatively" destructive and not negatively destructive.

3.5 Barriers and bridges at Nylsvley

The preceding discussion provides the basis from which to identify the barriers to improved management and information transfer in the context of the Nylsvley Nature Reserve, which can be stated as follows.

3.5.1 Barriers

- *The prevalence of the "Strategy of hope"*. Both the managers and the scientists linked to the reserve have been operating under the "strategy of hope". Although much scientific information is available for Nylsvley, it was not being transferred effectively to the managers (Scholes and Walker, 1993, Rogers, pers comm). The information that was provided had not been used to guide management decisions and it was not in an easy-to-use format. The managers also felt that the scientists were imposing their will and knowledge on them, thus the communication between scientists and managers had not produced the desired effects (i.e. effective information transfer) and managers had not absorbed the potential of scientific information.

- *A lack of forward-planning, strategic management.* There was no explicit protocol in place that identified operational goals to achieve the "vision" for the reserve. The management of the reserve was bureaucratic and resistant to change.

- *A lack of organisational memory.* There was very little, if any, organisational memory for the reserve because of high staff turnover at the reserve and poor information records.

3.5.2 Potential bridges to overcome the barriers

The following needs had to be addressed in developing a structured interface to overcome the above barriers:

- The reserve managers needed to adopt a more strategic, forward planning ("visionary") management approach to overcome the barriers identified (section 3.4.3).
- The reserve managers also had to ensure that "organisational memory" was developed and nurtured to provide continuity in a system where staff turnover is high and unpredictable (section 3.4.3).
- On the other hand, the scientists need to ensure that the information they provide was in an easy-to-use format (product) that could be incorporated in the management, and that it meets management's needs and requirements.

Arising from these is the need for:

1. A process for translating a conservation organisation's "vision" into achievable, auditable goals (Chapter Four and Five), and

2. A mechanism to ensure that the process is "user friendly" it becomes part of the organisational memory (Chapter Six, Appendices E and F).

CHAPTER FOUR

Protocols and Procedure for Developing an Objective Hierarchy

4.1 Introduction

A generalised goal setting protocol (What to do) and a procedure (How to do it) for developing such a protocol in conservation management is presented, as well as a basic protocol for auditing the achievement of the goals. The protocol for setting goals essentially became the interface between scientists and managers as it brought them together in a common forum to identify a common vision for the reserve and to set the goals required to achieve that vision.

This chapter has two main sections: a description of the development of the protocols (section 4.2), and then the protocols themselves (sections 4.3 and 4.5).

4.2 Developing the protocols and procedures

An open environment where consensus may be reached was required to develop a protocol that will be used by both scientists and managers in any conservation organisation. The protocol also needed to be unanimously accepted by both scientists and managers to be useful. Thus a workshop environment was deemed as the most appropriate means in which to develop the protocols and procedure. Workshops are also effective means of obtaining and integrating expertise from a wide variety of people to develop "new products", be they protocols, guidelines, ideas or models (Bourner *et al*, 1993; Maser, 1996).

Details of how the workshops were run are provided for two reasons: firstly, the workshops formed part of the methods used in this study and, secondly, a record of how the workshops were conducted provides a methodology for other researchers/scientific brokers to follow when developing protocols, guidelines or procedures that require consensus and ownership.

4.2.1 The participants

The reserve manager and the regional manager for Nylsvley were present at the workshops, along with members of other various conservation organisations. The presence of the other participants from the other organisations lent legitimacy to the workshop and bred confidence in the Nylsvley managers for the protocols that were developed as products.

Members of various South African conservation organisations and scientists (Appendix B) who had expressed similar views/needs about setting goals for effective conservation management, were identified and invited to attend a workshop from the 5 to 7 December 1995 at the Nylsvley Nature Reserve. Ten managers and scientists from the following organisations were present; Department of Agriculture, Land and Environment - Northern Province; Kruger National Park - National Parks Board; Natal Parks Board; Centre for Water in the Environment - University of the Witwatersrand.

4.2.2 Preparing for the workshop

A month before the initial workshop, a provisional agenda and "starter" document (Appendix C) were circulated to all the potential participants with the details of time and venue, as well as questions to provoke some thought about the objectives of the workshop.

One activity on the provisional agenda was the revision of the agenda according to developments during the workshop. The agenda was then revised by consensus - this was an important step as the more "ownership" the participants had for the workshop agenda, the more they would apply themselves to the activities and tasks at hand. They would also place more value on the facilitator's suggestions and on the outcomes of the workshop (Armstrong, 1990; Bourner *et al.* 1993; Maser, 1996).

The following questions were posed to the potential participants:

1. What is meant by "goal orientated conservation"?
2. What is meant by "goals"? How do they relate to other terms such as vision, objectives, principles and desired state?
3. How should goals be developed? Who should develop the goals? What form should the goals take?
4. How will goals be used and what for?
5. What environment/support system is needed to ensure that goals are set, met, revised and accepted within and outside an organisation?
6. What can be achieved in a short term and how can one move forward to make sure that one has something more concrete on which to pin the above theoretical questions?

Participants were requested to prepare a short statement of their views on the questions and to highlight particular management problems facing their organisation. This was to ensure active participation by all and that everyone's views and ideas were taken into account from the outset.

4.2.3 The workshop process

A boardroom approach (Figure 4.1) was used in the room layout as it is useful for long sessions, especially for note-taking and maintaining eye contact with fellow participants (Bourner *et al*, 1993). This layout was also useful in integrating and neutralising the role of the facilitator in the workshop process. Note that this layout is not appropriate for a workshop of more than 20 people as it tends to become unmanageable.

The room layout is important for two main reasons (Bourner *et al*, 1993). Firstly, it makes a statement - when participants enter, they immediately make assumptions about the professionalism of the facilitator and the organisers and formality of the workshop. Secondly, group work is highly dependent on seating arrangements as eye contact is important in ensuring efficient and effective communication.

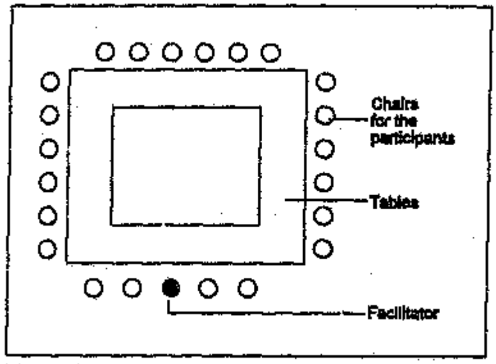

Figure 4.1 Boardroom design for conducting long sessions in workshops.

The workshop was facilitated by Prof K.H. Rogers of the Centre for Water in the Environment. The facilitator's role was essentially one of developing a climate in which participants can interact productively (Maser, 1996). Other roles of the facilitator included; sharing ideas, serving as a model, raising questions, guiding discussion, restating ideas, challenging thinking and summarising main points (Bourner *et al*, 1993; Maser, 1996). These are important means of ensuring and increasing productivity. The facilitator also recorded ideas on flip-charts during this workshop. Flip-charts sheets were placed on the walls for all to see, at all times, thus ensuring continuity and avoiding redundancy.

Although most participants had met the previous evening, some had not been present so everyone was asked to introduce them-selves, to identify what organisation they belonged to, to give a very brief account of their work and why they were at the workshop. This sharing of information provided useful background information for all the participants and the facilitator, as each one had their own ideas as to what they wanted from the workshop. It also ensured that everyone was made aware of each others' needs and aims and thus contributed to consensus building (Davis, 1979; Bourner *et al*, 1993).

Once the formalities were over, the participants presented their prepared statement on the management problems facing their organisations. After having heard each other's views, the participants were requested to take five minutes to individually brainstorm what they considered to be the most important issues concerning setting goals in conservation management, what they wanted out of the workshop and suggestions as to how to obtain what they wanted. Brainstorming generates a large number of useful ideas on any subject or problem by suspending criticism, judgement and evaluation (De Bono, 1982; Armstrong, 1990; Bourner *et al*, 1993) - the objective is quantity, not necessarily quality (Bourner *et al*, 1993). Brainstorming encourages cooperative and collaborative behaviour.

The facilitator then used the "Nominal Group Technique" to harvest the ideas of the participants, to identify the strength of support within the group for various ideas, and to avoid domination of the discussion by a single person or a small group of people (Bourner *et al*, 1993).

The Nominal Group Technique is an idea harvesting technique which has three essential steps. First, the facilitator explains the technique to the group. Second, the facilitator collects ideas from each person and writes them on the flip-chart for all to see. No discussion, elaboration or justification wis permitted at this stage, only questions to provide clarity on each person's contribution. There is no need to reach consensus on the ideas, therefore two contradictory comments/ideas can be listed at the same time (Bourner *et al*, 1993). Essentially, this technique allows all the participants to "place their cards on the table". Third, the facilitator checks that each idea is understood by all participants. Once this step has been completed the ideas are evaluated individually. Some ideas are erased, others are grouped together and yet others refined.

The workshop participants reached a unanimous decision to address the need;

- for a more rigorous pursuit of achievable goals in conservation, and therefore
- to produce prototype protocols for:
    - a) translating an organisation's vision into operational goals (section 4.3), and
    - b) ensuring that once goals have been set, they are met, revised, audited and, when necessary, reintegrated into the management process (section 4.5).

Goals should be set using a hierarchical approach to allow for cross linkages between vision and goals, and to address the needs of the various levels of management (section 2.2.3). Thus for the purposes of developing a protocol for setting goals in conservation management it was decided to follow this hierarchical approach. The resulting hierarchy was called an "objectives hierarchy", whereby the vision is decomposed into objectives, sub-objectives and finally operational goals.

Each of these protocols was developed in the workshop, continuing with repeated sequences of individual brainstorming to draw out ideas and needs of the individuals, the Nominal Group technique to collect the ideas, collective brainstorming to generate further ideas and synthesis to refine and prioritise ideas.

Once the workshop participants had developed the protocols, the protocol for developing an objectives hierarchy was "tested" on a hypothetical case study in order to identify any difficulties with the protocol and to refine it. The case study was developed by a subgroup of practising conservation managers who ensured a realistic scenario. The testing showed that the objectives hierarchy protocol was useful and achievable. It was, however, recognised that to do the protocol justice in any organisation would require much time, effort and dedication.

My roles before and during the workshop were varied:

1) Organiser - organised various logistical aspects of running a workshop, such as obtaining equipment, contacting participants etc.
2) Workshop rapporteur - kept a record of all that transpired during the discussions and brainstorming sessions.
3) Synthesiser - synthesised many of the points arising from the discussions and highlighting the important ones on flip charts for further discussion or perusal.
4) Participant - actively participated as a 'scientist' during the workshop, with the perspective that management and science need to be interfaced, ensuring that this crucial concept was not 'lost' during the proceeding and positively influenced discussion. One of my goals was to ensure this interfacing.

After the workshop I assumed the role of report writer - I compiled the proceedings and the protocols in a report (Bestbier et al, 1996).

Note that a range of appropriate people (Appendix B), including myself, developed the protocols together at the workshop. This lent credibility to the protocols and they were then used on a number of test cases (see section 4.2.4). One of these test cases was Nylsvley and I drove the process with some initial facilitation assistance (Chapter Five). The protocol is therefore common property of those who derived it, but its success has come from refining it when individuals have used it. I was one of those individuals. I have also collated the refinements that others have made and produced a refined version (section 4.3) of the objectives hierarchy protocol for this thesis.

4.2.4 The workshop "products"

The two protocols that were developed in the workshop are presented in section 4.4 and 4.6.

Another product of the workshop was the sense of ownership of the protocols by the participants. This is an important product as it ensured that the protocols, once they had been written up as a report (*Guidelines for Goal-Orientated Conservation;* Bestbier *et al*, 1996), were taken back to the respective conservation organisations, disseminated and put into practice. This has been the case in the Kruger National Park, where the objectives hierarchy protocol has been pivotal in the review of the Kruger National Park management plan and in preparing a new management plan. A comprehensive objectives hierarchy has been developed which is being used to structure a realistic and achievable monitoring system (Braack, 1997). The Natal Parks Board are using the protocols for the St Lucia lake and wetland area to determine a monitoring strategy for the managers in the region (Blackmore, pers comm).

Once an objectives hierarchy had been developed for the Nylsvley Nature Reserve (Chapter Five) and the protocol proved to be valuable, the protocols were presented to the Board of Directors of the Department of Agriculture, Land and Environment (Northern Province). The protocols have received their stamp of approval. Certain key members of the Department who were involved in defining an objectives hierarchy for Nylsvley have subsequently been instructed to facilitate the development of objectives hierarchies for all other reserves in the Northern Province, particularly those that have been earmarked for commercial development

(Nel, pers comm). The objectives hierarchy allows the conservation organisation to elucidate and prioritise those key elements that require management before the process of commercialisation begins. This is an important indication of the acceptance of the need of a strategic, forward planning approach to conservation management, in which scientists and managers work together to define conservation goals.

4.3 Protocol for developing an objectives hierarchy

The objectives hierarchy begins at the coarsest level with the organisation's "vision" for management (Figure 4.2).

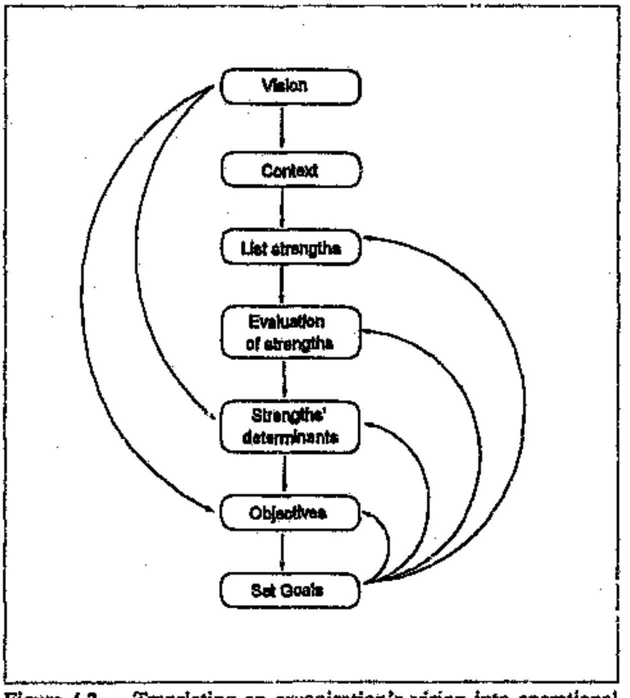

Figure 4.2 Translating an organisation's vision into operational goals.

The protocol provides a step by step process for decomposing the vision into a series of "objectives" of increasing focus, rigour and achievability. The finest level of the hierarchy is defined by achievable goals which may be either "organisational goals" or "conservation goals". Organisational goals define achievable targets for managing organisational structures and processes, while conservation goals define endpoints for ecosystem management.

The protocol leads to an objectives hierarchy which can service management's organisational hierarchy with acceptable and achievable operational goals. The higher level vision and objectives serve upper management levels with statements of strategic intent, while the low level goals provide on-the-ground managers with specific, spatially and temporally bounded, targets. Using an inclusive negotiating procedure to derive this hierarchy ensures its broad acceptability. This procedure is described in greater detail in section 4.5.

A set of working definitions of terms (Box 4.1) were derived by consensus in the workshops and provide a clear picture of what the terms should and should not be used for. Note that the Harvard approach (Keeney, 1992; Kaplan and Norton, 1996) was used with objectives at a higher level than goals.

Box 4.1 Definitions

Conservation goals
Goals which define ecosystem endpoints or targets for conservation.

Context
The circumstances relevant to something under consideration. The range of facts, conditions, time, places, manners, causes, surroundings, which define the circumstances, may all influence what an organisation does, and how it does it.
It differs from the term strength in that strengths are beneficial characteristics of something under consideration. Please note that a context can also be a strength, for example the fact that a protected wetland is a declared Ramsar site is context as well as a strength. It is a strength because it has international recognition but the rules governing the declaration of Ramsar sites provides specific context for management decision making. As the scale becomes smaller, so the line between strengths and context becomes less distinguishable.

Constraints
Constraints are factors within an organisation, which inhibit the determinant or strength itself, or inhibit the pursuit of the vision.

Goal
An achievable, testable and auditable target, with specified time and confidence limits. The goal is either achieved or not, and motivates achievement of objectives (Keeney, 1992).

Goods and services
The full range of commodities and services that are, directly and indirectly, derived from, or associated with the ecosystems by both local and non-local communities. Goods include water, firewood, herbal and animal products, biodiversity etc; services include river bank stabilisation, buffer functions, water quality enhancement, recreation and tourism opportunities, shade etc.

Milestone
A stage or reckoning point, a significant event in a project, "how much, by when?".

Objective
Objectives are qualitative articulations of the values defined in the vision, principles, context and strengths, which form a foundation for developing quantitative, operational goals.
An objective is more precise than the vision but it is not necessarily achievable. It supports achievement of the higher level vision by expanding upon the key elements of the vision and providing a broader, more rigorous information base for setting goals.

Objectives Hierarchy
The objectives hierarchy developed by this project begins with a "vision" at the top of the hierarchy. This vision is progressively decomposed through a series of "objectives" of increasing focus. The first level of the hierarchy is defined by achievable "goals" which may either be organisational goals or conservation goals. The latter are presented as "thresholds of potential concern".

Organisational goals
Goals which define achievable targets for managing organisational structures and processes.

Potential
The capacity for use and development of the system to be managed. A grassland, for example, provides no potential to develop a recreational fishery, but a river does. Conservation status of a system will contribute to its potential for conservation.

Principle
A broad truth or ethical constraint to which the organisation ascribes based on its value system.

Strategy
A game-plan describing where an organisation is going, how it is going to get there and it will do to ensure it arrives there.

Strength
A positive characteristic of the system to be managed. For example: a grassland, a river and technical infrastructure impart different strengths to the system. Strengths may be scientific, ecological, value judgements, legal, historic and socio-economic and may incorporate the concepts of conservation importance and ecosystem health.

Task
A piece of work required to be done as a step in achieving a goal.

