Guidelines for Strategic Adaptive Management

Experiences from managing the rivers of the Kruger National Park

Guidelines for managers and field staff of protected areas

Planning and Managing Protected Areas for Global Change.

Ecosystems, Protected Areas and People (EPP) Project
UNEP GEF No. GF/27-13-03-4679
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Downloadable from the PALNet website.

The Ecosystems, Protected Areas and People (EPP) Project

The Ecosystems, Protected Areas and People (EPP) Project, a project of the IUCN, seeks to establish a Protected Areas Learning Network (PALNet) to enable all stakeholders of protected areas to share the lessons they are learning in coping with global change factors. A network of nine Field Learning Sites (FLS) was established in 2003 as a way of drawing on pioneering work in protected areas. In summary:

- The EPP aims to enable protected area (PA) managers to adapt their strategies, policies and practices to the threats and opportunities of global change; support local, national, and global communities in securing their biodiversity and ecosystem services; and provide guidance to the CBD in relation to Article 8 on PAs.
- The project has five main components: Five Technical Expert Groups, Regional Workshops, publications, 9 Field Learning Sites and the Protected Area Learning Network (PALNet).
- Each of the FLSs has a number of 'change' factors being dealt with by the protected area management. FLSs are in South Africa (Kruger National Park and the Cape Floristic Region); Cameroon; Costa Rica; Yemen (Socotra); Philippines (Apo Island and Dauin Sanctuaries); Nepal (Terai Arc Landscape); Cuba (Zapata Swamp) and Ecuador (Yasuni National Park).
- Lessons learned from these sites have been synthesized/documented and then made available in multiple formats, but especially through the PALNet website.
- The EPP Project is supported by UNEP/GEF with co-funding from other partners. It is managed by IUCN-WCPA.

Contents

PART 1: Dealing with global change....4
The reality for managers & field staff 4
This guideline....4
A focus on managing rivers 5
PART 2: Strategic adaptive management....6
What is strategic adaptive management?....6
Why use SAM for protected areas?....7
The importance of thinking about complexity 8
Using the complex systems view in practice....9
PART 3: The importance of context 10
Rivers of the Park as an example....10
The Park responds....11
Variability and change: a challenge for river management 12
Fire management 13
Managing waterpoints in the KNP....14
PART 4 Guidelines....15
Who is involved in SAM?....15
The basic steps in SAM 16
The SAM Framework....16
A Framework for SAM 17
STEP 1 Creating a vision 18
STEP 2 Objectives hierarchy....20
STEP 3 Scoping options for objectives 26
STEP 4 Operationalise SAM....28
STEP 5 Evaluate & Learn 30
12 Lessons learnt 33
Glossary 34
Additional reading 35

Box 1: Global change

Global change is a broad term that refers to the myriad of factors, primarily human driven, which alter our biological, social, and institutional environment. Some examples are:
(a) Biophysical changes (climate change, sea level rise, invasive alien species, and fragmentation of forest cover/ change in land use);
(b) Socio-economic changes (human population growth, demographic changes and urbanization, growing demand for food and fibre, new technologies, and the impacts of globalisation on biodiversity, culture and social values); and,
(c) Institutional changes (access to information, participation, decentralisation, and cooperative arrangements for area management).

A view of the Letaba River at Shimuwini Dam

PART 1: Dealing with global change

The reality for managers & field staff

Members from IUCN's World Commission on Protected Areas (WCPA), have expressed concerns about the rapidly changing world in which they bear the responsibility to manage such important areas, supported as they are with little information or preparation to deal with these growing risks. Global change factors (Box 1) can pose serious challenges to the sustainability of protected areas (PA). Changes of these types can also bring important opportunities to protected areas that may strengthen the effectiveness and efficiency of protected areas management.

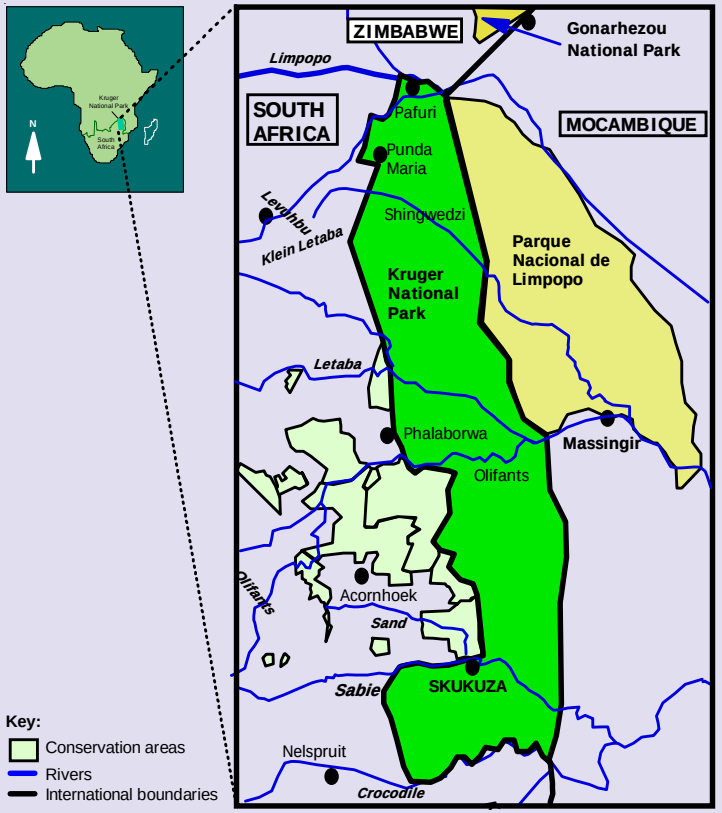
The overarching rationale is that many managers and practitioners in PAs all over the world are adapting to these changes but these experiences and lessons are not being shared. Policy makers and the other primary project stakeholders can benefit from exchanging information and lessons learned in a variety of ways. The purpose of this project is to enable PA managers and policy makers to develop the capacity for managing their areas adaptively in the face of global change. In this guideline we present the learning from one of the field learning sites (FLSs) – the Kruger National Park (KNP).

This guideline

This guideline outlines one management tool, strategic adaptive management, that has been developed by the staff and managers of the KNP. This approach recognises and is responsive to global change factors in a realistic and practical manner. The guideline aims to present an overview of strategic adaptive management practice, or SAM, as it has emerged within the specific context of the KNP. The specific illustrative context that we use is that of rivers which have undergone enormous change.

The Kruger National Park, South Africa as a field learning site

This FLS has introduced 'Strategic Adaptive Management' (SAM) as an approach to park and water resource management within the Kruger National Park, South Africa. The work has pioneered a new adaptive management methodology which is objectives-driven and recognizes the inherent variability and need for flexibility in natural systems. The SAM approach is explored through the lens of river management in this FLS.



A focus on managing rivers

The process of SAM can be applied to the management of any natural resource. However in this guideline we present the attempts of the managers and staff of the KNP to develop a comprehensive and holistic approach to SAM for the rivers of the protected area. This is pertinent because the degradation of rivers, together with democratic socio-political changes of 1994 acted in concert as a catalyst for the complete revision of Kruger's management. Moreover, water is the most limited and limiting resource in South Africa and the upstream impacts on all six rivers that traverse or border the Park are acute (Box 2). In the case of river management, the challenges for KNP are not just about managing the rivers within the borders of the park. Most rivers originate outside the park meaning that park managers and staff need to engage with stakeholders of very different interests - and hence demands - on the water resources (Fig. 1). Moreover, gaps existed between research and management. This case study provides invaluable insights into addressing these issues.

Box 2: Challenges that the KNP faces with respect to river management

- *Today's situation reflects the legacy of a political system that viewed water resources management differently and that constructed and reinforced the KNP as an "island".*
- *Almost all the rivers originate from outside and KNP has little control over upstream users.*
- *The rivers draining through the KNP are greatly over-utilised, mainly through over-abstraction but water quality problems also persist .*
- *Mozambique lies downstream of the Park and also requires water. KNP is often accused when that country's requirements aren't met although in fact the causes lie upstream. Thus KNP's role switches from one of downstream user when viewed within a national context, to upstream user when viewed in an international context.*

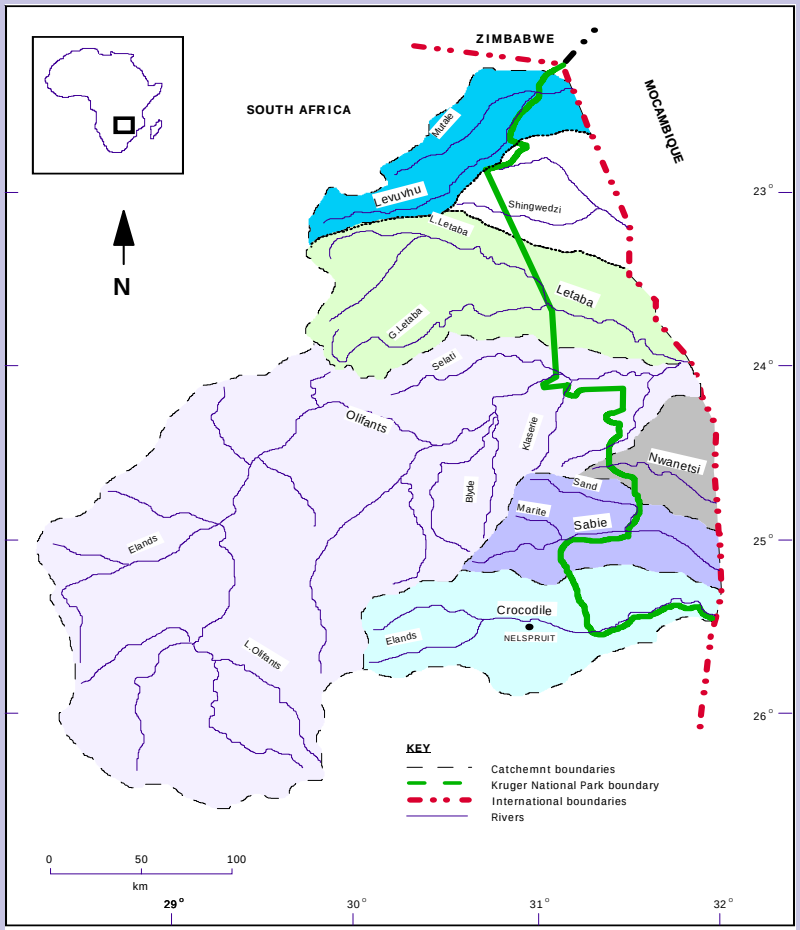


Figure 1 . Major river systems and associated catchments of the eastern escarpment, lowveld and Kruger National Park, South Africa

PART 2: Strategic adaptive management

What is strategic adaptive management?