Threats
Threats are factors outside an organisation which inhibit the determinant or strength itself, or inhibit the pursuit of the vision.

Vision
A broad philosophical statement of intent. A vision is durable beyond changes in personnel and organizational structure. Synonymous with a "mission statement" and "strategic objective" (Keeney, 1992).

Vital Attribute
An important property of the system which can be measured eg. fish quantity and size distribution, space/time coverage of blue-green algal blooms.

Details of the procedure and points to remember while following the protocol, are presented in text-boxes associated to each step.

This protocol and procedure should ideally be implemented in a workshop environment with the assistance of a facilitator who is familiar with the protocol and procedure.

Step 1. Reach consensus on the vision and operating principles

> This is one step at which negotiation is essential (see section 4.5).
>
> Identify the key elements of the vision and develop operating principles for each key element.
>
> Since the operating principles describe core organisational values they should be used as checks and balances at each step of the protocol.

An organisation's vision is a concise statement describing its core business and philosophy, whereas a statement of the operating principles describes the core values of the organisation.

Before any other management action can be taken the vision and operating principles need to be fully accepted to prevent subsequent procedural breakdown. Development of a sound information base to provide the full context for management will greatly assist this process.

Step 2. Provide the context for setting the goals

> This step requires considerable brainstorming, a knowledge of the literature, local conditions and policies, governmental policies and international agreements.

Describe the context of/for the managed system at local, regional, national and international levels and at ecological, socio-economic and legal levels. Often socio-economic, legal and ecological factors are included in international, regional, national and local context.

Step 3. Document the strengths of the system

List all the known and perceived, current and future strengths of the system.

Current strengths may be determined from inventory type lists of ecosystem characteristics and vital attributes e.g. species diversity and landscape types. Scenario modelling, on the other hand, may be useful for identifying future strengths.

> This is an important step in developing the objectives hierarchy as it identifies the fundamental purpose(s) of conservation management.
>
> It is essential that everyone's perceptions of the strengths/vital attributes are aired. This is a step which exposes hidden agendas, therefore some tact is necessary. Encourage participants to put their "cards on the table" to produce a provisional list of strengths.

The next step is to discuss and evaluate this list to reduce it to the essential elements compatible with the vision.

Step 4. Evaluate and consolidate the strengths

Matrices are a useful tool in exploring which strengths appear to be complementary and those that are conflicting (see Chapter 5, Tab' ".1 for an example). Strengths can be sifted, grouped together and condensed. Thus the end product would be a concise list of strengths for which the organisation would manage.

> Personal values seem to play an important role in this step. Look for common ground to rationalise the list of strengths to ensure compatibility with the vision and operating principles.
>
> This can be a complex task. Techniques such as ordination, overlapping, congruency, optimization, linkage and interaction may be used to investigate compatibility and trade-offs between strengths.

Step 5. Record all the determinants of, and constraints and threats to, the strengths

A major purpose of management is to ensure the maintenance of the strengths' determinants. List <u>all</u> the determinants of, and the constraints and threats to, the condensed list of strengths. Knowledge of the environmental and cultural "goods and services" the system has the potential to deliver is needed to complete this step. A matrix can be set up to facilitate the process of assigning determinants, threats and constraints to the particular strengths (see Chapter 5, Table 5.2 for an example).

> Expert ecological opinion is needed for this important step but do not let it be constrained by the lack of site specific knowledge. Develop hypotheses of determinants if they are not known.

Step 6. Formulate the objectives

Objectives are set to;

1) ensure the maintenance of the identified strengths and vital attributes of the system being managed, and
2) overcome the constraints and threats to meeting the vision.

A hierarchical approach should be adopted to formulate a set of nested objectives of increasing rigour and achievability. Note that this is an iterative process involving identifying, structuring and analysing objectives. and understanding how they relate to each other. It is important to recognise that objectives at different levels in the objectives hierarchy would be used to direct operations at different levels in the organisational hierarchy.

> Repeatedly cross reference the vision, principles, context and strengths with constraints and threats to set up statements of intent to ensure strengths are maintained by overcoming threats and constraints.
>
> When eliciting objectives from more than one person ask each one to provide a written list of objectives, then move onto group discussion. This promotes thinking from every individual (Keeney, 1992). If general discussion began immediately it would be easy for members to anchor on the first ideas.
>
> Several devices, other than those mentioned above, can help stimulate formulation of objectives (Keeney, 1992):
> 1. Drawing up a wish list.
> 2. Use of alternatives.
> 3. Identifying problems and shortcomings - articulate reasons for concern.
> 4. Identify consequences of existing objectives and management actions.
> 5. Use of different perspectives.

Step 7. Prioritize the objectives

It is important that objectives are prioritised to avoid conflict between the various objectives and to facilitate management (Coombes and Mentis, 1992).

Prioritising objectives is both difficult and subtle. Use the vision, strengths, principles and context as a basis to prioritize the objectives. It is important to note that the priority may change according to the level of management.

> Negotiation is an important tool. Not all the objectives will stand up to this process and there will be many perceptions of what is most important.
>
> The preceding steps of the protocol have set a good foundation though. Use this information to rationalize and prioritize the objectives.
>
> *One of the most useful devices for prioritising* is simply to ask WHY? Why is A preferred to B? (Keeney, 1992).

Step 8. Set goals

Construct an objectives hierarchy by decomposing the upper level objectives set into component objectives ("sub-objectives") of increasing focus, rigour and achievability. The final level represents acceptable, achievable and auditable goals.

The realisation of a goal often depends on its relationship with other goals. The relationship can be of three types (Miller and Child, 1983; Coombes and Mentis, 1992):

1) complimentary; where attainment of the one goal facilitates or causes the attainment of the another.

> Use the same procedure as for formulating objectives (Step 6) to sub-divide objectives into smaller and smaller, more circumscribed units until the statement ceases to describe an intent and becomes one of "what to do" (goal). *You have set a goal when clear* statements of the temporal, spatial and resource limits have been identified and they are unequivocally achievable.
>
> The most difficult task is to ensure that the smallest number of goals is set to achieve a particular objective. Again, ask WHY? Why is this needed, why is it the best option? Remember, the purpose is to maintain strengths by overcoming constraints and th... Also remember that one reason why you are conducting this exercise is to focus management on achievable goals. Therefore repeatedly check that the resources needed are available or potentially available.

2) indifferent; attainment of the one has no influence on the attainment of another,
3) conflicting; where attainment of the one causes a decrease in, or difficulty in, the attainment of another.

Goals need to be prioritised because of these three types of relationships. Different degrees of rigour can be given to the time frame of different priorities. A goal may have a low priority because other goals have to be achieved first, not because it is less important. Future goals may have low priority now, but will be given a time frame for revisiting them. One of the reasons for prioritising is to check for redundancy of goals between objectives. Often one goal serves two objectives or needs minor modification to do so.

Separate the goals for each objective into "organisational" and "conservation" goals. The organisational goals are those needed to set up processes and structures which will allow the organisation to function in a strategic manner. They are essentially administrative and bureaucratic and can be transferred to an appropriate Goal Maintenance System (section 4.5). Conservation goals, on the other hand, are those goals which define ecosystem endpoints or targets for conservation.

4.4 The procedure

Any attempt to set up an objectives hierarchy within or between organisations will entail dealing with peoples sensitivities, values and prejudices (Rogers and Bestbier, 1997). Having a protocol which explains what to do is of little value without guidance on how to do it, in a manner which keeps the process constructive and ensures consensus on, and commitment to, the end product.

Since strategic and goal-orientated management is new to conservation, especially in South Africa, any attempt to initiate it, and to develop an objectives hierarchy, will encroach on people's comfort zones (Rogers and Bestbier, 1997). Resistance to change is prevalent in all organisations (Calero and Oskam, 1983; Armstrong, 1990; Gunderson *et al.* 1995) and if not properly managed it will lead to decreasing morale, commitment and motivation. This resistance is natural - it arises out of a fear of losing stability and of the unknown (Armstrong, 1990). Therefore, overcoming resistance to change hinges on developing an atmosphere of trust. The best way of achieving this is to ensure that the process of change focuses on future needs, of individuals and the organisation, rather than present or past problems (Rogers and Bestbier, 1997). Needs, however, involve values and a structured procedure of negotiation is the best way to integrate values and meet needs. It is an axiom in such situations that everyone should recognise that the best way to achieve what they want, is to help others achieve what they want or need (Calero and Oskam, 1983). This philosophy should be central to any development of an objectives hierarchy for strategic conservation management.

Negotiation, to most people, means reaching compromise on solutions to the problems. Generally, such "negotiation for compromise" (Figure 4.3) leads to pragmatic but short term solutions. However, they are value neutral and are not durable beyond the specific negotiation circumstances (Rogers and Bestbier, 1997). Clearly, this would not be suitable for strategic management.

An alternative approach (Figure 4.3) focuses on developing a common understanding among parties of the values and needs which the future must hold (Rogers and Bestbier, 1997). This is a far more useful approach, better suited to conflict resolution in general. More importantly, it forms a firm foundation for the value-based decision making so fundamental to conservation management.

The most important procedure in this alternative approach to negotiation is to have all parties elucidate their values, needs and problems at the start of the exercise. This is not always easy to achieve and many iterations may be required before a complete list of values, needs and problems, understood by all, is established. This list then forms the basis for the other steps in that it facilitates adherence to the axiom that "the best way to achieve what you want, is to help others achieve what they want". Everyone now knows what the others want and what their values are. This basic procedure, laying all the cards on the table before attempting to discuss their merits, can be used at any point in developing an objectives hierarchy. It is built on another axiom of change management and negotiation which is: expose parties to all the possible solutions to a problem before attempting to select one to implement (Calero and Oskam, 1983;

Keeney, 1992). All too often people try to select the best of the immediately obvious solutions without sufficient analysis of either the problem or the possible solutions (Keeney, 1992). Therefore, unnecessary or even antagonistic debate is inevitable because the foundations for making a decision have not been properly laid (Rogers and Bestbier, 1997).

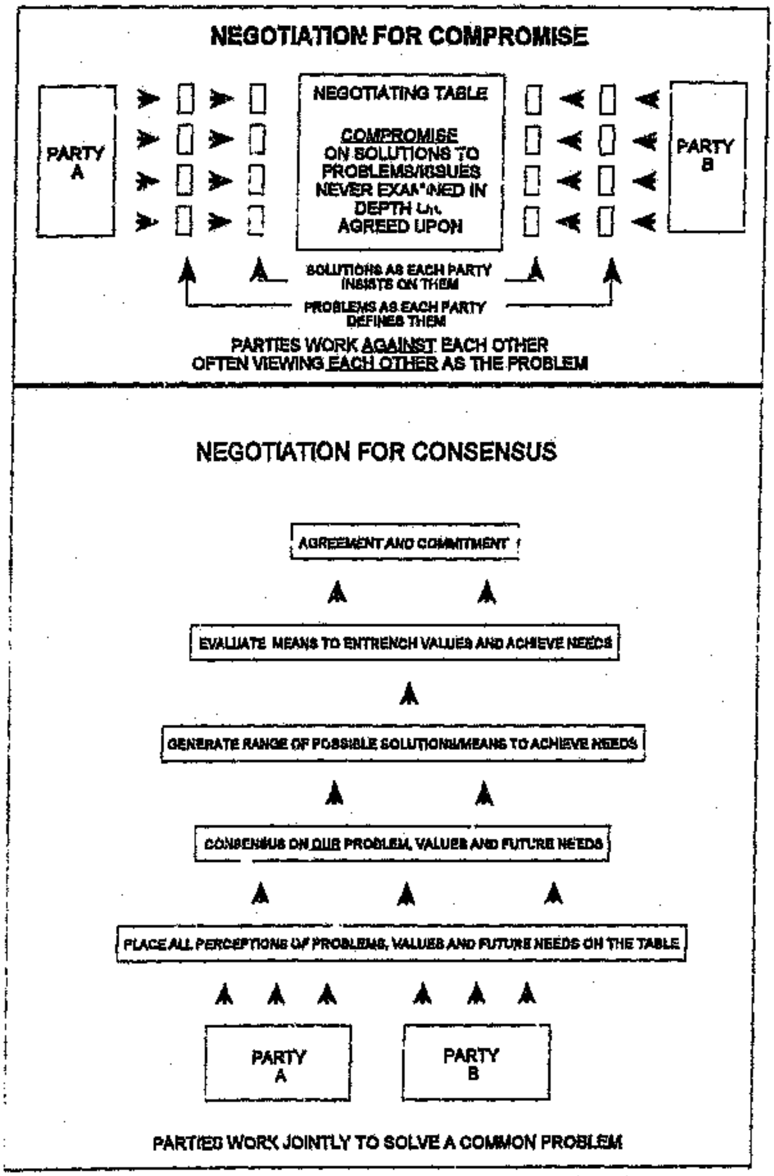

Figure 4.3 Contrasting negotiation strategies (After Rogers and Bestbier, 1997).

4.6 Protocol for a Goal Maintenance System

The Goal Maintenance System (Figure 4.4) provides an iterative internal auditing system to promote interaction between managers and ensure feedback between managers and scientists. The fundamental purpose of the Goal Maintenance System is to ensure that once acceptable goals have been set, they are met, revised, audited and, when necessary, reintegrated into the management process. Proper documentation of decisions taken and the reasoning behind them will provide the organisational memory needed to keep future management "on track".

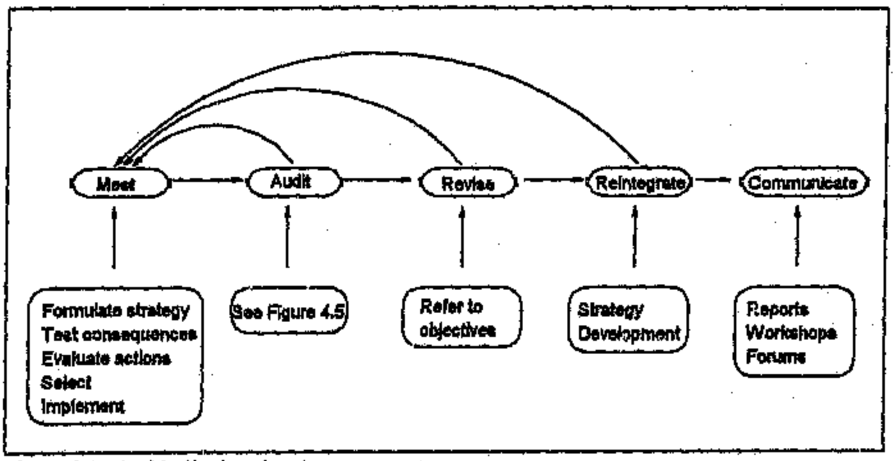

Figure 4.4 An idealised goal maintenance system.

The protocol outlined here will need slightly different interpretations for organisational and conservation goals but the principles embodied in the steps remain the same for both types of goal.

Step 1. Achieving the goals

Five steps are necessary to achieve a goal (Figure 4.5), namely:

1. Formulate a strategy with appropriate actions and tasks needed to achieve the goal.
2. Test (predict) the consequences of the actions to check the likelihood of them achieving the goal.
3. Evaluate the actions relative to the goals. Is the effort warranted and within resource constraints?
4. Select appropriate tasks and milestones for meeting the goals.
5. Implement the tasks and actions.

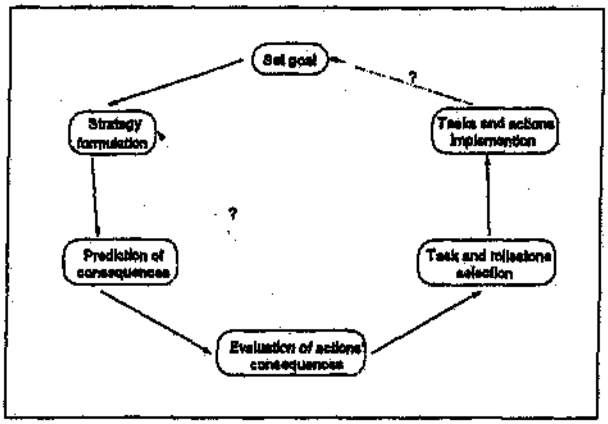

Figure 4.5 Achieving the goals.

Step 2. Audit the goals

1. Check that the actions for achieving the goals have been implemented as prescribed (Figure 4.6).
2. Monitor the consequences of the actions relative to the goals and the predictions made (this acts as an early warning system: see Step 1,#2).

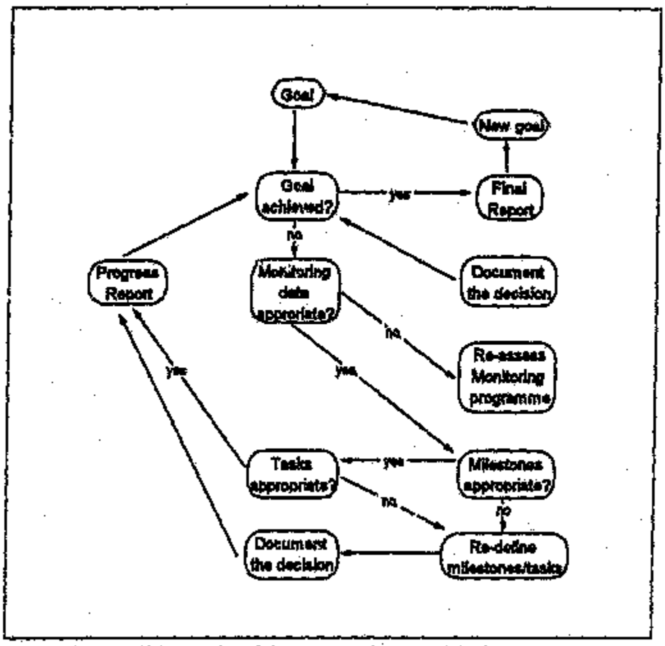

Figure 4.6 Auditing and revising the goals (after Blackmore, 1995).

Step 3. Revise the goals

Compare the results of the audit with the original goals and objectives to determine if the goal needs to be revised or if new goals need to be added (Figure 4.6).

Goals will normally only be changed if a change occurs at a higher level in the objectives hierarchy. This rule reduces the chance of goals being changed as a result of a change in staff or their enthusiasm (Blackmore, 1995).

Goals could be modified when:

1. there is strong motivation that a goal has been poorly or loosely defined,
2. there is change in the understanding of the potential of the system being managed, or
3. the full implications of the goal where not clearly understood (Blackmore, 1995).

While is important to be able to alter goals as the need arises, goals should be sufficiently entrenched to ensure continuity of purpose in the long term (Martin, 1984)

Step 4. Reintegrate the goals

If goals have been revised or new goals generated ensure that they are harmonious with the existing goals and objectives (Figure 4.6). Note that the *ad hoc* addition of goals without careful reintegration will erode the integrity of the goal orientated process.

Step 5. Actively communicate the goals and their attainment

Reports, workshops, meetings and fora are effective means of communication.

Goals, and the decision-making process preceding their setting, need to be actively communicated so that people at all levels of management are aware of the status of the system and their role within it.

4.6 Conclusion

The objectives hierarchy protocol potentially has wide use in conservation management and in environmental management because it has the following key principles: It generates forward planning therefore it leads to pro-active, strategic - not reactive - management systems. The definition of acceptable and achievable targets leads to action plans. It leads to accountability as a partnership among the role players is needed to identify needs and priorities. The objectives hierarchy protocol has higher level application, for example it can be readily adapted to form part of policy planning, provided that communities and stakeholders participate in the process of defining an objectives hierarchy. Once the objectives hierarchy has been developed it provides an explicit, well documented management decision process that can be justified. The protocol is easy for those unfamiliar with decision making methods to understand and use. It promotes and focuses discussion on objectives and goals. It is flexible and suitable for use in workshops and meetings (e.g. can swop vision and context steps depending on familiarity with the system).

The structured nature of the protocols forces managers and scientists to focus explicitly on aspects of their organisation and the system under management that they would usually gloss over, such as the operating principles of the organisation. Such principles provide an ethical and usually subconscious "control". Making them explicit and part of the procedure, guides the planning so that potential conflicts may be avoided.

Another advantage of following these protocols is that they provide a documented record of the decisions made with respect to vision, objectives and goals. and the actions plans implemented. This record will serve to justify, defend or refute future management actions and will also provide a base from which to work and increase the level of accountability, it therefore serves as a basis for organisational memory of the conservation organisation.

However effective the procedure may be, the objective hierarchy reflects the knowledge and judgement of the participants. therefore the objectives hierarchy is only as good as the input provided. This procedure is not regarded as definitive, but rather as a practical aid with a broad range of application, that should be refined through further use.

Most importantly, these protocols allow both managers and scientists to articulate their needs and then to reconcile them in a fruitful manner by developing a 'common' vision for the managed system. This is vital for interfacing science and management. The managers and scientists remain faithful to their culture and paradigms (section 2.2) but they now have a common 'currency' for interaction. Managers know what they are trying to achieve, the scientists know what the managers want, therefore the products that scientists produce with reference to the objectives hierarchy will have much more relevance to managers. This is expected to promote positive interaction between the two and thus help overcome the barrier of the "strategy of hope".

CHAPTER FIVE

An Objectives Hierarchy for Nylsvley Nature Reserve

5.1 Introduction

This chapter is a detailed presentation of the objectives hierarchy for Nylsvley using the protocol (section 4.3) and the negotiation procedure (section 4.4) described in Chapter Four.

5.2 Developing an objectives hierarchy for the reserve

Four workshops were held during 1996 to develop the objectives hierarchy for the reserve. Eleven managers and six scientists familiar with the reserve were present at these workshops (Details of the participants are provided in Appendix B). The objectives of the workshops were:

1) to familiarise the participants with the protocol for developing an objectives hierarchy, and
2) to define an objectives hierarchy for the Nylsvley Nature Reserve.

The first of the four workshops was facilitated by Prof K.H. Rogers. Once the workshop process was accepted and underway, I undertook the role of facilitator. These workshops were run in the same manner as the initial workshop in December 1995 (section 4.2.3), thus the workshops were highly participative with broad input, ensuring ownership and buy-in from the participants.

The explicit product of these workshops, an objectives hierarchy for the Nylsvley Nature reserve, is presented in the same step-by step format as the objectives hierarchy protocol (section 4.3). The rationale behind the vision and the objectives is explained in detail where appropriate. The objectives hierarchy for the Nylsvley Nature Reserve was developed by its managers under Prof Rogers', and then my, facilitation. Note that I did not produce this hierarchy, although I did play an instrumental role as a "scientific broker" and facilitator in encouraging the reserve managers into a new reality of conservation management which is reflected in the objectives hierarchy.

The context (Step 2) and strengths (Step 3) were identified during the workshop by the participants in a very rudimentary form as they were familiar with the reserve. Many of the points have been elaborated, and referenced, in this thesis to allow the reader to follow the reasoning behind the objectives hierarchy, but more importantly it provides a form of organisational memory. By referring to this step-by-step account of developing the objectives hierarchy a new manager should be able to understand why certain decisions have been made and also learn about the reserve and floodplain system in a relatively quick and easy manner. Much of what is presented here can also be found in the management module of the interactive computer program "Nylsvley Management Information System" (Chapter Six, Appendices E and F).

5.3 The Objectives Hierarchy

Step 1. Reach consensus on the vision and operating principles

Prior to this exercise there was no explicitly stated, official vision for the reserve in its management plan, i.e. there was no hierarchical structure to management planning and much of it was reactive (sections 3.4 and 3.5).

An explicit vision, that reflected the "core business" of the reserve, was developed at the initial workshop. The core business of reserve was identified as being the *conservation* and *sustainable utilisation* of natural resources for the *benefit of man*. This is in line with the new Environmental Policy and Constitution of South Africa. The vision for the reserve also had to be developed with the new vision of the Northern Province's Department of Agriculture, Land and Environment (hereafter referred to as the Department) in mind, under whose jurisdiction the reserve falls, to ensure that no conflicts of interest would arise. The new vision for the Northern Province was:

> *"To ensure a clean, healthy and sustainable environment."*

The derived vision for reserve was:

> *"To recognise the uniqueness of the Nyl floodplain system, to manage for biological integrity within the reserve and to promote conservation and sustainable utilisation within the entire catchment."*

The vision for the reserve was cast in the light of conserving the entire floodplain, from Moordrift to Potgietersrus. The floodplain area protected within the reserve is an integral part of the whole floodplain system, thus the reserve could provide a basis for further expansion of the area of floodplain under protection.

The vision for the reserve incorporates a number of key concepts; namely *conservation*, *sustainable utilisation* and *biological integrity*. A brief definition of each concept was developed.

Conservation

Broadly, *conservation* is defined as the preservation of critical resources so that normal ecological structure and function may continue and so that future options can be kept open (Owen-Smith, 1988; Mangel *et al*, 1996).

Conservation means:

1) The act or process of conserving;

2) a. Preservation from loss, damage or neglect. b. The controlled (i.e. restrained) use and systemic protection of natural resources such as forest, soils, water systems (Czech, 1995)

Sustainable utilisation

Sustainable utilisation refers to utilisation of natural resources ranging from consumptive to non-consumptive in a manner that ensures future options are kept open (Daily and Ehrlich, 1992; Cowan, 1995; Mangel *et al*, 1996). Consumptive uses would include the harvesting of grass for thatching or wood for fuel, while non-consumptive uses would include bird-watching. A sustainable process is one that can be maintained without interruption, weakening or loss of the valued properties of the system (Daily and Ehrlich, 1992).

Biological Integrity

Functioning and sustainablity of ecosystems may depend on their biological integrity (Tilman *et al*, 1996; Risser, 1994; Walker, 1995). Integrity implies an unimpaired condition, or quality or state of being complete or undivided (Angemeier and Karr, 1994; Karr, 1997). Biological integrity is defined as the ability to support and maintain a balanced, integrated, adaptive biological system having a full range of elements (genes, species, and assemblages) and processes (mutation, demography, biotic interactions, nutrient and energy dynamics and metapopulation processes) expected in a natural habitat of a region (Angemeier and Karr, 1994; Karr, 1997). Inherent in this definition is that (Karr, 1997):

1. Living systems act over a variety of scales from individuals to landscapes;
2. A fully functioning living system includes items one can count (the elements of biodiversity) plus the processes that generate and maintain them;
3. Living systems are embedded in dynamic evolutionary and biogeographic contexts that influence and are influenced by their physical and chemical environments.

By including "managing for biological integrity" in the vision, reserve managers recognise that ecosystem processes as well as species need to be managed, not only species.

Operating principles for the Reserve

Before deriving objectives and goals to achieve and maintain the vision, it was necessary to delineate the operating principles to which the reserve management would subscribe. Consensus was reached on the following operating principles, many of which were already part of the "culture" of the Department. Nationally, these principles are well recognised conservation principles (IUCN, 1980; Mangel *et al*, 1996).

1. Permit controlled utilisation. This means the conservative utilisation of resources and it includes tourism.
2. Promote and facilitate environmental education.
3. Rehabilitate the environment where necessary.
4. Subscribe to all treaties to which S.A. is party, eg. Ramsar Convention (Convention on Wetlands of International Importance especially as Waterfowl Habitat) and the Biodiversity Convention. These have accompanying principles which must be adhered to, such as promoting the wise of wetlands.
5. Maintain the integrity of the system (habitat and species).
6. Promote ecotourism.
7. Ensure that all development does not exceed resource potential.
8. Maintain the aesthetic quality of the area.

Step 2. Provide the context for setting the goals

The context for reserve and floodplain is described at local. national and international levels, however under each geographical level ecological, socio-economic and legal context is also included.

International context

- A proposal has been drawn up to have the Nyl River floodplain listed as a wetland of international importance according to the Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention). (Note: The proposal has subsequently been accepted and Nylsvley is now a designated Ramsar site.)

- International scientists have recognised it as an important representative site of the savanna biome. Much savanna research has been carried out at the reserve under the auspices of the International Geosphere-Biosphere Program (Scholes and Walker, 1993).

- Numerous international and regional Red Data species are found at Nylsvley, some of which breed at Nylsvley. The mammalian Red Data species are Roan antelope (*Hippotragus equinus*), Tsessebe antelope (*Damaliscus lunatus*), and serval (*Felis serval*) (Higgins and Rogers, 1993). Birds include the Dwarf Bittern (*Ixobrychus sturmii*) and Woollynecked Stork (*Ciconia episcopus*) (Appendix D) (Brooke, 1984; Tarboton, 1987a).

- The reserve has the highest bird species diversity in the Southern Africa, with 370 bird species recorded to date (Tarboton, 1977; Friends of Nylsvley Newsletter, 1997).

- The reserve is internationally recognised as being an excellent destination for bird-watchers as a result of its high species diversity.

- The floodplain is a unique system in South Africa in that it is the largest floodplain vlei in Southern Africa (Higgins and Rogers, 1993).

- South Africa is a member of the International Waterfowl and Wetland Research Bureau. The floodplain could potentially be used to build capacity in wetland management in South Africa because of its size, as well as the facilities available at the reserve for conducting training workshops.

National context

- The reserve has a high ecotourism potential, especially for bird-watching. The reserve forms the core of a growing ecotourism industry on the floodplain. The combination of antelope species, large flocks of birds and the physiognomy of a true African Savanna assures the ecotourism potential of the floodplain and the reserve (Higgins and Rogers, 1996).

- Twenty-three Red Data bird species (Brooke, 1984; Tarboton, 1987b) and three Red Data mammalian species are found at reserve and on the floodplain as a whole (Higgins and Rogers, 1993) (see International context).

- The vegetation of the floodplain is unique in that it is the only wetland in South Africa which is dominated by wild rice (*Oryza longistaminata*) (Marneweck, in prep; Ashton, 1993).

- The reserve is a nationally recognised research site. It is one of the better studied wetland areas (Tarboton, 1987b) while its savanna component is the best studied in the country and one of the best studied in the world (Scholes and Walker, 1993).

- The reserve is a Proclaimed Provincial Nature Reserve since 1974 (de Villiers, 1986) therefore it is legally protected.

- Legislation to implement the Ramsar Convention is now in place. This will have implications for the manner in which the reserve is managed once the floodplain is declared a Ramsar site. Provided its ecological character is maintained, for example, "wise use" of the floodplain is possible. Wise use is defined as "sustainable utilisation for the benefit of humankind in a way compatible with the maintenance of the natural properties of the ecosystem" (Cowan, 1995).

- While floodplain systems are poorly represented in South Africa, the Nyl River floodplain is the largest periodically inundated grassland floodplain in the country (24000ha) (Rogers, 1995).

Local context

- The floodplain is used primarily for agricultural purposes and game farming. The Nylsvley Nature Reserve and several privately owned nature reserves are located on the floodplain (Ashton, 1993).

- The reserve is situated in an agricultural area, with no large rural development or communities in proximity. Thus it serves as a refuge for "problem animals", such as warthog, jackal, *Quelea quelea*, finches and vervet monkeys in the area. The Redbilled Quelea (*Quelea quelea*), for example, are major pests for grain farmers on the Springbok Flats and the flocks, which may number in the millions, often roost in the *Phragmites* reedbeds on the floodplain (Rogers, pers comm).

- The floodplain is an important local breeding site for birds. Fifty-seven of the 102 aquatic birds recorded on the floodplain breed there (Tarboton, 1987b).

- The floodplain plays a significant role in all water issues in the catchment, for example; the building of dams on, and extraction of water from, the floodplain for irrigation purposes alters the frequency, timing, extent, depth and duration of the flooding regime that is essential for ensuring the productivity of the system (Higgins and Rogers, 1993).

- The floodplain's high productivity and soil fertility provides important grazing for cattle. It has a stocking rate which is ten times higher than the surrounding terrestrial systems (Higgins *et al*. 1996).

- The reserve has a high ecotourism potential, as a result of its high bird species diversity (see national context).

- The reserve is a source of employment for the community living near the reserve. There are 23 people employed a. .e reserve whose main job functions range from cleaning dormitories to clearing invasive plants (de Vos, pers comm).

- The floodplain is situated in a semi-arid savanna region (Higgins and Rogers, 1993; Frost, 1987), and the reserve is a good example of a component of the savanna biome (Scholes and Walker, 1993).

Step 3. Document the strengths of the system

This initial list of known and perceived strengths was compiled for the reserve. Many of these strengths have also been listed as context (see Step 2).

1. There is a good base of scientific information available. The Savanna Ecosystems Project generated much information (Scholes and Walker, 1993), as well as the Foundation for Research Development (FRD) funded programme "Nylsvley as a functional unit of the landscape", which focused on the structure and function of the floodplain. Numerous other individual research projects have also been conducted on the reserve since 1974 (Higgins and Rogers, 1993).

2. The floodplain is an excellent staging site for 102 aquatic bird species, 52 of which breed there (Tarboton, 1987b; Higgins *et al*, 1996).

3. The reserve has a large number of Red Data species (especially fauna); 23 bird species (Tarboton, 1987a) and three mammal species (Higgins and Rogers, 1993) (refer to context for details).

4. The reserve has a good spectrum of wild animals, ranging from aardvark to zebra, due to the variety of available habitat (de Villiers, 1986; Higgins and Rogers, 1993; Scholes and Walker, 1993).

5. The floodplain system is located in the bushveld savanna of South Africa and thus has numerous recreational and aesthetic attributes, such as hiking and birdwatching among others (Higgins and Rogers, 1993).

6. The reserve has a very high species and habitat diversity. The reserve contains approximately 600 plant species, 370 bird species, 67 mammal species, 18 amphibian species, 54 reptilian spec:es and a large, but unknown number of insect species (including at least 194 butterfly and moth, 60 grasshopper, 21 termite and 78 dung beetle species) (Coetzee *et al*, 1976; Jacobsen, 1977; Tarboton, 1977; Endrody-Younga, 1982; Ferrar, 1982; Gandar, 1983; Grei, 1990).

7. The catchment area of the floodplain, the Waterberg region and its foothills, is relatively small (520 km^2) (Tarboton, 1987b) and the potential for development is not high (other than the potential for building dams).

8. The reserve is highly accessible from Gauteng via railway and toll-road. The reserve is approximately 200 km from Johannesburg and less than 100 km from Pretoria, therefore its potential as a weekend getaway for city dwellers is high.

9. The wide variety of species and habitats, as well as the available facilities provide good research and education opportunities.

10. The floodplain and the reserve have good water quality due to the ability of the floodplain to collect and purify water (Rogers, 1995).

11. The reserve was proclaimed a protected area in 1974 (de Villiers, 1986), therefore it has legal protection.

12. The floodplain and the reserve is highly productive in terms of game (de Villiers, 1986).

13. There is a high tourism potential for the whole system, not just the reserve, as the floodplain extends from Moordrift to Potgietersrus; see context) (Higgins *et al*, 1996).

14. Many of the landowners on the floodplain are conservation conscious and therefore the potential to form a conservancy is good. Many of the farms became private nature reserves in 1973 (Tarboton, 1987b).

15. There are no highly dangerous animals (excluding snakes, such as black mambas (*Dendroaspis polylepis polylepis*)), therefore researchers and tourists can walk around with relative freedom. This is especially important from a bird-watching point of view.

16. There are good facilities for conferences and workshops. There is a conference room, a large kitchen and numerous dormitories (personal observation; de Vos, pers comm; Nel, pers comm).

17. Although there are mosquitoes, including *Anopheles gambiae*, during the wet season, the parasite causing malaria, *Plasmodium falciparum*, is not present (Tarboton, 1987b). There are also no tsetse flies (*Glossina sp*) (de Vos, pers comm).

18. The reserve is accessible to the community as currently there are no gate fees (de Vos, pers comm).

Step 4. Evaluate and consolidate the strengths

A matrix was used to initially identify any conflicting and complementary strengths. The interaction between the two strengths may be unknown in some cases due to lack of understanding or lack of data.