Strategic adaptive management (SAM) is a framework for management based on 'learning-by-doing'. In many cases this represents a fundamental shift from 'command-and-control' approaches of the past. At its heart lies the fact that we recognise that in complex systems (see later) we cannot know or predict everything and hence we adapt management actions as we gain experience. Strategic management is not strategic planning (*e.g. planning what to do in the future*) - it is ***acting with a purpose!*** (Meffe et al. 2002).

Strategic Adaptive Management

A strategy

- A game-plan describing where an organisation is going, how it is going to get there and what it will do to ensure it arrives there.
- Strategic management is the continual process of inventory-ing, choosing, implementing and evaluating what an organisation should be doing.

Adaptive management

- Adaptive management integrates research, planning, management and monitoring in repeated cycles of learning that seek to improve on, and achieve, objectives. It is adaptive in that processes can be repeated at intervals so as to revise the objectives with growing experience and knowledge - hence the term 'learning-by-doing'.
- Specifically, it is the integration of design, management, and monitoring to ***systematically test assumptions in order to adapt and learn***. The italics emphasise that, as Rogers (2005) points out, most organisations treat this part too loosely and their actions are therefore not truly adaptive but rather ones of trial-and-error.

Box 3: Principles of strategic management (see Rogers 2005)

- *Strategic management is explicit. Strategic approaches define what an organisation, group or individual intends to do, how and why those actions were selected and whether or not they are accomplished. Thus everyone knows what the group is doing.*
- *Strategic management sets direction but allows flexibility.*
- *Strategic management promotes action. When the purpose is explicit and agreed on, people are empowered to act.*
- *Strategic management starts at a high level. That is it starts with a high level purpose that guides decisions that must fit within its context, rather than using resources on actions not directly related to their targets.*
- *Strategic management involves all stakeholders. The purpose must be set and accepted by the full group of people who have an interest in the decisions.*
- *Strategic management requires good communication.*
- *Strategic management seeks improvement not perfection. A supposedly perfect plan will take so long to develop that it will be obsolete before it is finished. Thus, things are tackled in an evolutionary manner.*

Start now!

Why use SAM for protected areas?

Strategic Adaptive Management (SAM) is a framework for the stewardship of conservation areas based on learning-by-doing. In many cases this represents a fundamental shift from management approaches which were strongly interventionist and which viewed parks as a stable, linear system. Consequently management action often reduced variability.

In response SAM was adopted and developed in South Africa in 1996 by a group of South African conservation and river scientists and managers. A key aim was to move environmental management away from stable system thinking and from one that was reactive, conflict-driven, management of human impacts, to consensus-driven, learning-orientated management.

Figure 2. The two faces of the Olifants River. The floods and drought cycles of the KNP are a natural part of the system. Attempts at management need to be frameed by this reality to maintain the key system attributes.

The importance of thinking about complexity

People inherently seek certainty in life but in fact, uncertainty is the one thing that is certain! Uncertainty is inherently related to complexity because it is a feature of complex systems such as ecosystems. *Complexity* differs from complicatedness. For example, mechanical instruments may be complicated with many parts functioning together but the outcome is predictable. Ecosystems are not like this. This is because, typically, socio-ecological systems have the following features:

- Socio-ecological systems are **heterogeneous**, **dynamic** and in a state of **flux**. For example, rainfall may vary around an 'average' of 500 mm per year – from 200 mm in a dry year to 800 mm in a wet year. This brings about different effects both on an annual and cumulative basis.

- Systems have **multiple drivers**, many of which are non-linear in their effects and which operate at different scales. Hence outcomes are usually not entirely predictable. Also some of these drivers may relate to other 'sub-systems' such as a political or global drivers. For example, culling debates are now taken up internationally and these can influence local-scale decisions. An unstable political climate in a neighbouring country may influence the numbers of visitors – and hence revenue – for the park.

- Components of systems are interdependent and interacting. Understanding the linkages is important. In particular **feedback loops** are an important consideration of complex systems. For example, a reinforcing loop - where an effect increases - can be seen when wetland health improves, resulting in an increase in the water table which, in turn causes a further improvement in wetland health. A counterbalancing loop - where an effect is ameliorated.

- Multiple drivers and feedback loops often mean we **can't predict exact outcomes**, Moreover they can lead to **unexpected outcomes**. The case of rare antelope provided later illustrates this.

- Complex systems **display lags** thus it can take time to see benefits.

- Complex systems are not necessarily complicated. In fact they often only have a **basic set of drivers** and responses such as fire and rainfall.

The essence of these systems is that their **inherent variation** is what determines the system function. Also systems **interact** with other systems. These attributes add variation and novelty (i.e. they adapt). Gradually we are getting better at understanding and managing such attributes.

Box 4: KNP as a complex system

Recent recognition of the lowveld savanna, including Kruger, as a complex adaptive system necessitated a new approach to management that explicitly recognizes heterogeneity and variability as key characteristics. Questions then arose as how to structure a management system around these characteristics.

Kruger has adopted SAM based on a clear statement of vision and mission developed through extensive stakeholder involvement. Flowing from this is a hierarchy of objectives, which, through increasing levels of detail, is ultimately linked to clear, auditable endpoints called ***thresholds of potential concern*** *(TPC). These specified upper and lower ranges are essentially set as hypotheses that are mutable as new learning is brought to bear. Linked to the TPCs are clear lines of roles and responsibility.*

Using the complex systems view in practice

In the management of parks - as with other systems- we need an expression of a desired state. In practice this can be achieved by:

- developing a process that sets out a vision, mission and a set of related objectives;
- defining a systems context;
- identifying boundaries (such as conservation targets, or thresholds of potential concern) appropriate to the objectives; and
- defining a hierarchical set of objectives which ensure that our management is strategic.

The important implication is that we don't set a 'target' such as maximum sustainable yield. Rather by letting the system 'bounce around' inside the desired state, we are in fact promoting 'natural' processes and selection pressures, this being desirable in its own right.

The issue of seasonality is important in the KNP context. Periods of drought and extreme floods are all part of the KNP-system's character. It is therefore important that the vision and the objectives hierarchy recognise the heterogeneous nature of the protected area. Managers and their rangers need to recognize that in order to manage within complex systems they need to be able to respond in a variety of ways including being aware that extreme conditions are challenging but essential. This raises the issue of 'averages' which are regarded as inappropriate if one recognises the importance of complexity.

Managing in this way is based on the belief that defining and constraining the system state too tightly will reduce system resilience, a desirable feature for ecosystems (as long as the resilience favours maintenance of a desired state).

Notes from the field

A senior ranger pointed out that the 'old' system of management aimed to eliminate change and variability rather than to seek appropriate responses whilst "keeping an eye on the vision statement".

Managing for heterogeneity may not extend beyond the park borders - this poses particular challenges for working with external stakeholders.

Box 5: Dealing with complexity

There are a number of ways of dealing with uncertainty and complexity:

- *Get as many people as possible **thinking holistically** about the system (biophysical, socioeconomic and institutional) and events.*
- ***Scenario-based planning** (aided by mathematical and computer simulation, and statistical analyses if necessary) can help one plan and account for random events.*
- *Be prudent, making decisions with **buffers** to absorb surprises.*
- *Employ **adaptive management** which seeks to 'learn-by-doing' so that we adapt our direction as new information becomes available.*
- *Recognise that in complex systems there are a **number of ways** to arrive at the same endpoint or solution.*

PART 3: The importance of context

Rivers of the Park as an example

The lens through which SAM is being explored in this guideline is that of river management and the re-orientation towards water resources management. In this section we give some background to the water resources, and tell the story of their progressive degradation and of the changing management responses over time.

A key issue for the KNP has been the progressive decline in water quantity, quality and associated fauna and flora of the rivers that traverse its area from west to east. Of the six river systems of the KNP, five were perennial and one, the Shingwedzi, was naturally seasonal but today major changes have affected all but the Sabie. The first deterioration was evident some 45 years ago when the perennial Letaba ceased flowing and subsequent cessations have transformed this river into an annual system. All other rivers have experienced flow and water quality modifications (Table 1).

Increasing and changing upstream demands are implicated in these changes, including agricultural abstraction – by far the largest water user - as well as afforestation, mining and the construction of dams. This situation has been exacerbated by the past allocation inequities between the various user sectors, and has been accompanied by escalating conflict. In particular poor rural communities survived on very low quantities of water. All in all, the aridity of the lowveld and the frequency of drought, coupled with current and projected population densities and water demands, means that there is insufficient water to meet current and future needs at the required assurance levels in most catchments.

If one examines the length of rivers or area of catchments that fall within the Park, the linkages and vulnerability of the Park to external influences are starkly apparent (Fig. 3). From this it is quite clear that the extent of most of the rivers, together with their associated catchment areas fall largely outside of the Park boundaries. For example, in the Olifants River, a severely degraded system, only a 100 km stretch of its entire 840 km length (or 11%) falls within the Park.