Table 5.1. Initial evaluation of the strengths of Nylsvley Nature reserve and Nyl floodplain

(Key: O - complimentary X - conflicting ? - unknown)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	–	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O
2		–	?	O	O	O	O	?	O	O	O	?	?	O	X	O	O	?
3			–	O	O	O	O	?	O	O	O	O	?	O	?	O	O	?
4				–	O	O	O	?	O	O	O	O	?	O	?	O	O	?
5					–	O	O	?	O	O	O	?	O	O	O	O	O	O
6						–	O	?	O	O	O	O	?	O	?	O	O	?
7							–	O	O	O	?	O	O	O	O	O	O	O
8								–	O	?	?	?	O	O	O	O	O	O
9									–	O	O	O	O	O	O	O	O	O
10										–	O	O	X	O	?	O	O	?
11											–	O	X	O	?	O	O	?
12												–	?	O	?	O	O	?
13													–	O	O	O	O	O
14														–	O	O	O	O
15															–	O	O	O
16																–	O	O
17																	–	O
18																		–

While the majority of the strengths compliment each other. there are some that appear to be conflicting or their interaction is unknown. The conflicting and unknown interactions can be divided into two main areas of concern: 1) biodiversity vs tourism, and 2) the floodplain (with the associated aquatic birds) vs Roan. These potential conflicts had to be taken into account when defining and prioritising the objectives and goals for the reserve (*steps 6-8*).

Biodiversity vs tourism. The interactions between the 'biodiversity' strengths (strengths 2, 3, 4, 6, 11 and 12) and those of accessibility and potential for tourism of the reserve (strengths 8,13,15,18) are unknown or potentially conflicting. The biodiversity strengths attract tourists to the reserve. but a high human impact because of the accessibility of the reserve may lead to negative impacts on the biodiversity. Use by tourists creates pressure on the physical environment and may cause important changes to the natural habitats (e.g., soil compaction, loss of organic matter, or erosion) (Liddle, 1975; Brown *et al*, 1977; White and Bratton, 1980; Hall and Kuss, 1989; Matlack, 1993). This has important implications for the way in which the reserve should be managed; i.e. a long-term land use planning and management approach that embraces ecological perspectives must be adopted to ensure the ecological/biological integrity of the reserve (Lajuenesse *et al*, 1995).

Water quality (strength 10) may also be negatively affected by increased human impact which may cause increased soil compaction, loss of organic matter and/or erosion (Liddle, 1975; Brown *et al*, 1977; White and Bratton, 1980; Hall and Kuss, 1989; Matlack, 1993) on the reserve and the floodplain.

The floodplain vs Roan. Other potential conflicts occur between the strengths of the floodplain and the birds (2 and 5), and those of game species productivity, in particular Roan (strengths 3 and 12). The floodplain is a recognised breeding and staging site for nomadic birds, including numerous Red Data species, yet the reserve management has continued with an informal program to breed Roan. Many of the management practices to maintain a Roan population require active intervention in floodplain processes.

Many warthog, for example, are regularly culled as they are perceived as "destroying" the tall floodplain grasses that the Roan feed on such as *Oryza longistaminata*. It has been conjectured that the resultant low populations of warthog may cause significant vegetation change, which in turn may affect the foraging of floodplain bird species (Marneweck, pers comm; Rogers, pers comm). The wallows created by warthog have slightly different physical and chemical charateristics (clay content, conductivity and nutrient content) to the surrounding floodplain (de Fonteine, 1991; Rickard, 1993). These differences may be important for the germination of various grasses, in particular *Panicum schinzii*, whose seed is highly favoured by many aquatic birds (Petrie, 1997). Therefore culling warthog has a number of implications for the functioning and structure of the floodplain that the managers may not have considered, such as decreasing the forage for aquatic and non-aquatic birds among others.

Condensed list of strengths

The list of eighteen was then consolida and condensed to the following consensus view by grouping similar strengths together to reduce redundancy and to simplify the next step. The 'consensus' strengths are presented in italics with the justification below. These strengths are documented in the Nylsvley Management Information System within the Management Module (see Appenedix F and Chapter 6, section 6.3.2).

1. *There is a good base of scientific information available on which to build.*
   The Savanna Ecosystems Project generated much information (Scholes and Walker, 1993), as well as the FRD funded programme "Nylsvley as a functional unit of the landscape", which focused on the structure and function of the floodplain. Numerous other individual research projects have also been conducted on the reserve since 1974 (Higgins and Rogers, 1993).

2. *The floodplain is an excellent breeding and staging site for nomadic aquatic birds.*
   The floodplain is an excellent staging site for 102 aquatic bird species, 52 of which breed there (Tarboton, 1987b; Higgins *et al*, 1996).

3. *The reserve has a very high species, including Red Data species, and habitat diversity.*
   The reserve has a large number of Red Data species (especially fauna); 23 bird species (Tarboton, 1987a) and three mammal species (Higgins and Rogers, 1993) (refer to context for details). The reserve has a very high species and habitat diversity (de Villiers, 1986; Higgins and Rogers, 1993; Scholes and Walker, 199'). The floodplain and the reserve is also highly productive in terms of game (de Villiers, 1986).

4. *The floodplain system is located in the and therefore has numerous recreational and aesthetic attributes.*

The floodplain system is located in the bushveld savanna of South Africa and thus has numerous recreational and aesthetic attributes, such as hiking and birdwatching among others (Higgins and Rogers, 1993).

5. *The reserve is highly accessible.*

The reserve is highly accessible from Gauteng via railway and toll-road. The reserve is approximately 200 km from Johannesburg and less than 100 km from Pretoria, therefore its potential as a weekend getaway for city dwellers is high. The reserve is accessible to the local people as currently there are no gate fees (de Vos, pers comm). There are no highly dangerous animals (excluding snakes), therefore researchers and tourists can walk around with relative freedom. This is especially important if bird-watching is to be promoted. Although there are mosquitoes during the wet season, the parasite causing malaria is not present (Tarboton, 1987b). There are also no tsetse flies (de Vos, pers comm).

6. *The catchment area of Nylsvley is not too big and the potential for development is not very high.*

The catchment area of the floodplain, the Waterberg region and its foothills, is relatively small (520 km^2) (Tarboton, 1987b) and it has limited exploitative resources therefore the potential for development is not high (other than the potential for building dams).

7. *There are good research and education opportunities and facilities.*

There are good research and education opportunities because of the wide variety of species and habitats (Higgins and Rogers, 1993: Scholes and Walker, 1993). There are also good facilities for conferences and workshops. There is a conference room, a large kitchen and numerous dormitories (personal observation; de Vos, pers comm; Nel, pers comm).

8. *The floodplain has good water quality.*

The floodplain and the reserve have good water quality due to the ability of the floodplain to collect and improve the quality of water (Rogers, 1995).

9. *The reserve was proclaimed a protected area in 1974.*

The reserve was proclaimed a protected area in 1974 (de Villiers, 1986), therefore it has legal protection.

10. *There is a high tourism potential for the whole system not just the reserve.*

There is a high tourism potential for the whole system, not just the reserve, as the floodplain extends from Moordrift to Potgietersrus; see context) (Higgins *et al*, 1996). Many of the landowners on the floodplain are conservation conscious and therefore the potential to form a conservancy is good. Many of the farms became private nature reserves in 1973 (Tarboton, 1987b).

Step 5.	*Record all the determinants of the strengths*

Table 5.2. Determinants of, and constraints (inside the organisation) and threats (outside the organisation) to, the strengths of the Nylsvley Nature Reserve. Suffixes refer to key information sources.

Strengths	Determinants	Constraints	Threats
1. A good, but limited, information base on which to build.	• There is a history of academic and management involvement in research on the reserve. • Information on a wide variety of themes (from birds to geology) and from numerous sources (researchers, managers, public) is available.	• The information is not in a user(manager) friendly format and it is also widely dispersed among the various stakeholders. • Management does not have clear goals, and therefore does [illegible] demonstrate their information requirements.	• The reserve incorporates a small part of the floodplain and its catchment, as a result researchers and managers do not have an holistic understanding of the system. • Reduced funding to academics for research. • Reduced access to the rese[illegible] for researchers.
2. It is an excellent breeding and staging site for aquatic birds.	• Hydrological and geomorphological characteristics are the primary determinants of diversity.[4] • The ge[illegible]orphology is the underlying determ[illegible]nt of floodplain process and function.[1] • The hydrological regime drives the wetland processes and influences the water quantity and quality.[1] • The grazing and fire regimes used on the reserve influence bird breeding and other life history strategies of plants and animals.[2] • Dykes built on the floodplain create habitat for numerous aquatic birds.[2,3] • High productivity of the floodplain system due to its fertile soils.[4]	• A lack of integrated understanding by management of the floodplain system as a whole.[4,8] • Lack of a broad perspective which recognises the heterogeneity of landscapes - both natural and man-modified.[4] • Lack of an interdisciplinary approach to research and management.[4] • "Territorialism" of managers exists in many state and parastatal organisations, resulting in a lack of integrated management of resources.[4] • A species-focused management approach rather than an integrated ecosystem approach. • Management does not know how to, and have not, explicitly managed for aquatic birds.	• The floodplain is situated in a semi-arid region, where water is the resource that is most limiting to human development and natural ecosystem functioning.[3,1] • Water resources development (dams, ground water abstraction, off-channel irrigation) in the catchment resulting in reduced run-off.[3,1] • Development of highways, roads and other structures across the floodplain which potentially alter floodplain structure, function and process. • Introduction of exotic plants in the catchment, such as forest plantations and invasive aliens, will alter the water quantity by reducing the run-off to the floodplain.[3] • Habitat fragmentation in the region and on the floodplain due to the different land uses such as agriculture, cattle ranching and forestry.[5]

Table 5.2. Determinants of, and constraints and threats to, the strengths of the Nylsvley Nature Reserve.

Strengths	Determinants	Constraints	Threats
2. It is an excellent breeding and staging site for aquatic birds. continued...			• Agricultural practices such as aerial spraying of *Quelea quelea* roosts with toxic chemicals have potentially serious consequences for other birds, fish and animals[3] and excessive nutrient release in agricultural runoff.[5] • A high human impact as a result of development or ecotourism may affect the life history strategies of particular aquatic birds. • Afforestation can cause large changes in soils and plant cover with impacts on hydrological processes.[1]
3. Very high species and habitat diversity.	• Hydrological and geomorphological characteristics are the primary determinants of diversity.[4] • Habitat availability is high due to the grazing and fire regimes on the reserve, and also due to the hydrological regime. • The hydrological regime drives wetland processes, and influences water quantity and quality. • Habitat diversity is a determinant of species diversity.	• Management for biodiversity can be problematic as there are few guidelines. • A species-focused management approach rather than an integrated ecosystem approach.	• The attitudes of local landowners, residents, and locals to particular species such as *Quelea quelea* and warthog, and to the floodplain as a whole. • Over utilisation of the catchment area, eg: overgrazing by domestic stock which concentrate on the floodplain during the dry season. • Severe droughts. • The same threats as for strength two.

Table 5.2. Determinants of, and constraints and threats to, the strengths of the Nylsvley Nature Reserve.

Strengths	Determinants	Constraints	Threats
4. Numerous recreational and aesthetic qualities.	• Hydrological and geomorphological characteristics are the primary determinants of landscape function and values.[4]	• Management of the floodplain is problematic - it is difficult to manage the floodplain, as it is highly variable and there are no guidelines to do so.	• The same threats as for strength 3.
5. The Reserve is highly accessible.	• A highway and a railway line from Gauteng are situated close to the reserve. • No highly dangerous animals (excluding snakes) on the reserve. • No tsetse fly and malaria carrying mosquitoes are found in the region. • No gate fees are charged at present, increasing its appeal to day visitors.	• The introduction of potentially dangerous animals such as buffalo. • A lack of marketing by management may decrease the perception of high accessibility. • There is no regular bus or taxi service to the reserve, therefore its potential as an eco-tourist destination may not be fully realised.	
6. The catchment of the floodplain is not too big and the potential for development is not very high.	• The four main contributing streams have a cumulative area of 520 km^2,[4] as a result of the regional geomorphology. • There are limited exploitative resources.		• Water resources development (dams, ground water abstraction, off-channel irrigation) in the catchment resulting in reduced run-off.[3,1] • Development of highways, roads and other structures across the floodplain. • Habitat fragmentation due to the different land uses such as agriculture, cattle ranching and forestry.[5]
7. Good research and education opportunities and facilities.	• There is a history of involvement by academics, researchers and management. • The diversity of the reserve affords many research opportunities in a wide range of fields from taxonomy to systems ecology. • There is a good group camp and infrastructure.	• Reduced access to researchers. • Lack of maintenance.	

Table 5.2. Determinants of, and constraints and threats to, the strengths of the Nylsvley Nature Reserve.

Strengths	Determinants	Constraints	Threats
8. Good water quality.	• The floodplain acts as a filter of diffuse nutrient and pollution transfer between the terrestrial system and the river channel via surface runoff and subsurface flow.[4]		• Water resources development (dams, ground water abstraction, off-channel irrigation) in the catchment resulting in reduced run-off.[3,1] • Afforestation – a decrease in natural vegetation may cause water quality problems by increasing erosion.[5,6] • Spraying of *Quelea quelea* roosts with toxic chemicals contaminates the water downstream.[3] • Increased tourism may result in decreased water quality, due to increasing sewerage demands etc.
9. Protected area.	• Proclaimed in 1974 as a provincial Nature Reserve. • The Vogelfontein farm was acquired and added to the reserve in 1997.		• Increasing public demands on uses of nature reserves and their resources such as harvesting grass for thatching purposes.
10. High tourism potential of the whole system not just the reserve.	• There are other tourist areas in the region such as Warmbaths (hot mineral springs). • A change in societal attitudes towards increasing environmental awareness and the value of ecosystems. • There are many privately owned nature reserves on the floodplain and many of the other landowners are conservation conscious. • High biodiversity attracts eco-tourists.		• Water resources development (dams, ground water abstraction, off-channel irrigation) in the catchment resulting in reduced run-off.[3,1] • Habitat fragmentation due to the different land uses such as agriculture, cattle ranching and forestry.[6]

1 - Higgins *et al*, 1996; 2 - Marneweck, 1990; 3 - Tarboton, 1987b; 4 - Rogers, 1995; 5 - O'Neill *et al*, 1997; 6 - Karr, 1997

Steps 6 -8.   Formulate and prioritise objectives, and set goals.

A hierarchical approach was adopted to formulate the objectives. The key elements of the vision were identified and then expanded upon. The key elements of the vision in this case are *conservation* and *utilisation*. Ut lisation has these key aspects; ecotourism, research and education. Consumptive utilisation is not considered a viable option on such a small reserve. Specific objectives (Figure 5.1-5.4) were formulated for each key aspect ensuring that the strengths (Table 5.2) are maintained. The maintenance of strengths 2, 3, 4 and 5, for example, is ensured by objectives 1, 2, 3 and 4 under the conservation objective.

These objectives were then prioritised according to the vision and the operating principles, therefore they are value priorities, not time priorities.

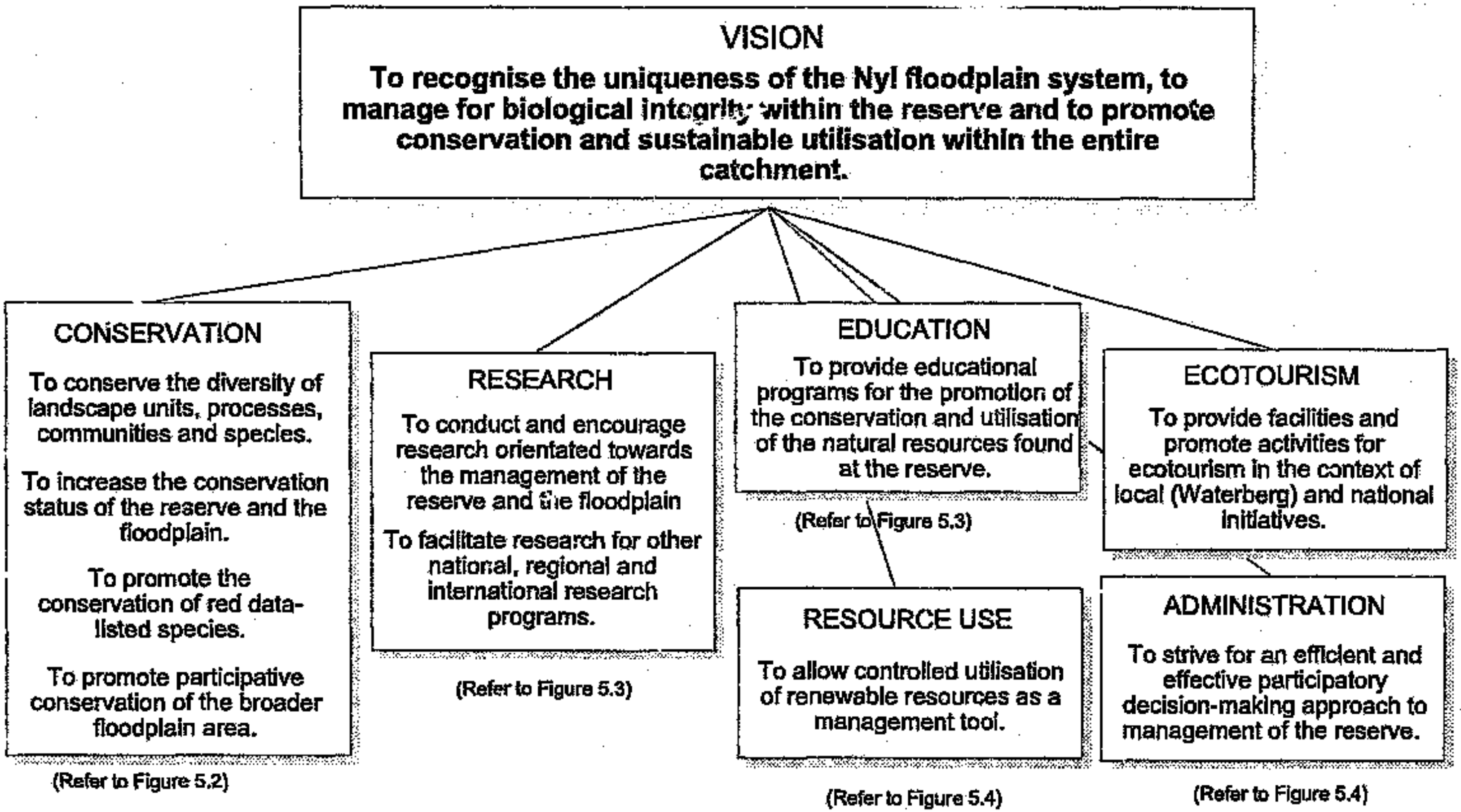

Figure 5.1. Objectives Hierarchy for the management of the Nylsvley Nature Reserve.

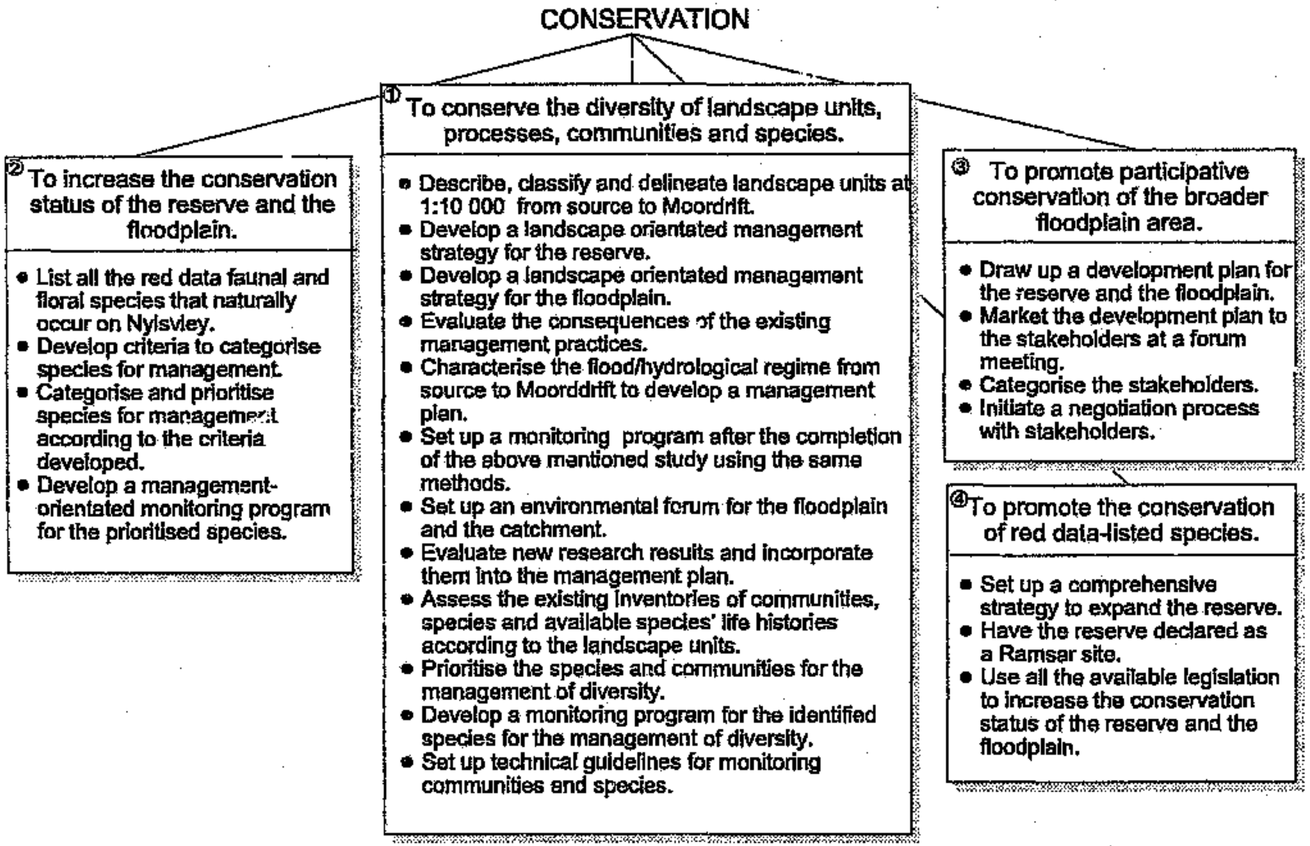

Figure 5.2. Conservation objectives and sub-objectives for the Nylsvley Nature Reserve (circled numbers at the top left-hand corner of the boxes indicate their priority rating, with 1 being the top priority)

RESEARCH

⑤ To conduct and encourage research orientated towards the management of the reserve and the floodplain

- Identify existing databases and information available for and of the reserve and floodplain and develop a information base.
- Identify research programs and projects for the reserve/floodplain to assist in the achievement of management goals and objectives.
- Prioritise programs and projects according to necessity, available finance, time and manpower.
- Identify projects that can be conducted "internally".
- List relevant "expertise" outside of the department for consultation.

⑩ To facilitate research for other national, regional and international research programs.

- Allow research from non-departmental institutions to take place that is not contradictory to the objectives of the department and reserve.

EDUCATION

⑥ To provide educational programs for the promotion of the conservation and utilisation of the natural resources found at reserve.

- Conduct a stakeholder analysis.
- Conduct a socio-ecological impact analysis
- Develop specific environmental education (EE) programs to assist in the achievement of the goals and objectives of Nylsvley.
- Upgrade the EE facilities on the Nylsvley Nature reserve.
- Translate available information into a user friendly format to use for EE purposes.
- Investigate the option of developing an environmental school at the reserve.

Figure 5.3. Research and Education objectives and sub-objectives for Nylsvley Nature Reserve(circled numbers at the top left of the boxes indicate their priority rating, with 1 being the top priority).

ECOTOURISM

(7) To provide facilities and promote activities for ecotourism in the context of local (Waterberg) and national initiatives.

- Conduct a stakeholder analysis. (see goal 6.1)
- Assimilate information on consumptive and non consumptive utilization pertaining to ecotourism.
- Determine ecotourism potential of reserve and floodplain.
- Develop and implement a tourism plan for the reserve.
- Initiate the development of a tourism plan for the floodplain.
- Establish an enviro-tourism forum for Nylsvley.

RESOURCE USE

(8) To allow controlled utilisation of renewable resources as a management tool.

- Inventory all natural resources which are and can be utilized.
- Analyse the utilization potential of natural resources (includes identifying renewable and cultural resources, eg hunting, tourism, harvesting)
- Develop sustainable utilisation strategies for each of the identified resources (eg zonation)
- Integrate utilization strategies into the overall management strategy.

ADMINISTRATION

(9) To strive for an efficient and effective participatory decision-making approach to management of the reserve.

- Have a reserve management committee meeting every three months.
- Have a regular meeting between reserve manager and staff.

Figure 5.4. Ecotourism, Resource Use and Administration objectives and sub-objectives for Nylsvley Nature Reserve(circled numbers at the top left of the boxes indicate their priority rating, with 1 being the top priority).

5.4 Discussion

The management of the Nylsvley Nature Reserve was a classic case of reactive, non strategic management. While numerous attempts had been made to transfer scientific information from scientists to managers and to determine managers' information needs, they met with little success (section 3.4). Using the objectives hierarchy as an interface there has been some success with regards to the processes that management has put into place, the products that have been developed and the roles that certain people have taken up in ensuring that the particular processes and products were developed, transferred and utilised.

5.4.1 Achievements in the development and implementation of the Nylsvley objectives hierarchy

Nylsvley's management realised the need to adopt an innovative, consultative management process in which the interactions between scientists and managers are facilitated. Iterations of the management process encourage *transfer* of updated understanding and predictive potential to managers and *feedback* of management success and problems to research (Breen *et al*, 1995; Rogers, 1997).

Management is now far more structured, compared to the previous reactive, *ad hoc* way of managing (section 3.4). Compared to the "old" way of managing, management is now no longer in a vacuum. The development of the objectives hierarchy provides management with both purpose and direction.

The development of a sense of involvement, ownership and belonging by the people within the conservation organisation was important in generating the objectives hierarchy. This was achieved by involving them in the initial development of the objectives hierarchy protocol. Using a workshop environment with the use of needs-based negotiating techniques was also instrumental in developing a sense of ownership and involvement (see section 4.2).

The need for a strategic forward planning approach to management has also been recognised at the higher levels of management within the Northern Province's DALEA and as such the objectives hierarchy protocol has been accepted. These managers now want to implement it for the other reserves within the province (seven initially). They have begun the process of defining an objectives hierarchy for the D'Nyala Nature Reserve, one of the bigger reserves which is situated near Ellisras. This process has been facilitated by the "champion" within the DALEA's scientific services.

This objectives hierarchy reflects a change in thinking of the reserve management about what the reserve is about and also about what they need to do. The "old" objectives of the reserve management were primarily concerned with *conservation* per se (section 3.4) while the new objectives reflect a change in perspective with objectives related specifically to eco-tourism, resource use, environmental education and research, as well as conservation. This is a more modern approach to conservation management, than the previous "preservation" type of management (section 5.2, steps 6-8).

The objectives also reflect that the reserve management have adopted a landscape approach to management (section 5.2, steps 5 and 8). This is a significant move from a species/population focus in management and is in line with modern scientific thinking (Pickett *et al*, 1997).

Now that an objectives hierarchy is in place future managers of the reserve will have a record of what decisions were made, why they were made, and how they relate to each other.

Fundamental to the development of the interface for Nylsvley was the development of informal collegia (networks), with contact inside and outside the system. These informal collegia, comprising people such as Prof Rogers and myself who are outside the system and Lizanne Nel and Johan Kruger who are inside the system, were necessary for unlocking "organisational gridlock" (*sensu* Holling, 1995). During this study I acted as a "scientific broker". I built on the "network" that has been developed by previous "brokers" from the University of the Witwatersrand and the reserve management. During this study period I have established personal contact with numerous DALEA personnel, which has been of prime importance in building mutual respect and trust. Mutual respect and trust is imperative for the successful development of a successful interface.

During the development of the objectives hierarchy protocol and the objectives hierarchy for the reserve, a high level "champion" emerged from within the management structures of the Northern Province DALEA's Scientific Services. Lizanne Nel has been instrumental in the development of the objectives hierarchy for Nylsvley and in facilitating the process for developing an objectives hierarchy for other reserves within the Northern Province. Currently, Lizanne Nel (the "champion") and other members from Scientific Services facilitate the process of determining an objectives hierarchy to the level of goals. It is intended that once goals have been set, the Regional Services' managers take over. Together with the reserve managers they should set up a goal maintenance system whereby action plans to achieve the goals and the means to measure and audit them are determined.

5.4.2 Constraints and limitations to the further development and implementation of the Nylsvley objectives hierarchy

While there have been numerous successes during this study there have also been a number of difficulties which have constrained and limited the study. Most of the constraints and limitations encountered during this study are related to the people element of the interface.

Unfortunately, the objectives hierarchy for the Nylsvley Nature Reserve is not as comprehensive and complete as it could be. Using the strict definition (Box 1) no operational goals have been defined. Although they have been referred to as "goals" they cannot strictly be seen as goals as they do not have explicit spatial, temporal, quantitative/qualitative resolution which is compatible with management's potential, constraints and resources. The conservation goals are also not defined in terms of structural, compositional and functional criteria. The reasons for this are numerous and relate to the people element of the interface.

The protocol and method of developing the structured interface have been accepted at the higher levels of the Reserve's management, but they do not operate by it themselves. Therefore there is no overall management system to audit the process of developing an objectives hierarchy and operationalising it. Therefore Nylsvley stands isolated within the system at the moment. It doesn't fit in with the way the whole department operates so it is difficult for the individuals concerned to remain different even if they believe it is the 'right thing' to do. As more and more reserves begin to operate by means of an objectives hierarchy this situation should improve.

The role of the scientific broker (myself) in itself was perhaps not enough to propel the interface. There is a need to develop the role of the scientists within the conservation agency (loyal heretics) (section 2.4.2) and the role of networks (section 2.4.3) to increase the perception of value of the interface and to make it work.

5.4.3 Recommendations for further development of the Nylsvley Interface

To be successful conservation agencies need to be "learning" organisations to be truly adaptive. This interface is just the beginning. For the reserve's management to grow as a "learning" adaptive organisation the interface must be modified, changed radically or even "overthrown" (Westley, 1995). The interface should however always contain elements of vision, planning and learning that are forever "evolving".

To ensure that the interface is institutionalised the following recommendations are put forward:

1. The Reserve's objectives hierarchy must be further developed. Goals which are achievable, measurable and auditable must be defined. They must have spatial, temporal, quantitative/qualitative resolution which is compatible with management's potential, constraints and resources. Conservation goals should be defined in terms of structural, compositional and functional criteria, which have implications for the spatial, temporal and qualitative/quantitative resolution. Implicit in these criteria are confidence limits, i.e. an anticipated range of values which must be achievable and therefore testable.

2. A goal maintenance system must be set up to ensure that the managers and others involved in the Reserve know exactly what needs to be done, by when, to ensure that it is done and if necessary to change or revise the goals.

3. A low level "champion" for this specific reserve needs to be identified and nurtured to ensure the success of the interface.

4. Higher level management needs to be more supportive and generative (Senge, 1990) in their leadership.

The development of a structured interface, in this case in the form of an objectives hierarchy, takes time. It must evolve taking into account the personal growth of the individuals that function within it. Thus, a complete turnaround could not be expected within the time-span of this M.Sc however much progress has been made (section 5.4.1) and the foundations have been solidly laid.

CHAPTER SIX

Organisational Memory - The Nylsvley Management Information System

6.1 Introduction

A fundamental part of this thesis was the development of a prototype computer program called the "Nylsvley Management Information System" (NMIS). This program was built for a number of reasons:

1. "Organisational memory" is especially important in a system such as Nylsvley Nature Reserve which has high staff turnover and often inexperienced rangers are put into management positions (Chapter Three). Objective Six, *to develop a mechanism to ensure organisational memory for the Nylsvley Nature Reserve*, was addressed in part by developing the objectives hierarchy for the reserve (Chapter Five). The objectives hierarchy, however, does not provide a mechanism for ensuring that managers (and scientists) have access to past, and present, information that is relevant for considering alternative management decisions and actions. A tool had to be developed to address this need.

2. Within objectives hierarchy for Nylsvley (Chapter Five), the Research Objective (Figure 5.3) emphasises the need to conduct and encourage research that is orientated towards the management of the reserve and the floodplain. A sub-objective specifically addressed the need to identify existing information and to develop an information base (Figure 5.3).

A prototype computer program, which would reside on the managers' PCs, was developed to address these two needs The motivation for developing a computer program as opposed to having a paper-based filing system is twofold:

1. A computer program is designed in such as manner as to allow the users (managers and scientists) to access relevant information almost instantaneously. All the information is in one place so alternative management actions and decisions can be easily considered and explored, by analyzing data or viewing particular information. The program can also be updated easily as more information becomes available.

2. A computer program of this nature can provide a 'technological interface' (*sensu* Rogers, 1997) between scientists and managers whereby research is transformed into a product that the managers can use.

This chapter describes the basic modules of the prototype computer program (NMIS) that was developed (section 6.3), and the concepts (section 6.4) and tools (section 6.5) used for developing it. Ideally, the reader (you) should install NMIS to gain a fuller understanding of what the NMIS can and cannot do, and to better follow the points raised in this chapter. Use the disks provided in Appendix F and follow the instructions in the User's Manual (Appendix E) to install NMIS.

6.2 The users - their expectations, requirements and involvement

The development of any computer system has to be seen in the light of it's user population, the people who will interact with it and use it. Thus it is important to detail who the users are in terms of their computer literacy, their expectations and requirements, and their involvement in the production of the system.

Since the main purpose of the information system is for 'organisational memory' and then the transfer of scientific information from scientists to managers, the managers are essentially the main user group. There are two levels of managers directly involved in the management of the reserve - the reserve manager and the regional manager. Their expectations, computer literacy and involvement in the development of the information system were very similar (de Vos, pers comm; Kruger, pers comm; Nel, pers comm).

The managers' requirements of the information system and their expectations were determined from the outset. Their main concern was that the information system should provide continuity in an environment where managers change often i.e. ensure organisational memory. Thus the information system contains information specifically requested by the managers and it is linked to the spreadsheet application allowing them to access and modify information (section 6.3).

The managers who were involved in the development of the information system are all familiar with Windows operating systems. This will facilitate the "learning curve" for using the information system as the information system was developed to run on a Windows operating systems, either Windows 3.1 or Windows 95. However, none of them have experience with hypertext environments (section 6.4). This should not be problematic as hypertext environments are intuitively easy to work with and to master.

Users must be involved from the outset of the development of the system to ensure effective and efficient information transfer (Van Vliet and Gerber, 1992; Le Maitre *et al*, 1993). Thus the reserve manager and regional managers were involved in the development of the information system from its inception. They provided valuable comments and input into its design. Their continued involvement is foreseen especially during the implementation of the information system.

6.3 A management information system for Nylsvley Nature Reserve

The NMIS consists of a computer program with two modules, an Information Module and a Management Module supported by a User's Manual.

6.3.1 The Information Module

The Information Module (INFONYL) contains up-to-date, easy-to-read scientific and general information about the reserve, with an emphasis on floodplain processes because of Nylsvley's pending Ramsar status.

The information provided in this module focuses on geology, vegetation, climate and animal species, among others, of the floodplain and the reserve (Figure 6.1). A basic description of floodplain ecosystem processes and hydrological processes ... also contained within the information module (Refer to the NMIS program for details). This floodplain information is structured using a landscape ecology approach, which ... ping with the Conservation sub-objective of conserving and managing the diveristy of lan...ape units (Figure 5.2).