Table 1. Summary of major changes that have occurred in the five rivers that flow through the KNP

River	Changes
Levuvhu	- Ceased as a perennial system since late 1960'sSummary of major changes that have occurred in the five rivers that flow through the KNP - No-flow approximately 20% of time
Letaba	- Ceased as a perennial system since late 1960's until 1995 - No-flow approximately 30% of time - Negotiations returned perenniality
Olifants	- Severe flow regime and water quality problems
Sabie	- Least modified of 5 rivers. About 70% of MAR remaining
Crocodile	- Abnormally high, stable winter flows Infestations of water hyacinth

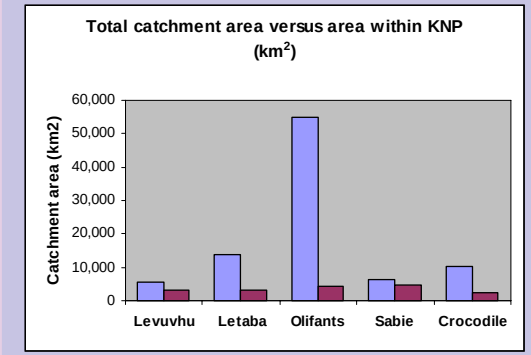


Figure 3. Total catchment areas for five perennial river systems found within the KNP

The Park responds

As the precarious state of the water resources became apparent, the Park responded through communiqués with the national government in the 1970s. However, concerns largely went unheeded until the late 80s, and the Park adopted internal strategies to mitigate the effects of declining and transforming flow regimes through an extensive network of surface water provision (see Figure 7). In 1983, attitudes started to change when the first formal recognition of water for instream flow needs for South African rivers, albeit simplistic, was introduced.

In 1988 the KNP Rivers Research Programme was initiated as a co-operative undertaking by resource-use managers, funding agencies and researchers. This signified a change in attitude to rivers and environmental water requirements. During this phase that collaboration between managers and researchers improved with some co-learning. The political transformations that accompanied democratic transitions in 1994 were also major drivers for change, opening up windows of opportunity for effective international engagement as well as focussing interests around holistic water resources management. Also researchers started to pick up on complex theory and adaptive management within the arena of natural resource management. Interest in these ideas arose as a critique of approaches based on averages, and the propensity to view nature as in balance, linear and predictable whereas variability is in fact the key characteristic of semi-arid systems. This paradigm suggested that variation and extreme events are actually fundamental for biodiversity management. This idea was a central theme of rivers research and in the determination of environmental flows where variation in flow regime was seen as a key driver of the system.

Other concerns centered on the entrenched and autocratic nature of management within the Park. Moreover, political transformation necessitated change from an insular approach of managing the Park as an 'island' to one where the KNP saw itself embedded within the socio-economic landscape. Moreover, the entrenched stable state concepts were challenged for the failure to embrace spatial heterogeneity and flux in ecosystems.

Moreover, all the major river systems flowing eastwards through the KNP ultimately feed Moçambique and, under international obligations, South Africa is required to honour certain flows through to that country. Kruger thus sits between two realities: on the one hand it is the victim of upstream abuses and on the other it is the buffer with Mozambique downstream.

All these factors contributed to the development of the SAM approach which adopted the approach of 'learning-by-doing" with stakeholder involvement. Adding to the catalysts for change was the fact that the management of rivers was in crisis at this time and Park staff had only just started to recognise that river management was part of their brief. Thus SAM was tested within the arena of water resources management. The complete overhaul of water resources management at a national level provided an enabling environment for change.

Box 6: Key change factors

A number of key change factors frame SAM in the Park. The first is the alarming decline in surface water quality and quantity, together with the associated biodiversity changes of the rivers.

The second relates to changes in thinking, namely (a) the recognition that lowveld savannas are not stable-state systems but rather an inherent characteristic is their heterogeneity and flux, and (b) the Park is not an island but is embedded in a broader landscape with which it must interact.

A third factor was the policy changes that accompanied South Africa's democratic transformation. These brought new principles such as sustainability, equity and democracy.

In retrospect, an interesting aspect of these is how closely interlinked their histories have been and many suggest it has been their mutual influence that has transformed the management of KNP in the last decade.

Variability and change: a challenge for river management

The Park had to respond to challenges that it faced (Box 6). Amongst others, two key questions emerged: (a) how much research was enough to 'do' management?, and (b) how was management to embrace such variability and flux? It is one thing to recognise that ecosytems are complex, linked and variable but it is another to build this into a management system in a meaningful and practical way.

As we have introduced and will illustrate in Part 4, strategic adaptive management offered a new way of addressing the research-management-policy interface.

Figure 4: The Lowveld is an area of variability. The top photos show the Sabie River, both taken in the dry season. The first shows 1987, a wet year and the second, 1992, which was the worst drought in recorded history. The lower photos of the Olifants River indicate seasonal variations in flow between the wet and dry season in 2005. [Photos: F. Venter]

FEATURE: more examples of the application of SAM

Fire management

Scientists have noted that dominant vegetation patterns in Kruger are mainly driven by fire (Figures 5 & 6) and large herbivores, and both interact strongly with rainfall variability especially drought. However, management practices such as burning regimes and water provision alter the outcomes of these drivers.

In the case of fire management, between 1956 and 1992 the KNP adopted a strongly prescriptive burning regime at a fixed return period (von Wilgen et al, 2003). However, by the late 1980s this policy came under scrutiny and heated debate due to the dampening of variability related to fixed burning cycles. Various researchers also commented on (a) the associated decline in large trees, (b) the practice of "ringburning" which gave rise to high intensity fires over large areas and animal deaths, and (c) the prevalence of grass species that are characteristic of poorly managed areas. Thus after 1992 a policy of natural, lightening fires was adopted. For a number of reasons this has recently been replaced by an integrated approach that combines elements of patch mosaic, range condition and lightening burns. The primary reason for this is that evidence suggests by ensuring variability, especially in the occasional, longer intervals between fires, one improves the recruitment of trees into fire-resistant size classes. This provides an example of how management practices have been strategically adapted over the decades to best suit the management of the resources of the park.

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Figure 5. Fire is a key determinant of vegetation characteristics in the Park. This photo shows a patch burn. [Photo: F. Venter]

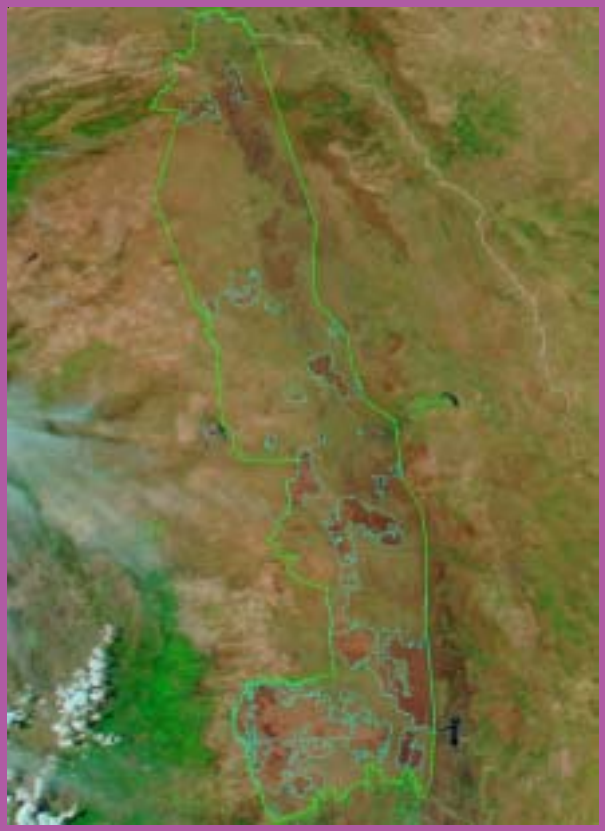


Figure 6
Location of patch burns in the KNP in 2005 [Source: KNP Scientific services]

Managing waterpoints in the KNP

In the 1970's Park managers were concerned about the state of rivers flowing into the park. In an attempt to secure water resources within the park, and ostensibly make it independent of external factors, managers embarked on a program of borehole development in the park. The 365 boreholes and some 50 earth dams that had been constructed by 1995 (Figure 7) ensured that the majority of the land was within 5 km of a permanent water source (Gaylard et al. 2003). Again, as prudent as this policy may have seemed at the time, it was detrimental in two respects. Firstly, the numbers of game, especially of rare antelope like roan, did not improve - potentially because of the competition with escalating zebra population and herbivore numbers continued to fluctuate (see Grant 1999; Harrington 1999).

The second issue relates to the fact that the use of surface water influences faunal and hence vegetational distribution patterns at multiple scales. For example, associated with the extensive network of artificial water points has been a decrease in tree density, changes in the diversity of aquatic, avifaunal and carnivore communities, including a doubling of lion population, the loss of the brown hyaena and an increase in water-related parasites.

Moreover, water points in waterless savannas have been blamed for erosion attributed to overgrazing and changes in nutrient distributions. This compelling evidence meant that, although somewhat controversial, by 1997 management reversed the water provision policy and initiated the closure of a number of boreholes. Kruger's strategic adaptive management framework through monitoring outcomes was able to address many concerns.

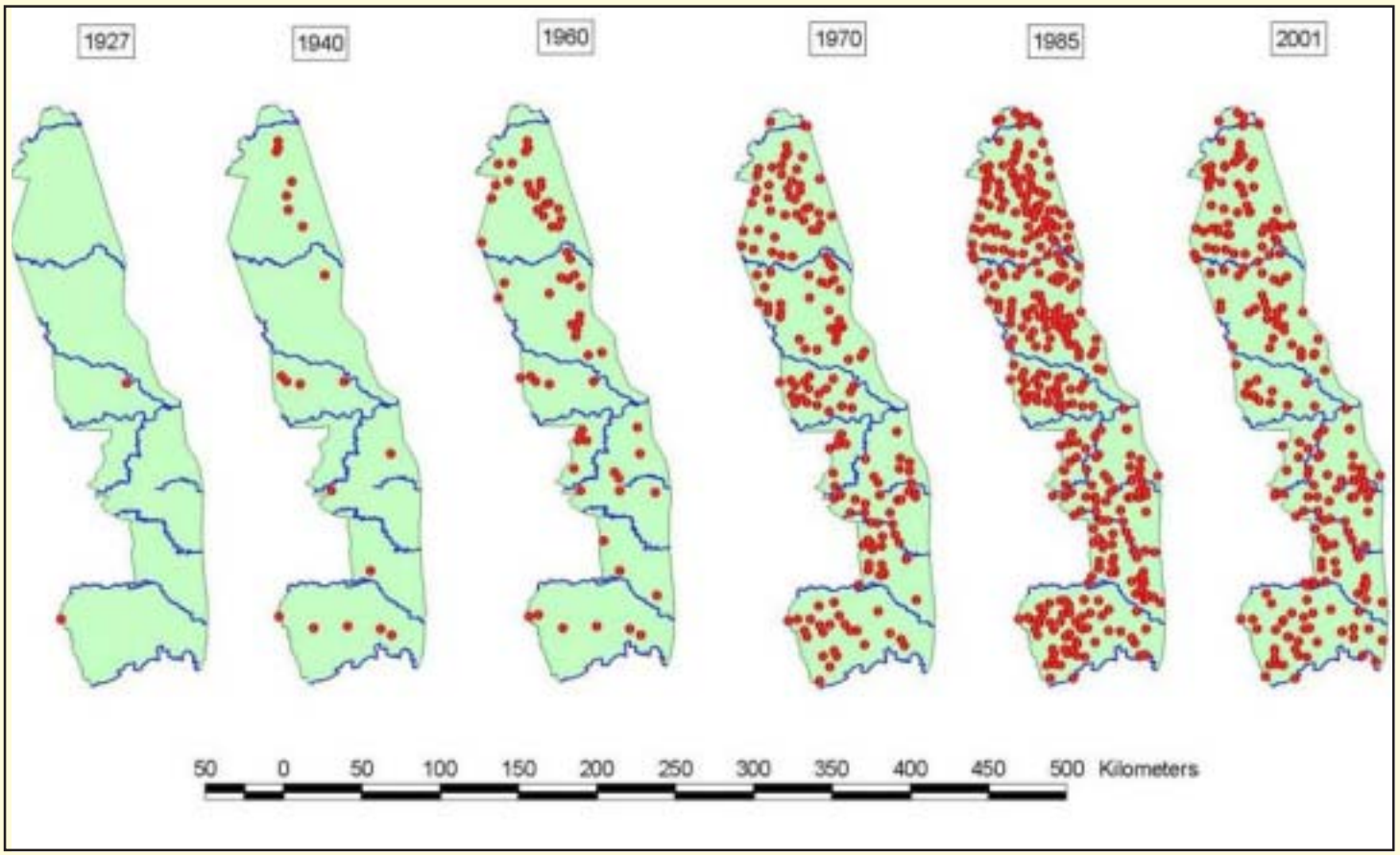


Figure 7. The distribution of waterpoints in the KNP at different time intervals between 1920 and 2001

PART 4 Guidelines

In this section of the guideline we present a STEP-BY STEP guide for strategic adaptive management

Who is involved in SAM?

One of the most important shifts away from 'top-down' management to a more inclusive management structure has been to involve all levels of management and field staff in the design, implementation, monitoring and review of the SAM process. This implies that the organisation is transformed into a 'learning organisation' where members are drawn into the ongoing development and refinement of a responsive management system.

The work of protected area managers in SANParks: an example

- *Conservation of biodiversity and cultural heritage.*
- *Sustainable Tourism in synergy with conservation and socio-economic development.*
- *Building co-operation with stakeholders.*
- *Managing day to day operations effectively and within budget.*
- *Providing, or using, support services to ensure accountable and cost effective management that meets corporate values, principles and vision.*

The SAM Framework

The basic steps in SAM are:

1. **Visioning**. Understand, with stakeholders, the social, economic and ecological context of the system to be managed, and the principles/values that guide management. Develop a broadly acceptable vision of the future.
2. **Translate vision into ecosystem targets**. Develop an objectives hierarchy that documents the sequential reasoning used in translating a broad societal values-based vision into science-based ecosystem outcomes.
3. **Options analysis**:
    a. **Scope** the range of management **options** to achieve the desired future conditions and predict their likely outcomes under different scenarios. Expect the unexpected.
    b. **Assess** the acceptability of outcomes from a range of perspectives
    c. **Select** the best options in co-operation with stakeholders.
4. **Operationalise** (implement, monitor and audit achievements).
5. **Reflect** at each step. Is thinking and action congruent with principles/values? What does knowledge gained tell us about (1) our understanding of the system, (2) its responses and, (3) how realistic are the desired outcomes and (4) how useful are the processes used to achieve them.

Box 7: What is different in Kruger's case?

Many organisations claim to be practicing adaptive management. However, we suggest that in many cases these organisation are not undertaking one or all of three critical steps, namely:

1. Setting a vision from which flows objectives, and measurable endpoints

2. Scoping of options. This step better positions the organisation to respond under different scanarios and to anticipate surprise.

3. An absolutely critical step is that of reflections and learning. Often organisations undertake monitoring but fail to ask the critical questions:

- *Is the monitoring adequate, cost effective and feasible?*
- *Has the intended plan of operation materialized?*
- *Were the selected options appropriate?*
- *Were the predicted outcomes correct? (If not, why not?)*
- *Was the outcome actually acceptable?*
- *Even if the predicted outcomes are correct, are the objectives and vision being met?*

The importance of these questions cannot be over-emphasised. So often we meet our endpoints but fail to reflect on whether or not these relate to the next hierarchy and ultimately to the vision.

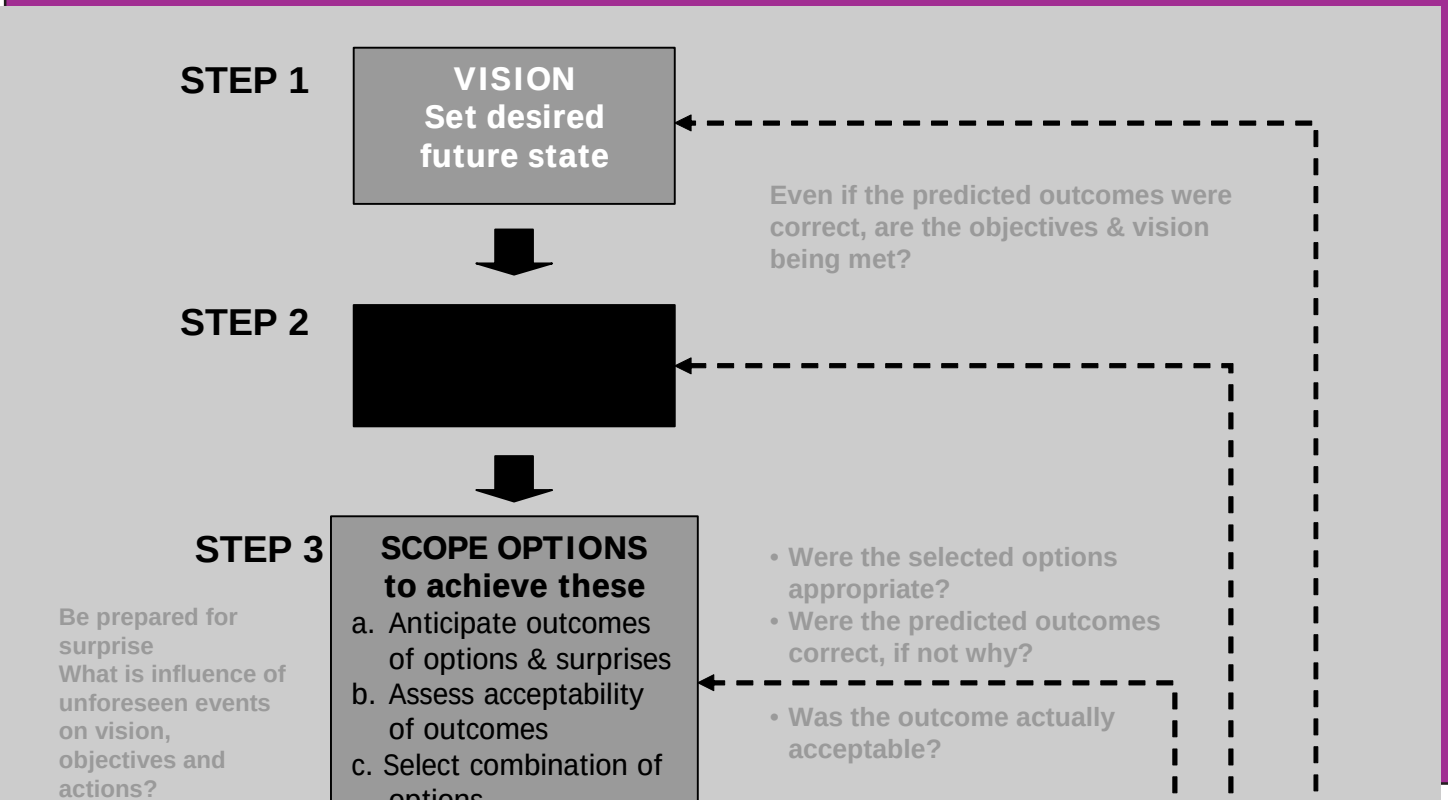


Figure 8. A Framework for SAM showing 5 key steps

(from Biggs & Rogers 2003, adapted by Pollard & du Toit)

In Part 4 & 5 we present details for each step of the strategic adaptive management process

STEP 1 Creating a vision

The first step in the process of SAM is the development of a vision. Visioning is the starting point of collectively developing a medium-to-long term **desired state** for the protected area based on an understanding of the context and values. The importance of visioning cannot be overstressed as this provides the basis for SAM. Once this 'higher-order' statement has been debated and captured, it provides the foundation for the development of objectives and sub-objectives which are ordered in a hierarchy of increasing levels of detail. Ultimately these are expressed as measurable endpoints (including targets or Thresholds of Potential Concern).