6.3.2 The Management Module

The Management Module (MANAGENYL) is different from the Information Module in that it focuses on the actual management process. It contai... ...s of an explicit management process that identifies management needs and informat... ...irements.

The completed nodes (section 6.4.1) correspond to the general objectives hierarchy protocol (Chapter Four) and the objectives hierarchy details for the reserve (Chapter Five).

6.3.3 The User's Manual

The user's manual is another component of the information system. It is an important component in that it should promote the efficient and effective use of the information system. It reinforces the information transfer process by providing detailed information on how to use the information system, as well as what information is contained within the information system. It also provides explicit instructions on how to update and modify the information system to enable the users to add new information to the system as it becomes available. The manual is appended to the thesis (Appendix E).

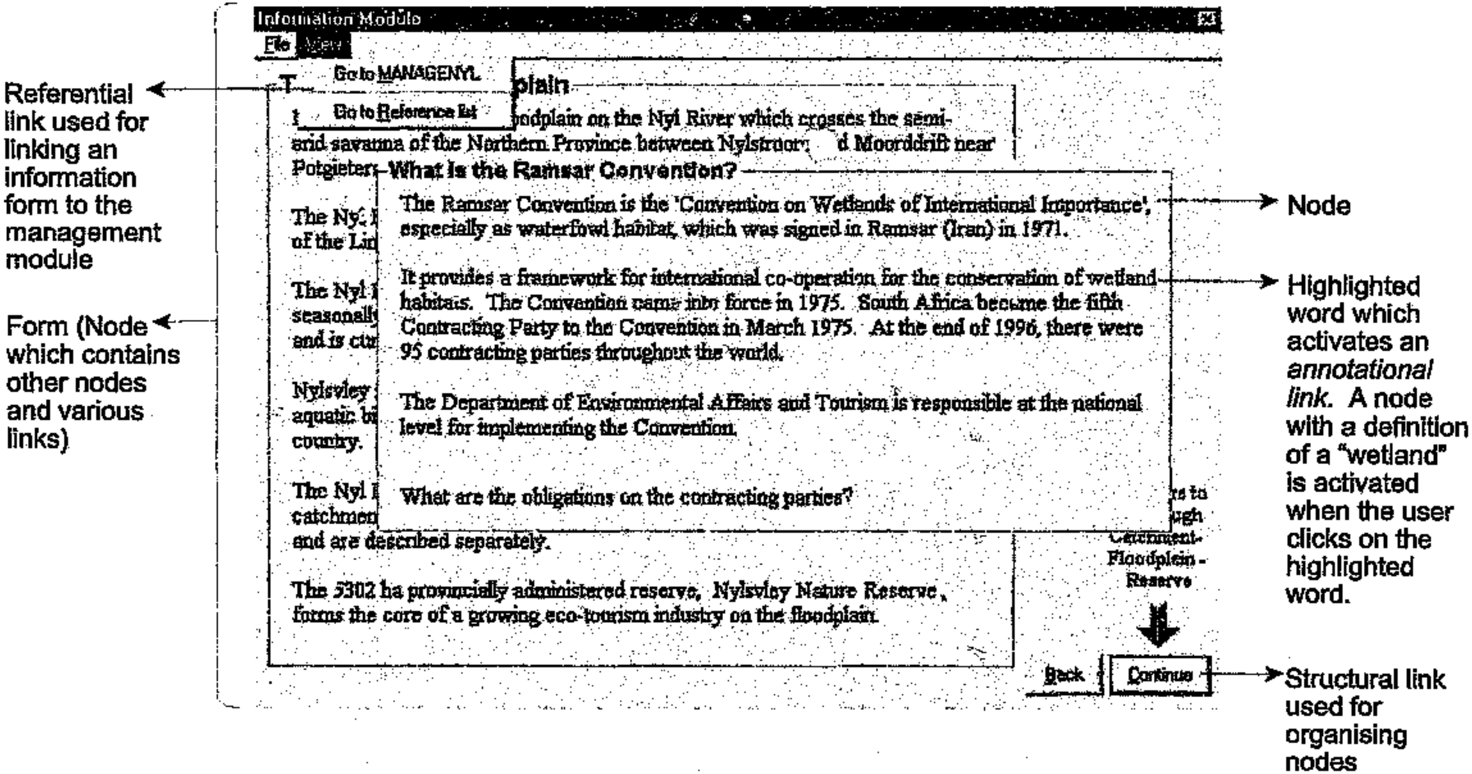

Figure 6.1 The Nyl River Floodplain form with examples of some types of nodes and links used in the NMIS.

6.4 The hypertext concept

The information system was designed using a hypertext approach. Hypertext systems are emerging as a new class of information systems. These systems provide a non-sequential and entirely new method of accessing information unlike traditional information systems which are primarily sequential in nature. They provide flexible access to information by incorporating notions of navigation, annotation and tailored presentation (Balasubramanian, 1995).

Hypertext enables the connection of different information sources and types (texts, graphics, images, knowledge) in an intuitive and accessible way (Balasubramanian, 1995; Carrascal *et al*, 1995). Hypertext was used to design and develop the information system, because hypertext environments allow the user to "navigate" (also called "browsing") through the data, information, images/graphics, and specialised decision support systems, in such a way that the user is free to use or bypass any facility, and thus make intuitive decisions as well as rational ones (Balasubramanian, 1995; Carrascal *et al*, 1995). It also allows for the increasing depth of focus, by the developer, of concepts, explanations or results at various levels (Carrascal *et al*, 1995). Particular words, for example, used in describing the floodplain such as "landscape unit", may require further explanation. A link can be created to a node specific to the word "landscape unit" in which a more detailed explanation can be found.

6.4.1 Information/knowledge structure of hypertext

Hypertext uses two components to structure all the information (text, images, etc) in the system (Balasubramanian. 1995; Carrascal *et al*, 1995), nodes and links. **Nodes** are well-defined, independent and coherent units of information, for example different aspects of the Ramsar convention are represented with rectangular text boxes (Figure 6.1). Each of these is a node, which can be displayed independently on the screen.

Links provide the associative connection between two or more nodes. They can be typified according to the type of relation they establish between nodes (Carrascal *et al*, 1995);

structural - to organise nodes (information units),

annotational - giving explanation about terminology, illustration
referential - connecting associated concepts,
relational - providing links with other applications such as spreadsheets, GIS, expert systems.

All four types of links are used in INFONYL. The relational links provide connections with the spreadsheet application. MANAGENYL currently has structural links, to organise the nodes, and referential links (through the drop-down menu), to provide connections to INFONYL. The relational links in INFONYL allow the user to shell out of the hypertext environment into the spreadsheet application, accessing a number of "notebooks".

The notebooks are files which contain a number of pages with specific data, for example, the SPECIES notebook contains data on the species present in the floodplain landscape units in the following pages: woody vegetation, herbaceous vegetation, amphibians, birds, fish, mammals, reptiles. These notebooks can be edited and modified by the users as research provides new information. Standards for modifications and editing are provided in the user's manual. This encourages buy-in, ownership and use of the system, thus it becomes an interactive data base and filing system for the manager/user.

The consequence of structuring the system's text base through links and nodes with an internal hierarchical and/or network structure is the production of hyper-documents. They are the translation of conventional linear structures, which require sequential reading, into interactive associative documents. Hyper-documents allow access to further explanations, related information, references and/or visualising graphical concepts in a manner that is intuitive, automatic and directly controlled by the user (Balasubramanian, 1995; Carrascal *et al*, 1995).

6.4.2 Navigation/Browsing

The objective of hypertext is to give the user "control" over the system. The user is not forced to interact with the system by a series of preestablished dialogues or by acquiring information in a sequential linear way, but the user can access the information pool as desired.

Thus the hypertext structure offers the potential to attain the information through different paths and it is adapted to the way that human beings think (Carrascal *et al*, 1995).

Navigation throughout the information system is both flexible and "rigid" depending on the section the user is in. For example, when the user is in "Floodplain Subsystem" form, the user can choose which landscape unit to visit first. After accessing the information on a particular landscape unit, the user can only return to the "Floodplain Subsystem" form, unless the user decides to use the menu to go into another section of the information system. This is also the case in the Management Module. The rationale for this approach, is that it provides a "guided", yet flexible environment to lead the non-specialist through the information system ensuring that the user gains the relevant knowledge in order to proceed to the next step.

Backward and forward navigation, an inherent feature of hypertext technique, was implemented using the following elements (Figure 6.2):

- highlighted words (in blue) as information anchors,
- graphical icons, providing hints of the type of information accessible, for example the bird icon in "Reserve" form,
- buttons such as "back", "continue", "spreadsheet",
- check boxes eg. the red data listed species check box in each landscape unit.

Drop down menus were also implemented as a form of navigation. From any of the information nodes, for example, MANAGENYL can be accessed via the drop down menu (Figure 6.2).

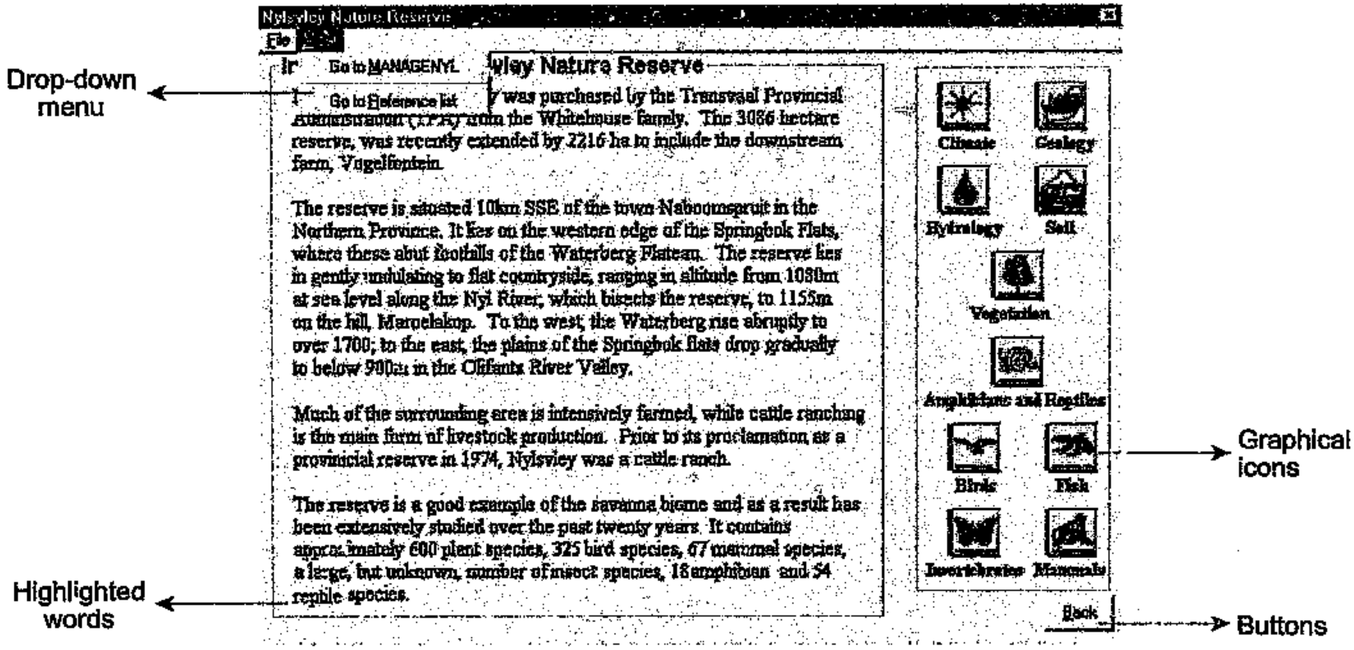

Figure 6.2 Elements used for backward and forward navigation in the NMIS.

6.5 Tools used in developing the MIS

Visual Basic was used to develop the information system because it is a visual programming language, allowing the developer to create easy-to-use graphical user interfaces and to use hypertext concepts. It can also be linked to other applications such as spreadsheets, databases, GIS and expert systems. Although 16-bit and 32-bit applications can be developed using Visual Basic, it was decided to develop the information system as a 16-bit application as the reserve managers at the start of this study were using Windows 3.1. 32-bit applications cannot be run on operating systems that are 16-bit such as Windows 3.1., while 16-bit applications can run on 16-bit operating systems and 32-bit operating systems.

A spreadsheet application, Quattro Pro was used to provide detailed data about specific aspects of the floodplain. Quattro Pro was used as it is the application the managers are familiar with.

Slides and photographs were scanned and converted into 256 colour bitmaps using Corel-PhotoPaint and a Hewlett-Packard scanner.

A graphics package, Presentations, was used to create maps, profiles and graphs and then convert them into bitmaps for input into VB during the design time of the information system. An example of these are the floodplain and catchment profiles in the Information Module.

A number of information and data sources were used to gather information for the information system. Much of the information was obtained form Honours, Masters and Doctoral Theses whose subject is the Nyl River Floodplain (Marneweck, 1990; Otter, 1992; Rickard, 1993; Petrie, 1997; Marneweck, in prep; Coetzee, in prep). Reports by the Centre for Water in the Environment, University of the Witwatersrand (Higgins and Rogers, 1993), and journal articles (Higgins *et al*, 1996) provided information on the landscape units and hydrological functioning. Background information on geology, soils and climate was extracted from Frost (1987) and Scholes and Walker (1993). The Northern Province DALEA's ecological files on the reserve provided information on animal census, management blocks and vegetation monitoring. All the scanned photographs were obtained from Prof. K.H. Rogers.

6.6 Installing and using the MIS

The information system was developed to run on IBM compatible micro computers (PCs) with at least 386 processor, 4 Mega-bytes of RAM, a VGA card and running Windows 3.1 or Winodws 95. It also requires that Corel Office Suite be installed (version 8) with Quattro Pro.

The information system is provided in a pocket at the back of this thesis (Appendix F). The installation instructions are contained in the user's manual (Appendix E).

There are opportunities for the users to update some information in the vision, objectives and goals forms in the Management Module. The users can update and modify all the spreadsheets in the Information Module, but cannot edit or modify the actual system structure.

At this stage there is no on-line user help. This is recognised as being a limitation of the information system. It is hoped that it will be included in the near future. The only form of user support is the paper-based User's Manual (Appendix E).

6.7 Discussion and Conclusion

A prototype NMIS has been installed at the office of the reserve manager and at the Department's head office in Pietersberg. Although the NMIS is only a prototype it has successfully illustrated to the managers the potential of what can be done with the information available.

The NMIS incorporates the various changes in perspectives that were precipitated in developing the objectives hierarchy i.e the landscape approach and an ecosystem rather than species focus (see section 5.3). Therefore it helps the managers to internalise these concepts.

The NMIS serves a form of organisational memory whereby a record of decision making (goals and the objectives from which they are derived, as well as the strengths and contsrints of the systems) is kept in an easy to access, easy to use format. Thus the NMIS provides some continuity in an environment where there is high staff turnover and a legacy of poor information records(sections 3.4.3 and 3.5.1.).

At the moment the NMIS is a stand-alone system with links to Quattro Pro, a spreadsheet application. However it has the potential to become an "integrated system" with links to Geographical Information Systems (GIS), expert systems, data bases, among others to allow for comprehensive data base management (eg.for tracking resource inventories), spatial analysis, simulation and optimization (Loh and Saarenmaa, 1992). It can serve as a vehicle for other products that could be generated at the interface between scientists and managers.

CHAPTER SEVEN

General Discussion and Conclusions

"The better we know where we are going the more likely we are to get there"
Olson (1986)

7.1 Introduction

The thesis of this study is that to overcome barriers between scientists and managers an interface must be developed between the two groups based on sound technology transfer principles (product development, transfer processes, consensus building, feedback, form and function (Rogers, 1997)) and three primary elements - processes (which regulate the functioning of the interface), products (which are developed within the interface) and people (who 'drive' the interface) (section 2.5). The interface developed in this study takes the form of an objectives hierarchy, and its primary functions are to develop consensus on organisational purpose, culture and structure and to neutralise the negative effects of the diverging operating philosophies and reward systems of science and management (Rogers, 1998).

An overview of the thesis briefly recaps on the barriers between scientists and managers and then highlights the characteristics of the Nylsvley interface (section 7.2). The characteristics are then translated into general concepts that should be applied when developing science-management interfaces in general (section 7.3).

7.2 An overview of this thesis

A review of the literature (Chapter Two) identified barriers between scientists and managers which result in a lack of integration of scientific information into conservation management. Differences in the goals and reward systems of managers and scientists (Cullen, 1990; Huenneke, 1995; Christensen, 1997; Rogers, 1997) lead to managers feeling that scientists do not produce the "goods" that they require, while scientists claim that managers do not provide the questions for which they require answers (Cullen, 1990; Baskerville, 1997; Walters, 1997; Rogers, 1998). There is also a lack of forward thinking, goal-orientated management (Brussard; 1991; Rogers, 1997). As a result much of conservation management relies on intuitive, *ad hoc* decision-making which leads to a problem-by-problem curative approach (Steedman and Haider, 1993; Meffe and Carroll, 1994; Lajeunesse *et al*, 1995)(cf. adaptive management (Walters, 1997)) as well as a lack of accountability and evaluation (Peters *et al*, 1997; Rogers and Biggs, 1998).

There is a need to put conscious effort into developing and sustaining an exchange of information (in various formats) which both groups recognise as having value (Breen *et al*, 1994; Barrett and Barrett, 1997; Rogers, 1997) to break down or at least to overcome these barriers. Many suggestions have been made for overcoming the barriers between scientists and managers ranging from establishing closer working relationships at all levels by networking (Mckerchar and Dingwall, 1984; Cullen, 1990; Holling *et al*, 1997) to actively promoting management orientated research (Mckerchar and Dingwall, 1984; Parrish *et al*, 1995), to establishing technological interfaces (Rogers, 1997).