What you need to do...

The following steps help build a vision that is locally-grounded and provides a basis for setting objectives.

A. Understand the context and operating principles

The key principle in this step is that to develop a meaningful vision, stakeholders need to understand the context from as holistic a perspective as possible (Fig 9). A useful framework for this is known as V-STEEP, which provides the prompts to examine different issues (Fig 10). The danger of ignoring these factors is that the vision becomes unrealistic and unattainable. It is important to involve all stakeholders in building the vision to ensure common understanding as a base for future negotiations.

Tips

- *Ask people to work individually at first to list two key characteristics of the area under each factor of V-STEEP. These are collected and discussed as a group.*
- *Try to describe the context of the managed system at local, regional, national and international scales.*
- *Values refer to the societal values that are pervasive at the time (e.g. 'equity' or 'securing wilderness')*
- *Although this step is presented first, experience shows that when people are familiar with the context it may be better to start with the vision – a step which is more 'dynamic' – and then cross-check against the context and principles. Equally, moving straight into describing vital attributes may provide a good entry point for an experienced stakeholder group (Fig. 9).*

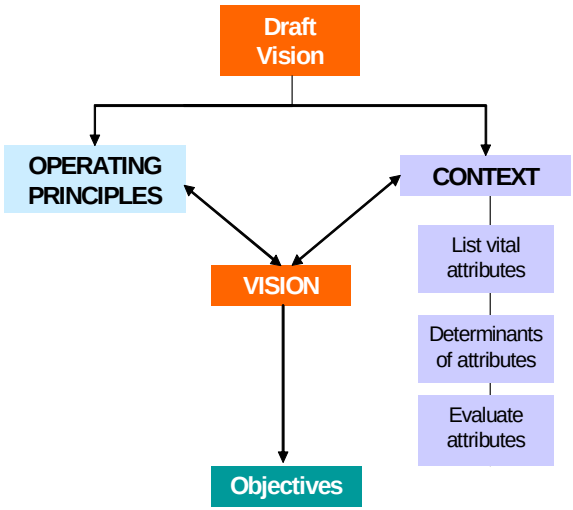


Figure 9. The vision is developed by understanding context and principles. This is an iterative process.

Box 8: The KNP Mission (Vision)

In keeping with the SANParks mission,

- *to maintain **biodiversity** in all its natural facets and fluxes*
- *to provide **human benefits** and build a strong constituency,*
- *and preserve as far as possible the **wilderness qualities and cultural resources** associated with the Park*

B. Reach consensus on the vision and operating principles

Identify the key elements of the vision and develop consensus on an acceptable draft vision. You may revisit this after describing the vital attributes and so this should be seen as an iterative process between describing the context, the operating principles and the vital attributes.

Tips

- *Before any other management action can be taken the vision and operating principles need to be fully accepted to prevent subsequent procedural breakdown.*
- *The ideal situation is to have as much information available as possible **before** the visioning process is initiated. However, since the visioning process is iterative, a vision can be refined over time, as and when information is made available. In any event, a vision should be revisited as part of a regular review process.*

Key question

Is the vision adequate to set objectives and subobjectives?

C. Document, evaluate and consolidate the vital attributes of the system to be managed and their determinants

The vital attributes refer to 'what makes your park unique or special' or what is distinctive about the park in question. For example, unique features may be a wetland or gallery forest, or key cultural, heritage sites. This is an important step in the SAM process as it identifies the fundamental purpose of conservation management for a particular park and focuses effort and attention for developing higher-order objectives.

The starting point is to list **all** the known and perceived, current and future vital attributes of the system. Thereafter, stakeholders discuss and evaluate lists generated to reduce them to the essential elements compatible with the vision. An important final step is to describe the key determinants of these attributes. For example, the determinants of a wetland may be dry season low-flows in the river and groundwater inputs. Again, describing these helps to focus attention for the next step.

Tips

- *Vital attributes may be determined from the V-STEEP characteristics of the system*
- *Encourage participants to put their "cards on the table" to produce a provisional list of their perceptions of the vital attributes, without debating their merits. Then reduce the list by eliminating those incompatible with each other, or the vision.*
- *Personal values play an important role in this step as long held assumptions about what is "vital" in a Park need to be discussed and supporting evidence found.*

V-STEEP

The V-STEEP framework can help describe the context

Factor		Example
V	Values	▪ Sustainability issues now nationally important ▪ Improving equity for people
S	Social	▪ Many poor people reside on the park borders
T	Technical	▪ Fences are ▪ Few trained staff
E	Ecological	▪ Ramsar wetland
E	Economic	▪ High poverty ▪ Tourism revenue on the increase
P	Political	▪ Good policies nationally ▪ Neighbouring instability

Figure 10. The V-STEEP framework offers an approach to describing the context as holistically as possible.

Quotes from the field

The vision statement is very important but it must be logically broken down so that we can understand it as field rangers. It is important for field rangers to understand why they are performing certain tasks in order to be able to evaluate their own actions against the overall vision.

STEP 2 Objectives hierarchy

This is a nested, hierarchical set of objectives that flows from the vision down to finest level of the hierarchy, which consists of clearly achievable objectives and measurable endpoints. Indeed, the hierarchy begins at the highest level – the vision. The step-by-step process allows for the deconstruction of the vision into a series of objectives of increasing focus, rigour and achievability.

What you need to do...

The process of developing and objectives hierarchy together with endpoints is summarised below and shown in Figure 11. It should ideally be implemented in a workshop environment with the assistance of a facilitator who is familiar with the process. Importantly, it is an iterative process of identifying, structuring and analysing objectives, and understanding how they relate to each other. **The vision and objectives hierarchy is given Figure 12.**

Tip: It is important to recognise that objectives at different levels in the Objectives Hierarchy would probably be used to direct operations at different levels in the institution

a. Formulate and prioritise the high level objectives

At this level objectives are set to:

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

Prioritising objectives is both difficult and subtle. Use the vision, strengths, principles and context as a basis to prioritise as they provide the checks and balances. Note that the priority may change according to the level of management personnel involved so try to involve a wide range of stakeholders.

Tips: Repeatedly cross reference the vision, principles, context and vital attributes

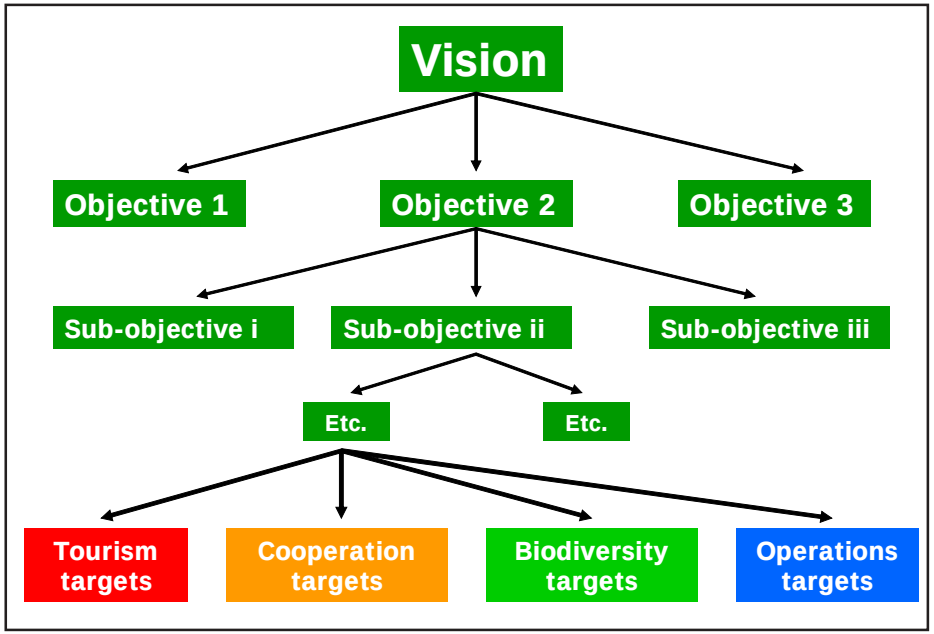


Figure 11. An example of an generalised Objectives Hierarchy

with constraints to ensure that the statements of intent can overcome these.
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.

Negotiation is an important tool since there will be many perceptions of what is most important. Use the preceding steps to provide checks and balances. Do not do it by vote as this often reduces decisions to gut feel or personal agendas. One of the most useful devices for prioritising is simply to ask - WHY? Why is A preferred to B?, and then to relate the answer to the vision, principles and vital attributes.

b. Set lower level objectives

Continue to deconstruct the higher-level objectives to their constituent sub-objectives. There is also a need to **prioritise these lower-level objectives**. Different degrees of rigour may apply – for example, an objective may have a low priority because other objectives have to be achieved first, not because it is less important. One of the reasons for prioritising is to check for redundancy between objectives. Quite often one lower objective serves two higher level objectives, thus avoiding duplication.

*Tips: Use the same procedure as that for formulating objectives (Step a) to sub-divide objectives into smaller and smaller units until the statement ceases to describe an intent and becomes one of **"what must be done".** You have set the final objectives 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 objectives is set to achieve a particular high level objective. Again, ask - why is this needed? Remember, the point of this exercise is to focus management on priority, achievable and measurable objectives. Therefore repeatedly cpk+[heck that the resources needed are available or potentially available.

c. Set measurable endpoints for each objective

Part of turning strategic planning into action involves defining what to measure – the calibrated endpoints are the final outcome of setting a desired future state using the objectives hierarchy. In the KNP, the endpoints are known as TPCs (Thresholds of Potential Concern) or targets (see Glossary). These are developed collaboratively with stakeholders so that there is understanding of why they are being monitored and how they relate to objectives and ultimately to the vision. These TPCs form the basis for designing a monitoring programme (see Step 4). Much has been said about these TPCs and they are described in the Section entitled: Feature on Thresholds of Potential Concern.

Quotes from the field

You might not know it all but there is always enough to make a decision

Sequence and priorities are important for constructing the objectives hierarchy

Key questions

Does the objectives hierarchy flow clearly from the vision?

Does is provide the basis for developing measurable endpoints? (e.g. TPC's see monitoring under Step 4)

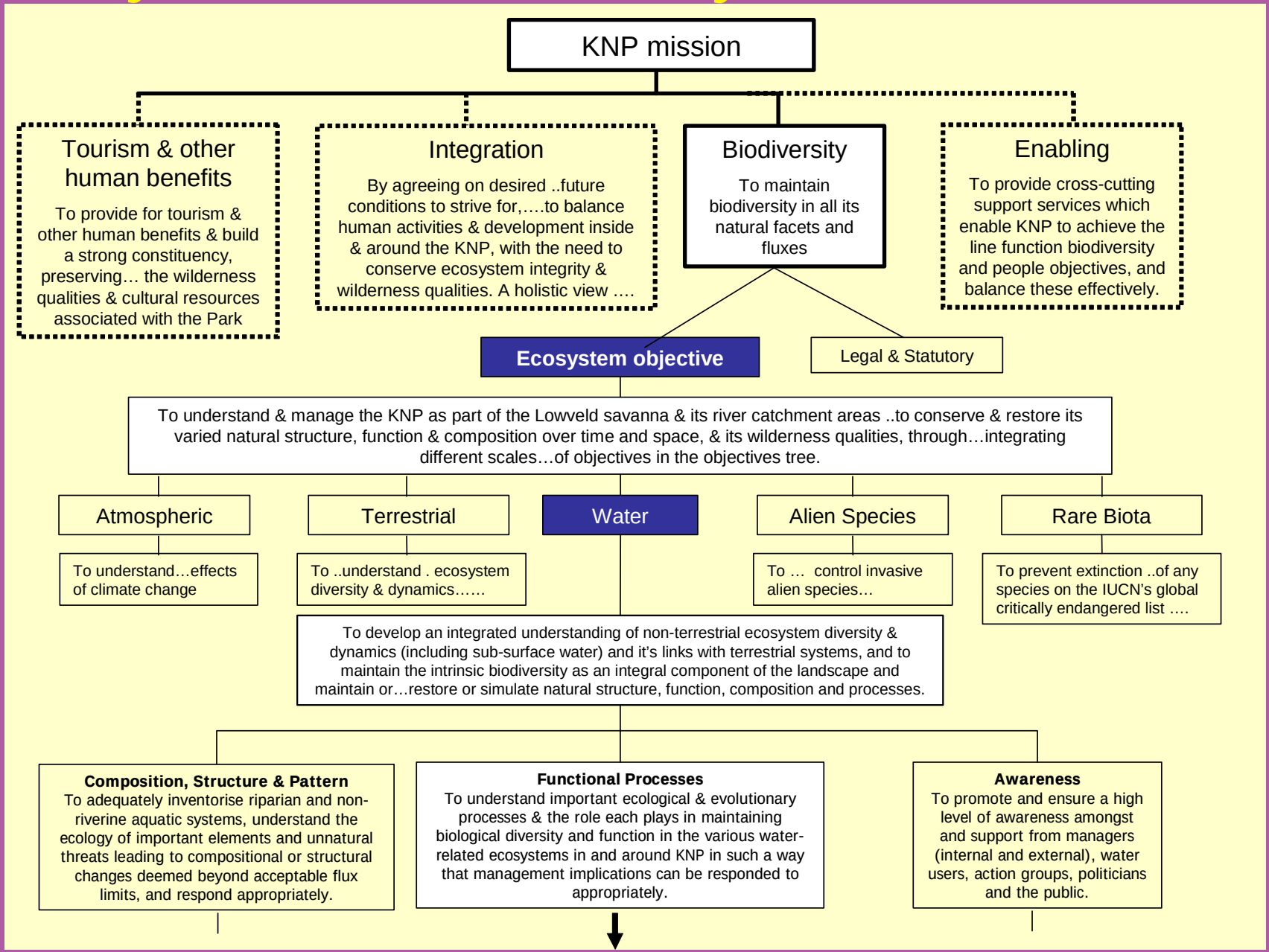
Notes from the field

1. The link between the top end and the bottom end of the hierarchy is not always understood by field rangers. This needs to be made simple and people need examples of how the objectives hierarchy is developed.

2. The objectives hierarchy helps explain the actions and activities of the KNP to the general public and other stakeholders. So it helps in the communication process. This is likely to be especially important where a protected area is involved in multiple stakeholder platforms outside the park.

STEP 2

Objectives hierarchy for KNP



a

b

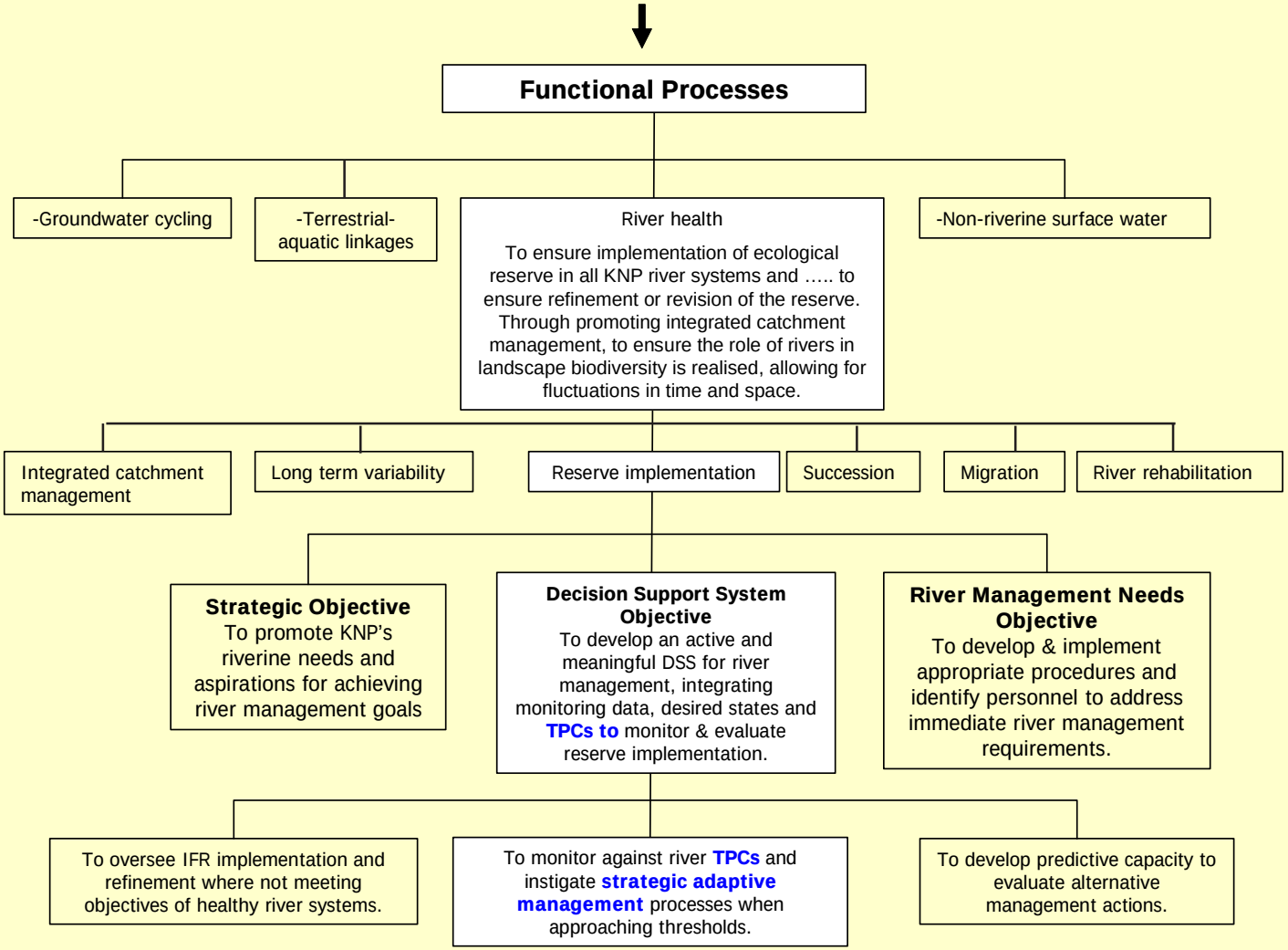


Figure 12 (a & b). This figure shows part of the KNP objectives hierarchy. In this example the KNP mission (vision) is deconstructed to lower-level objectives. This example highlights the theme of water.

SPECIAL FEATURE: TPCs

What are TPCs?