This thesis focused on developing an interface, which combines the various strategies in to a comprehensive framework, for Nylsvley Nature Reserve. The interface took on the form of an objectives hierarchy (Chapter Five). An objectives hierarchy protocol was developed to enable conservation organisations to translate policy into focused, purposeful action, thus ensuring that the management is more goal orientated. The procedure for developing the objectives hierarchy is essentially based on the process of consensus building (section 4.4), thereby ensuring that the managers and scientists involved in the objectives hierarchy development interact effectively and understand each other in a non-conflicting manner.

The objectives and goals, in particular those that require scientific input, provide managers and scientists with a better sense of connection to each other as it provides a framework for determining individual roles and responsibilities. The hierarchical nature of the objectives hierarchy allows managers and scientists to trace the origin of goals and the products related to those goals, thus increasing the accountability of those involved and removing 'ad hocracy' from the management approach.

The objectives hierarchy also provides organisational memory as the reasoning behind the goals and actions is recorded. However once the goals have been set an auditing system (Goal Maintenance System (GMS), section 4.6) must be set up to ensure that the goals are met, revised, audited and where necessary reintegrated into the adaptive management process. The GMS provides a system to link management actions to goals which is analogous to the Balanced Scorecard approach developed by Kaplan and Norton (1996). It allows for continuous feedback between managers, and between managers and scientists.

The organisational memory of the organization and the feedback between scientists and managers can be further enhanced by the development of efficient data management systems (Christensen, 1997; Mckerchar and Dingwall, 1984). The Nylsvley Management Information System is an example of such a product that can arise from the objectives hierarchy which ensures that the managers have access to past and present information that is relevant for decision-making.

The development of this interface was strongly dependent on the involvement of particular people. A spirit of co-operation and participation which is vital for the success of an interface was fostered by informal collegia (networks)- people with contact inside and outside the conservation organisation. During the development of the objectives hierarchy protocol and the objectives hierarchy for the reserve, a "champion" emerged who has played a significant role in ensuring that the interface is accepted, and the products within it transferred.

In summary, the Nylsvley interface translates policy into focused, purposeful actions by a process of consensus building, participation, feedback and strategic planning, and it is dependent on people to make it function. Thus the interface is composed of three primary elements: Products, Processes and People.

7.3 Interfaces in general

To ensure that the science management interfaces effectively overcome the barriers between scientists and managers, they must translate policy into action and management problems into hypotheses to be tested, they must be consensus building and participatory and operate in a strategic manner. To ensure these characteristics attention must be paid to the three primary elements of the interface: Processes, Products and People.

The processes that regulate the functioning of a structured interface must ensure that the products developed within the interface are transferred between scientists and managers. They must also ensure that the needs and requirements of managers are communicated to the scientists. Effective interaction between scientists and managers must be based on the interlinked processes of feedback, consensus building and transfer which will ensure effective integration of research results into management and of management needs into research.

The products that scientists develop to service the interface could range from simple conceptual constructs to complex matrix models and information systems. Scientists previously caught up in the search for intellectual challenge and truth, and modeling for modeling' sake (Walters, 1997) can instead translate viable information into useful products for managers.

Finally, it is fundamental to the interface that there are people who 'drive' it and ensure that the barriers are overcome and that information is transferred. The roles of facilitator and champion are especially important in ensuring consensus building and feedback, especially in deeply entrenched bureaucracies that are characteristically unresilient to new challenges.

7.6 Conclusion

Scientists, and in particular ecologists, have often been urged to make the products of their research available and useful to managers (Huenneke, 1995; Dewberry and Pringle, 1994; Parrish *et al*, 1995; Adams and Hariston, 1996; Baskerville; 1997; Pringle, 1997; Rogers, 1997). As 'generators' of fundamental knowledge and theory I firmly believe it is our duty to ensure that scientific information is used in an effective manner by managers and that we generate information that is useful. Initiating the development of interfaces between science and management is one way that we, as scientists, can ensure the successful integration of the products of our research into the management of the natural resources. However, we need to recognise that developing interfaces requires much commitment from our part and that of the managers. Therefore, it is greatly dependent on the "people" factor.

The way people are managed will determine how useful and successful the interfaces are. Adhering to the principles of consensus building, feedback, participation and planning will take us a long way towards ensuring that those involved are committed and stay on track. We need to recognise that the way people are rewarded will greatly influence the way they interact with each other and with the ecological systems that they manage (Holling, 1995, Breen *et al*, 1997). We must, therefore, expend some energy in putting processes in place to ensure that appropriate reward systems are developed and maintained so as to neutralise the negative effects of the diverging operating philosophies of science and management.

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PERSONAL COMMUNICATIONS

Blackmore, A.	Natal Parks Board St Lucia Estuary
De Vos, R.	Nylsvley Nature Reserve Northern Province
Kruger, J.	Department of Environmental Affairs Northern Province
Nel, L.	Departement of Environmental Affairs Northern Province
Rogers, K.H.	Centre for Water in the Environment Department of Botany University of the Witwatersrand

APPENDIX A Interviewees

Interviewee	Occupation	Organisation
Mr Matt Coetzee	Environmental Consultant Completing Ph.D. on the Nylsvley Nature Reserve	Stefan, Robertson and Kirsten Consulting Engineers
Mr Rudolf de Vos	Reserve Manager of Nylsvley Nature Reserve	Department of Agriculture, Land and Environment Affairs, Northern Province
Mr Johan Kruger	Conservation Biologist	Department of Agriculture, Land and Environment Affairs, Northern Province
Mr Gary Marneweck	Environmental Consultant Completing Ph.D on the Nylsvley Nature Reserve	Strategic Environmental Focus Consulting Company
Mr Gawie Nel	Regional Ecologist Formerly Nylsvley Nature Reserve Manager	Department of Agriculture, Land and Environment Affairs, Northern Province
Lizanne Nel	Assistant Director Biodiversity Unit	Department of Agriculture, Land and Environment Affairs, Northern Province
Dr. Scott Petrie	Ornithologist Completed Ph.D on Nylsvley Nature Reserve	Centre for Water in the Environment, University of the Witwatersrand
Prof Kevin Rogers	Ecologist Director	Centre for Water in the Environment, University of the Witwatersrand
Mr Alan Solkunder	Owner of Mosdene farm	Mosdene Private Nature Reserve, Nylstroom
Dr Warwick Tarboton	Ornithologist Owner of farm on Nyl floodplain	Beeshoek Farm, Nylstroom

APPENDIX B Participants of the Workshops held in 1996

Participant	Occupation	Organisation
Regina Bestbier	Student - Conservation and Environmental Ecology	Centre for Water in the Environment, University of the Witwatersrand
Morne Booij-Liewes	Student - Wetland Ecology	Centre for Water in the Environment, University of the Witwatersrand
Klaas Boonzaaier	Acting Deputy Director Tourism Planning	Department of Trade, Industry and Tourism, Northern Province
Johan Botha	Director of Professional Services	Department of Agriculture, Land and Environment Affairs, Northern Province
Annemie de Klerk	Socio-ecologist	Department of Agriculture, Land and Environment Affairs, Northern Province
Gideon de Klerk	Assistant Director, Ecological Services	Department of Agriculture, Land and Environment Affairs, Northern Province
Rudolf de Vos	Reserve Manager of Nylsvley Nature Reserve	Department of Agriculture, Land and Environment Affairs, Northern Province
Johan Kruger	Conservation Biologist	Department of Agriculture, Land and Environment Affairs, Northern Province
Simon Makhari	Resource Manager, Regional Head, Region A, Nylstroom	Department of Agriculture, Land and Environment Affairs, Northern Province
Gary Marneweck	Wetland Ecologist	Department of Environmental Affairs and Tourism, Pretoria.
Sam Mashele	Resource Manager Subregional Head, Region CI, Louis Trichardt	Department of Agriculture, Land and Environment Affairs, Northern Province
Emmanuel Maswangonyi	Resource Conservator Region DI	Department of Agriculture, Land and Environment Affairs, Northern Province
Mike Mube	Conservation Services Officer Sub-region D; Giyani	Department of Agriculture, Land and Environment Affairs, Northern Province

Participant	Occupation	Organisation
Lizanne Nel	Assistant Director Biodiversity Unit	Department of Agriculture, Land and Environment Affairs, Northern Province
Christopher Nghenabo	Resource Manager Sub-regional head, Region AI Potgietersrus	Department of Agriculture, Land and Environment Affairs, Northern Province
Scott Petrie	Ornthilogist	Centre for Water in the Environment, University of the Witwatersrand
Jan Rapolai	Resource Conservator Section Head North AII Potgieterus	Department of Agriculture, Land and Environment Affairs, Northern Province
Kevin Rogers	Wetland Ecologist	Centre for Water in the Environment, University of the Witwatersrand
Warwick Tarboton	Ornithologist	Private Consultant
Peter Thseola	Environmental Educator Region AI	Department of Agriculture, Land and Environment Affairs, Northern Province
Jurg van Loggerenberg	Chief Nature Conservator, Region AI	Department of Agriculture, Land and Environment Affairs, Northern Province

APPENDIX C Workshop agonda

WORKSHOP

Goal Orientated Conservation

Nylsvley Research Station
5-7 December 1995

Purpose

The general purpose of this meeting is to discuss the concept of, need for and process of goal orientated conservation. The participants are all people who see a need for more rigorous setting and pursuit of acnievable goals in conservation and are keen to share their ideas in an informal setting.

Participants

Dr Harry Biggs	Kruger National Park
Mr Paul Funston	Kruger National Park
Dr Morne du Plessis	Natal Parks Board
Mr Andrew Blackmore	Natal Parks Board
Mr Johan Kruger	Department of Environment Affairs, Northern Province
Mrs Lizanne Nel	Department of Environment Affairs, Northern Province
Mr Gideon de Klerk	Department of Environment Affairs, Northern Province
Mr Wietche Roets	Department of Environment Affairs, Northern Province
Prof Kevin Rogers	Centre for Water in the Environment
Ms Regina de Ornelas	Centre for Water in the Environment

Catering and Organisation — Wendy Midgeley, CWE.

Schedule

Tuesday 5th December

- Arrive at Nylsvley (16h00)
- Evening drive. Introduction and discussion of Nylsvley problems.
- Dinner

Wednesday 6th December	-	Workshop
	-	Evening braai
Thursday 7th December	-	Synthesis and Summary
	-	Tea (10h00)
	-	Depart

Approach

I suggest we aim to address the following general questions:-

1. What is meant by "goal orientated conservation"?
2. What is meant by "goals"? How do they relate to other terms such as vision, objectives, principles and desired state?
3. How should goals be developed? Who should develop the goals? What form should the goals take?
4. How will goals be used and what for?
5. What environment/support system is needed to ensure that goals are set, met, revised and accepted within and outside an organisation?
6. What can be achieved in a short term and how can one move forward to make sure that one has something more concrete on which to pin the above theoretical questions?

I suggest we start the meeting with participants describing the problems they face and how they are going about trying to solve them. This will give each one the chance to put their cards on the table and influence the agenda and process of the meeting. The idea is to talk about what you think is important so don't be shy.

We will draw up a more specific agenda from a quick synthesis of these individual presentations.

Regina and I will summarise the proceedings and send them on to each of you early in the New Year.

Accommodation and Catering

The Centre for Water in the Environment will provide accommodation at Nylsvley and do all the catering. Please bring your own towels. If you have any specific requirements or need more information please contact Wendy at (011) 716-2218.

An overhead projector will be available and a slide projector can be taken to Nylsvley if need be. Let us know if you need it.

APPENDIX D Red data aquatic bird species found on the Nyl Floodplain

Red data listed aquatic birds recorded on the Nyl Floodplain during 1941-1987 (adapted from Tarboton, 1987b).

Common Name	Scientific Name	Status	Occurrence
White Pelican	*Pelecanus onocrotalus*	Rare	Vagrant, non-breeding, last recorded in 1984.
Pinkbacked Pelican	*Pelecanus rufescens*	Rare	Vagrant, non-breeding, last recorded in 1956.
Rufous-bellied Heron	*. deola rufiventris*	Rare	Erratic visitor, breeds, maximum 10 pairs.
Whitebacked Night Heron	*Gorsachius leuconotus*	Intermediate	Vagrant, non-breeding, last recorded in 1975.
Little Bittern	*Ixobrychus minutus*	Rare	Regular visitor, breeds, maximum 30 pairs.
Dwarf Bittern	*Ixobrychus sturmii*	Intermediate	Regular visitor, breeds, common.
Bittern	*Botaourus stellaris*	Vulnerable	Regular visitor, breeds, fairly common.
Black Stork	*Ciconia nigra*	Intermediate	Regular visitor, breeds, 3 pairs.
Woollynecked Stork	*Ciconia episcopus*	Rare	Vagrant, non-breeding, last recorded in 1983.
Openbilled Stork	*Anastomus lamelligerus*	Rare	Vagrant, non-breeding, last recorded in 1974.
Saddlebilled Stork	*Ephippiorhynchus senegalensis*	Rare	Vagrant, non-breeding, last recorded in 1987.
Marabou Stork	*Leptoptilos crumeniforus*	Rare	Vagrant, non-breeding, last recorded in 1980.

Red data listed aquatic birds recorded on the Nyl Floodplain during 1941-1987 (adapted from Tarboton, 1987b) continued.

Common Name	Scientific Name	Status	Occurrence
Yellowbilled Stork	*Mycteria ibis*	Rare	Regular visitor, non-breeding, fairly common.
Greater Flamingo	*Phoenicopterus ruber*	Intermediate	Vagrant, non-breeding, last recorded in 1981.
Lesser Flamingo	*Phoeniconaias minor*	Intermediate	Vagrant, non-breeding, last recorded in 1954.
Pygmy Goose	*Nettapus auritus*	Rare	Regular visitor, breeds, scarce.
Palm-nut Vulture	*Gypohierax angolensis*	Rare	Vagrant, non-breeding, last recorded in 1942.
Osprey	*Pandion haliaetus*	Intermediate	Vagrant, non-breeding, last recorded in 1985.
Baillon's Crake	*Porzana pusilla*	Intermediate	Erratic visitor, probably breeds, scarce.
African Finfoot	*Podica senegalensis*	Intermediate	Vagrant, non-breeding, last recorded in 1960.
Lesser Jacana	*Microparra capensis*	Rare	Vagrant, non-breeding, last recorded in 1964.
Caspian Tern	*Hydroprogne caspia*	Rare	Vagrant, non-breeding, last recorded in 1959.
African Skimmer	*Rynchops flavirostris*	Locally extinct	Vagrant, non-breeding, last recorded in 1982.

APPENDIX E Nylsvley Management Information System: User's Manual

Nylsvley Management Information System

version1.0

User's Manual

Centre for Water in the Environment
Department of Botany
University of the Witwatersrand
1998

TABLE OF CONTENTS

INTRODUCTION

What is NMIS?

Welcome to the Nylsvley Management Information System (NMIS) - the quickest and easiest way to access information on the Nyl River Floodplain and specifically on the Nyslvley Nature Reserve. NMIS enables you to make informed management decisions by providing two modules for the different aspects of managing the reserve

- INFONYL - the Information Module provides updated, easy-to-read scientific information on the floodplain and the reserve.
- MANAGENYL - the Management Module oulines an iterative management process and provides a step-by-step protocol for defining an objectives hierarchy in general, with specifics for the reserve.

This manual will illustrate how to set up NMIS on your computer and how to use it.

System Requirements

Before you setup NMIS make sure that your computer meets the minimum requirements. To run NMIS you must have certain hardware and software installed on your computer. The system requirements include:

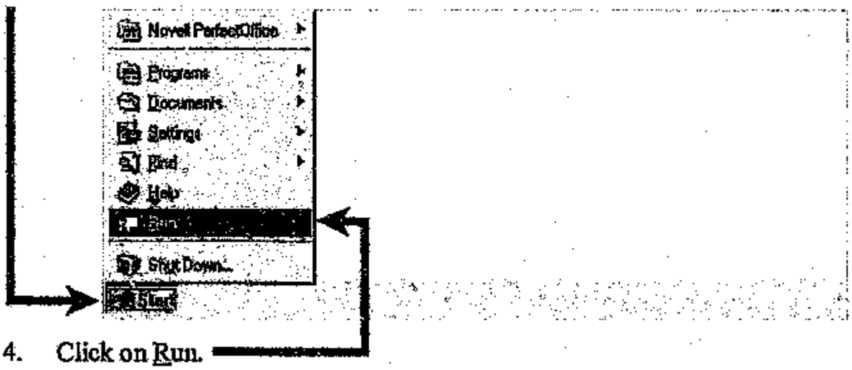
- Microsoft Windows 3.1 or later, running in standard or enhanced mode.
- Any IBM® personal computer with an 80386 processor or higher.
- A 1.44M disk drive.
- VGA or higher resolution screen supported by Windows.
- Four megabytes of memory (RAM) are required on Windows.
- A mouse or other suitable pointing device.
- Corel PerfectOffice version 8 running Quattro Pro. Note that you **must** have version 8 or the NMIS will crash when retrieving spreadsheets.

Running Setup

1. Start (or restart) your computer ensuring that no programs are running.

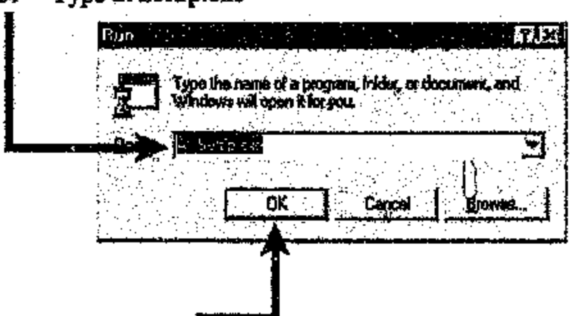
2. Insert NMIS Setup Disk 1 in drive A (your 1.44 drive).