A **Threshold of Potential Concern** – or TPC - is an articulation of the measurable end point of the objectives tree. They are meant to provide an early warning that some specification (such as and ecological specification is in danger of being exceeded. For example, "the absence of 'X' fish species in three consecutive surveys" may constitute a cause for concern and hence a TPC.

More formally, TPCs are upper and lower levels along a continuum of change in selected environmental or biodiversity indicators. Invariably, they are hypotheses of **limits of acceptable change** in ecosystem structure, function and composition. As such their validity and appropriateness are always open to challenge and they must be adaptively modified as understanding and experience of the system being managed increases.

When this level is reached (or when modelling predicts it will be reached) it prompts an assessment of the causes of the extent of change. The assessment provides the basis for deciding whether management action is needed to moderate the change, or if recalibration of the TPC is needed (See Figure 15). They provide management with strategic targets or outcomes against which to monitor the consequences of the activities

Quote from the field: TPCs in a nutshell

*Essentially once stakeholders work out what state you would like your rivers to be in (the desired future state); they would identify warning signs that things are moving dangerously in the wrong direction (**Thresholds of Potential Concern**); and when those signs appear, take corrective action to prevent the ecosystem going "over the cliff" into another state from which it may be difficult or impossible to recover.* (Tim Hirsch, environmental journalist).

Example 1: River management – geomorphic diversity

In rivers of the KNP, terrestrialisation is a major concern. The loss of geomorphological diversity is leading to habitat and species loss. In particular bedrock where the matumi tree grows (see photo) is being covered in sediment. Thus in pool-rapid channel types the TPC may be set as the ratio between sandy, water and rocky feature, specified technically as:

- lateral and point bars must not cover > 20% of total area.
- pools must cover 15% and more of total area.

SPECIAL FEATURE: TPCs

Notes from the field:

- The collaborative role in developing TPC's, and collaboration between research and management has been cited as a powerful motivation for staff, such as rangers and wardens, who then become a key link in the iterative SAM cycle. The role of involving field staff in setting management objectives cannot be underestimated.
- The initial setting of TPC levels can be a difficult process but it is essential to initiate the SAM cycle and, bearing in mind that these are hypotheses, they also highlight important research gaps. A sequenced approach that takes the first attempts as 'first generation' TPCs is useful where uncertainty and gaps prevail. The TPC's that have been developed must be carefully audited and controlled.
- The risk of a 'false alarm' is an important consideration in that a response may be launched 'too early' under the SAM model. As Biggs and Rogers (2003) put it, " the challenge is to blow the whistle *before* exceedence, whenever trajectories are seen to be heading in the wrong direction... one wants as few as possible false alarms". They recommend that field staff should err on the side of caution by tabling a TPC sooner than later. No false warnings are reported in Kruger to date but scientists feel that some TPC's should have been submitted when they were not.
- Understanding stakeholder needs, building trust and being in a position to negotiate with competing users is important in such an environment. This means that TPCs are used **with** others rather than in isolation as there is a strong need for "evidence" in order to establish credibility and trust in the TPC system. This means that SAM and TPCs will need to be explained to stakeholder groups.

Example 2: River management- flow

A reduction in flows leading to terrrestrialisation (see photo) is also cause for concern. Thus environmental flows have been developed for the rivers. The TPC may be set as:

- Low flows are exceeded 20% of the time
- High flows are met less than 80% of the time
- The indicator is flow regime. Both low flows and high flows are very carefully defined.

STEP 3 Scoping options for objectives

This step involves an options analysis, or scoping, assessing and selecting a range of management options for meeting the objectives outlined in Step 2. This process serves to ground the vision given the context and resources.

What you need to do...

The key components in this step, shown in Figure 8, include the following.

1. Scope out the range of management options
This is to achieve the desired future conditions, and predict (formally or informally) their **likely outcomes** under different scenarios. It is important here to **expect the unexpected**.

Tips: Use a variety of tools to do this step. This may include scenario planning, systems thinking, models, historical records and so on. These can also help scope the unexpected by being explicit about the ranges - and likely spatio-temporal limits - of unusual events and their implications for management towards the desired future conditions.

2. Assess the acceptability of the outcomes.
This step brings in an important dimension in that not only are the potential outcomes discussed (often biophysical in nature) but the social responses to these are also considered.

Tips: The values that were raised under visioning by stakeholders should guide the potential social responses.

3. Select and implement the best options.
In co-operation with stakeholders decide which management options provide the best potential learning opportunities, and social-ecological system outcomes.

Tips: The values can also help to propose and choose between alternative options and decisions.

Figure 13. The Phalaborwa Barrage was problematic for the Park and a range of options were scoped out to address this (see Box 7)

Box 8: Options scoping for the Phalaborwa Barrage

The Phalaborwa Barrage lies on the western boundary of the KNP on the Olifants River. The barrage has been problematic for the Park because of the periodic fish kills that were attributed to the silt releases from the barrage (scouring). The sediment from the barrage also destroyed many macro- and micro-habitats of the aquatic species.

*The **objective** of strategic planning in this instance was to ensure that river flow from the weir does not detrimentally affect the biodiversity downstream. The table below summarises the options considered by the Park as outlined in Figure 8.*

Summary of the options considered, the predicted outcomes and their acceptability

Options considered	Summary of predicted outcomes of the above options and acceptability
1. Destroy the barrage	Would affect potable water supply to community and mines but positive impact on biodiversity. Assessed as unacceptable overall.
2. Litigation to get different operations in place	Too costly.
3. Dredge silt out near gate	Expensive and time consuming
4. Remove silt on banks on KNP side	Ineffectual
5. Negotiation with operators for a new release regime (controlled releases)	Deemed beneficial to all. Reduced fish deaths and water would still be available to current users.

*The **criteria** that were used to assess these options included:*

- *Impact on biodiversity;*
- *Continued supply of potable water to communities;*
- *Costs to KNP and operator;*
- *Considerations to mines and others.*

Option 5 was finally selected and is being monitored for outcomes.

Key questions

Have a number of stakeholders been involved in scoping out options? (in order to consider diversity of ideas)

Have options been assessed using V-STEEP criteria?

STEP 3

STEP 4 Operationalise (plans, implement and monitor)

This step involves the operationalisation of the objectives tree. It is the process of turning objectives, sub-objectives and endpoints into action through action plans, implementation and monitoring.

What you need to do…

Here the focus changes from one of intent to become one of "what must be done", through standard operations and procedures, routines, detailed plans and so on. Part of the action plan involves describing what to implement and monitor, as well as the allocation of resources to these activities. As described in Step 2, the endpoints that are used by the KNP, for action, are known as TPCs – or Thresholds of Potential Concern. The objectives and their TPC's form the basis for designing a monitoring programme, a framework for which is given in Figure 14.

Tips: It is suggested that the park uses a range of research projects, traditional monitoring, modelling and surveys to understand system response to natural flux and management intervention.

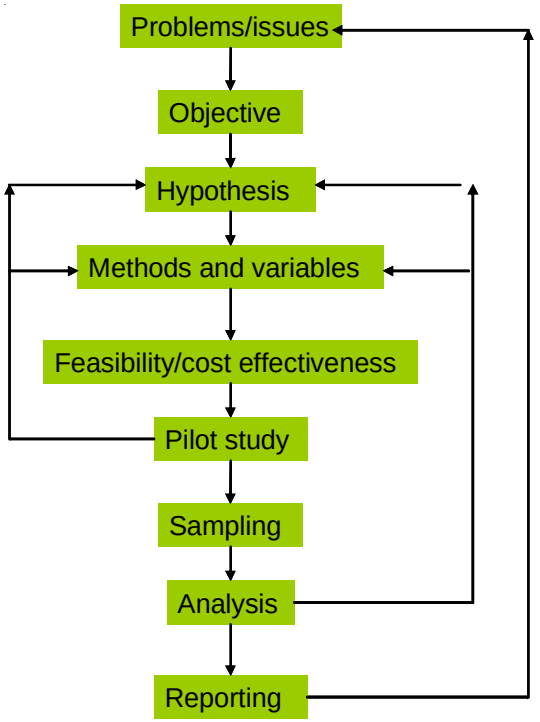


Figure14. Framework for designing a monitoring programme (from Rogers & Biggs 2003)

Example from the field: Monitoring in the KNP

Kruger's monitoring programme is based on the monitoring, auditing, reflection and modification of TPCs as shown in figure 8. A particular difficulty with river systems is their transboundary nature. In Kruger's case, they are almost totally reliant on good water resources use and management practices outside of their border to meet aquatic TPCs. Thus they initiated a 10-point plan which ranged from engaging national departments through to local-level interactions with stakeholders. To date, the results have been only partly satisfactory and the Park is to re-visit strategic actions. This case clearly demonstrates the challenges faced when managing linked, transboundary systems.