3. Click on Start.



4. Click on Run.

5. Type **a:\setup.exe**



6. Click 'OK'

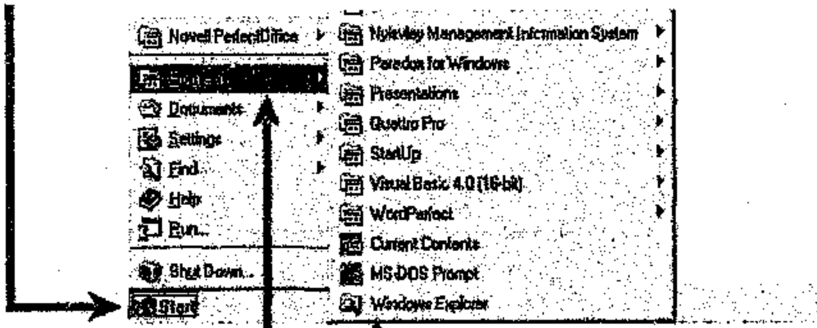
7. Follow the instructions on your screen.

Setup adds NMIS to the Start, Programs menu.

Installing the NMIS spreadsheets and textfiles

1. Insert NMIS Setup Disk 5 in drive A (your 1.44 drive).

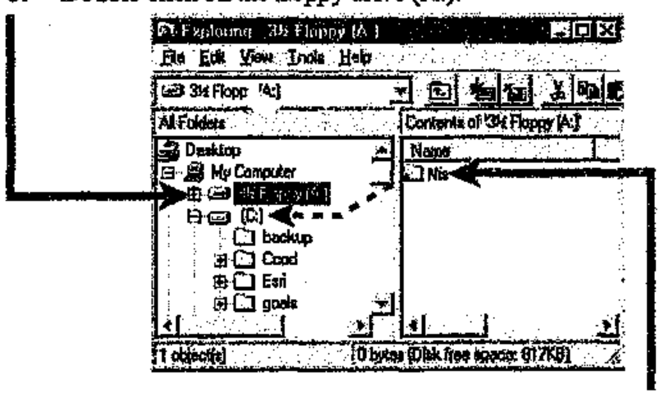
2. Click on Start.



3. Click on Programs.

4. Click on Windows Explorer.

5. Double click on the floppy drive (A:).

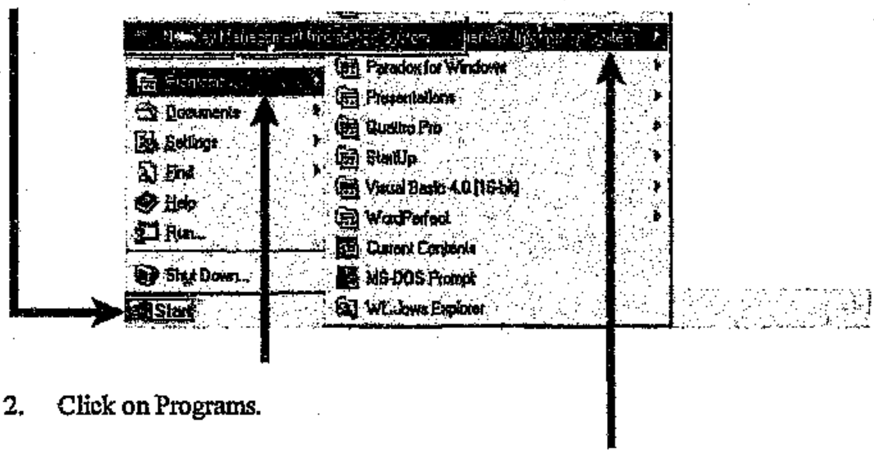


6. Click on the NIS folder, hold the left mouse down and drag the folder into C: root directory.

NOTE: DO NOT alter the file names or the directory names. The program will not recognise the files if you do.

Running NMIS

1. Click on Start.



2. Click on Programs.

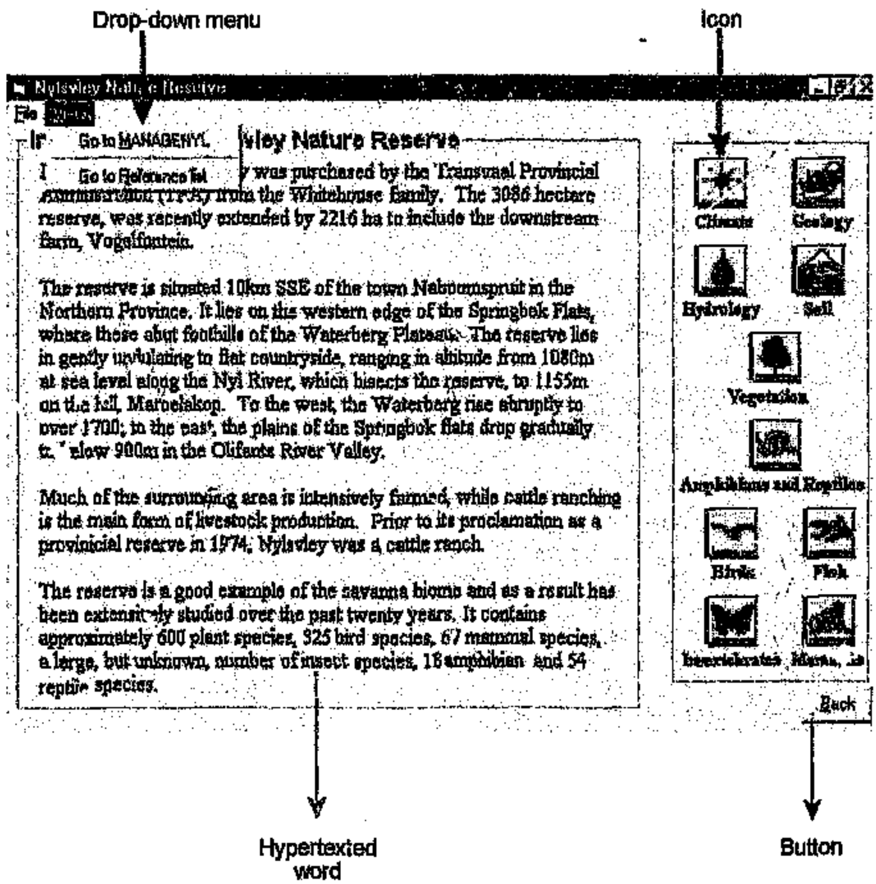
3. Click on Nylsvley Management Information System.

4. Once the NMIS has been activated, click on the 'Continue' button to move to the next form

Learning the basics - a quick tutorial

Navigating in NMIS

Moving about the NMIS is relatively easy. By clicking on either the drop-down menus options, buttons, icons and hypertext words you will be led backwards and forwards into new windows (forms).

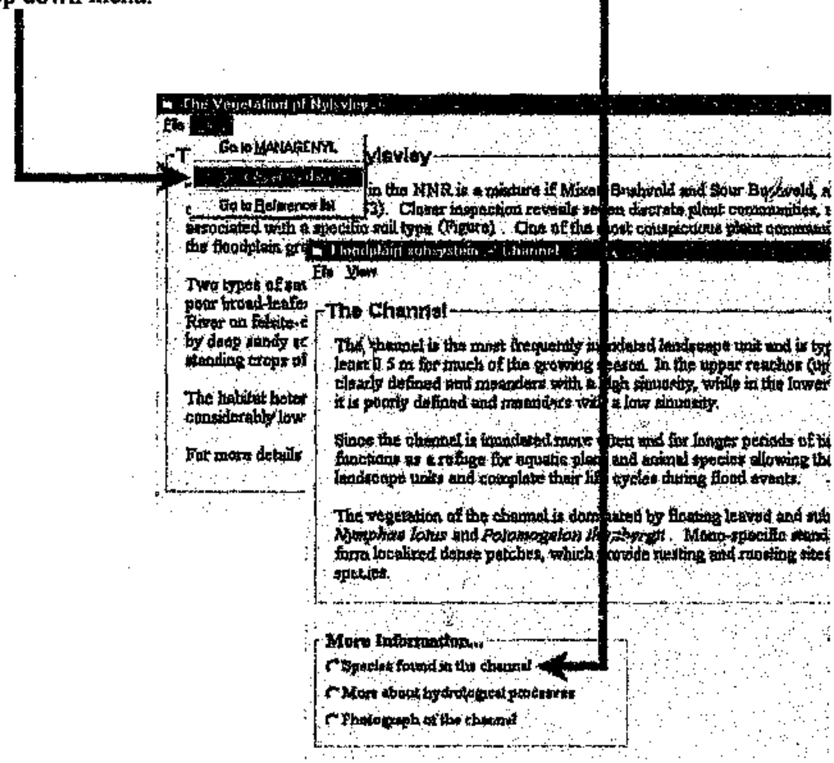


Using the spreadsheets

The NMIS has three types of information which is stored in spreadsheets (in Quattro Pro):

1. Weather data - daily rainfall, minimum and maximum temperatures and presence of frost.
2. Hydrological data - gauge plates measurements of water levels in the Nyl River channel.
3. Lists of species found on the floodplain units and for the reserve in general.

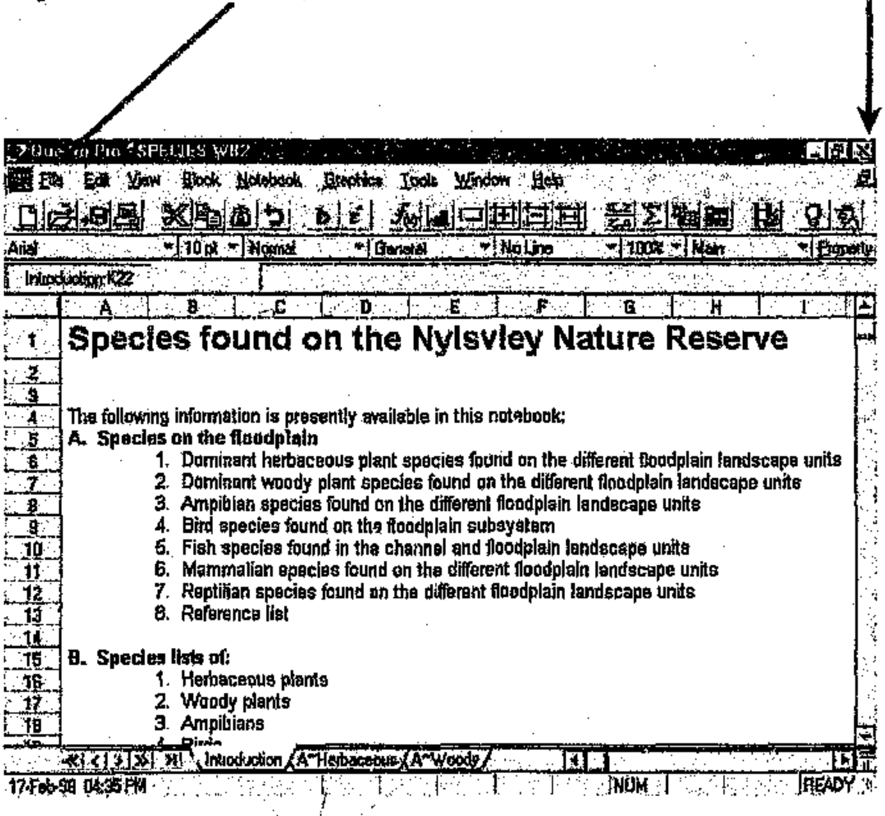
These spreadsheets can be accessed either by hypertexted words or by using the drop down menu.



Using the spreadsheets

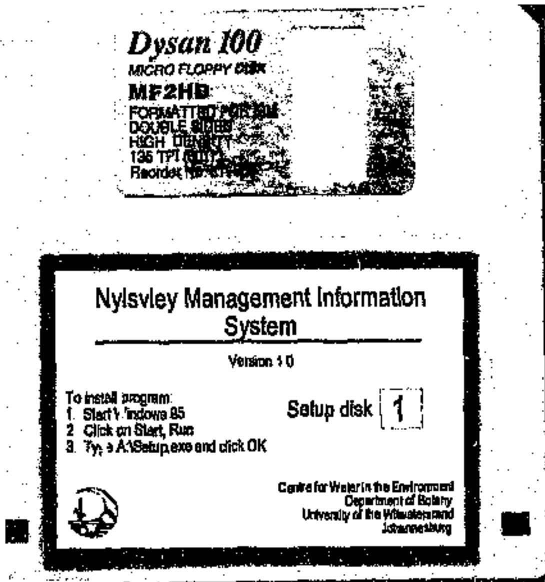
Once the selected spreadsheet has loaded, the different pages can be accesses by clicking on the tabs at the bottom of the notebook.

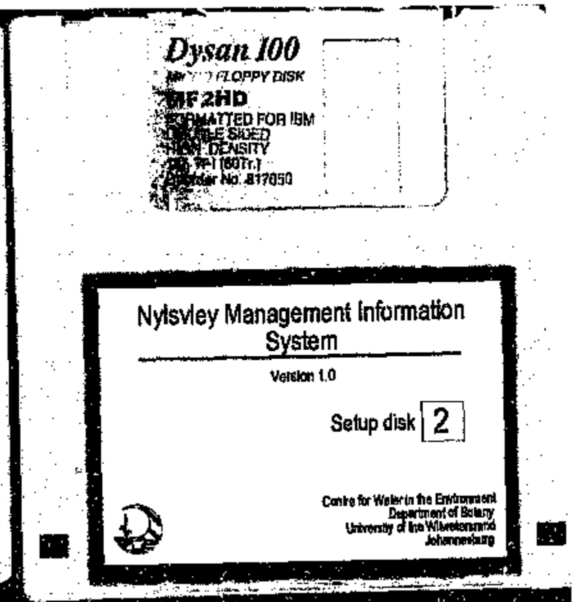
Once you have finished with the spreadsheet - shut it down using either the drop down menu: File - Exit, or else double click here...

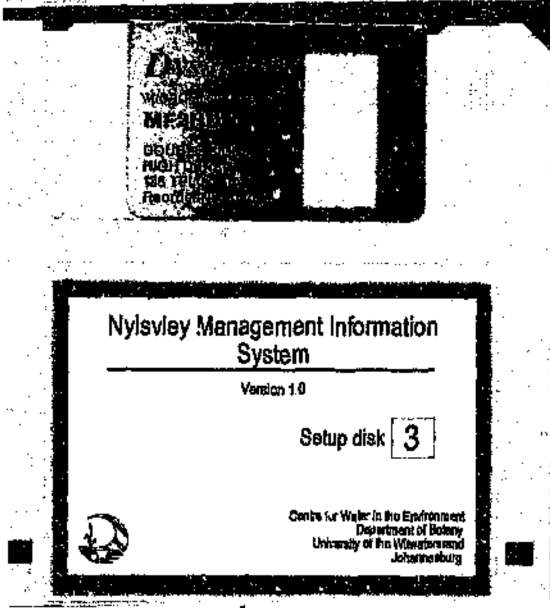


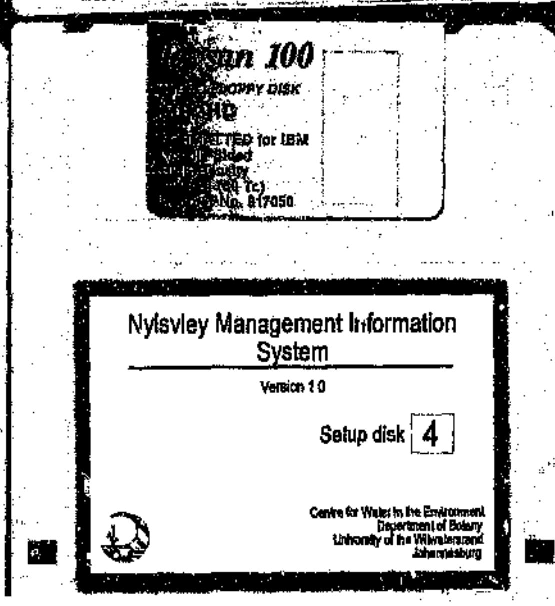
Tabs

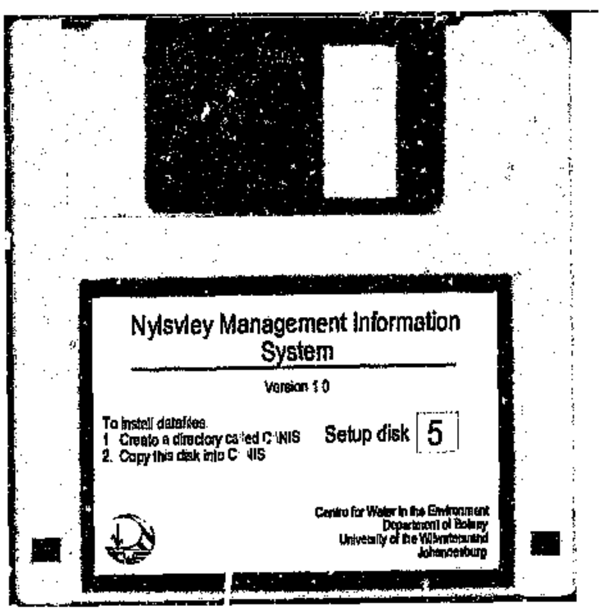
APPENDIX F **Setup disks for the Nylsvley Management Information System**


Dysan 100
MICRO FLOPPY DISK
MF2HD
Nylsvley Management Information System
Version 1.0
To install program:
1. Start Windows 95
2. Click on Start, Run
3. Type A:\Setup.exe and click OK
Setup disk 1
Centre for Water in the Environment
Department of Botany
University of the Witwatersrand
Johannesburg


Dysan 100
FLOPPY DISK
MF2HD
FORMATTED FOR IBM
Nylsvley Management Information System
Version 1.0
Setup disk 2
Centre for Water in the Environment
Department of Botany
University of the Witwatersrand
Johannesburg


Nylsvley Management Information System
Version 1.0
Setup disk 3
Centre for Water in the Environment
Department of Botany
University of the Witwatersrand
Johannesburg


Nylsvley Management Information System
Version 1.0
Setup disk 4
Centre for Water in the Environment
Department of Botany
University of the Witwatersrand
Johannesburg


Nylsvley Management Information System
Version 1.0
To install datafiles:
1. Create a directory called C:\NIS
2. Copy this disk into C:\NIS
Setup disk 5
Centre for Water in the Environment
Department of Botany
University of the Witwatersrand
Johannesburg