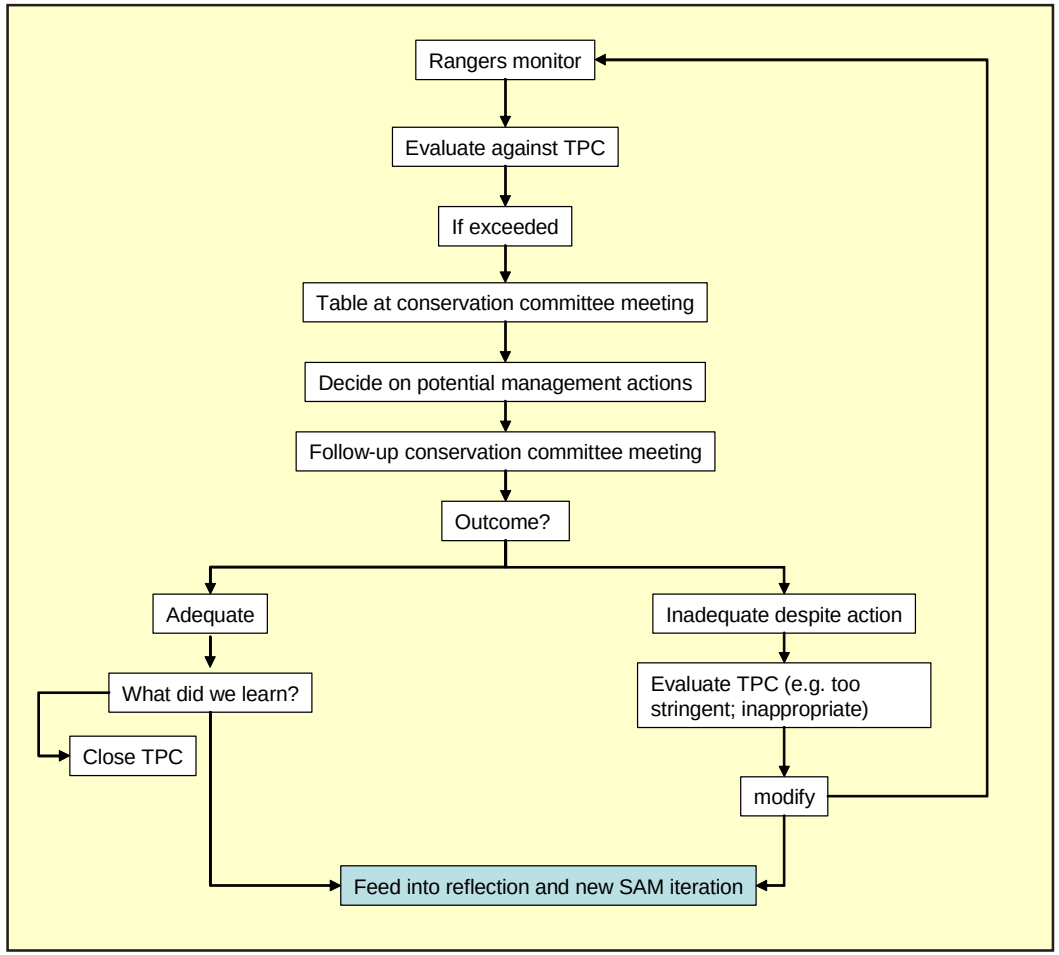


Figure 15. This figure illustrates the management actions that are taken in the KNP for the monitoring of TPCs and how this contributes to learning adaptively.

Key question

Is the vision adequate to set objectives and subobjectives?

Notes from the field

On monitoring… once river systems are dynamic and in a continual state of flux it is necessary to monitor conditions and to revisit management objectives. System dynamics needs to be understood in the broader context of what is occurring inside and outside of the protected area.

Quotes from the field

Feedback on how we are doing is motivating

We rangers need to be part of the process in order to do better monitoring. Involving all levels in the process creates better field practices.

STEP 4

STEP 5 Evaluate & Learn

An important aspect of the strategic adaptive management process is to learn and adapt over time. It is therefore critical that the management process builds learning into the process from the very outset.

The kind of learning for SAM is that of 'learning from action' - with the specific aim of improving management practices. This is called reflexive learning. Reflexivity is the basis for SAM and the process of being reflexive is sometimes described as a 'feedback loop' because actions are influenced by 'feedback' from the context within which they are executed.

For the learning process to be meaningful it is important that we are clear what actions we are learning from. Learning for SAM should be focused on the 5 steps set out in this guideline.

What you need to do...

A critical step for SAM is that of reflections and learning. Many people think they are learning by doing things, but this is not necessarily true. Learning really occurs when a person reflects on what they have done, evaluates the action and then uses the assessment to influence future actions. So often organisations undertake monitoring but fail to ask the following critical questions of each step as shown in figure 16:

- Is the monitoring adequate, cost effective and feasible?
- Has the intended plan of operation materialized?
- Were the selected options appropriate?
- Were the predicted outcomes correct? (If not, why not?)
- Was the outcome actually acceptable?
- Even if the predicted outcomes are correct, are the objectives and vision being met?

The importance of these questions cannot be over-emphasised. So often we meet our endpoints but fail to reflect on whether or not these relate to the next hierarchy and ultimately to the vision.

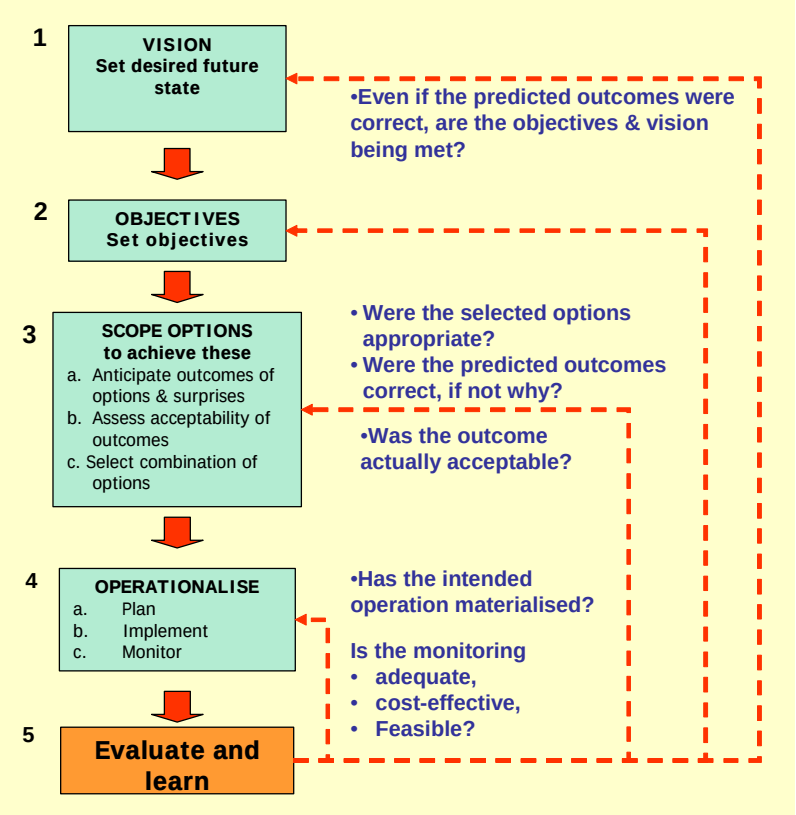


Figure 16. This figure highlights that at each step of the framework we need to reflect on the following. Is thinking and action congruent with principles/values? What does knowledge gained tell us about (1) our understanding of the system, (2) its responses and, (3) how realistic are the desired outcomes and (4) how useful are the processes used to achieve them?

Reflexivity: examples from the field

There are many examples of how practitioners, managers and researchers have experienced learning within the SAM framework. We will share a few examples here.

1. The development of a set of TPCs has been an iterative, reflexive process. Some staff reported that at times they were over-ambitious in the early stages when too many themes and TPCs were developed. Consequently, not all themes have been implemented (Biggs & Rogers 2003). It is important to accept that 'first generation' SAM's are likely to be broad and will most likely be scaled-down with time.
2. Developing processes that respond to feedback has been challenging. Here KNP has experimented with the formation of 'communities of practice' (Lave & Wenger, 1991) where a core of enthusiasts continually rework and improve the SAM system and make it more accessible for use by others.
3. The need for adequate support in terms of understanding SAM and TPCs was emphasized. Most field staff said they learnt about SAM whilst working in the Kruger Park. Networking through PALNet might provide a professional support tool for other protected areas interested innovations such as SAM.
4. Experience from KNP shows that there is a need for the integration of the various park programs. By drawing on the past experience, new techniques and a wide variety of experiences, it is suggested that more realistic practices (e.g.TPC's) can developed.

Key questions

Have we achieved what we wanted to achieve?

Are our actions helping us achieve our vision?

Quotes from the field

In past the system was different. We were given instructions, we collected data and there was no feedback. Now there is feedback. We sit around the table and we feel free to discuss the management of the park as equals. There is information sharing and communication between the different staff on how to run this section

Dialogue is critical. Sometimes we need help with interpretation – what are the samples telling us and so on.

Meetings are too irregular, we need a more structured review process. There is a need to capture 'good experiences' and talk about these. Communication becomes and important way of improving the management system.

Box 9:Creating a 'learning organization'

Some important considerations for the process of reflection and learning are distilled below.

The role of managers

Managers have a crucial role to play in the development of learning organizations and they need to encourage learning and responsivity. There are a number of important things to note:

- *Managers need to re-orientate field staff - this is NOT the same as capacity development. Rather it implies that all practitioners need to know that there is a new way of working regardless of their skills and competency levels.*
- *Capacity development will be required where specific skills are needed. The following should be noted: avoid creating dependency on the 'trainers'; start from real needs; identify and invest in key 'agents for change'; look for underlying causes that are an obstacle to new practices; identify opportunities for success; focus on improving reputation; and celebrate success!*

Structuring the learning process

The learning cycle developed by Kolb (1984) provides us with an approach for conducting reflexive learning. The emphasis is on trying something new in practice instead of outside knowledge as the only source of innovations. This means that the practitioner, through experimentation and reflection, has the power to influence and change practices.

The need for communication channels

For the reflection process to be able to influence future actions there needs to be adequate communication between field practitioners, managers and researchers.

Reflection and action at the appropriate level

Although individual reflections are important, it is critical that 'collective' reflection occurs if management actions are to have an impact on the system. This means that PA managers need to actively collate learnings and make these available BEFORE the next cycle of planning begins.

Understanding knowledge and learning

Sound knowledge is critical for SAM to function but it is important to accept that we do not have 'all the answers' and that we have to act on the best available information. Knowledge does not precede action, but emerges from it through a process of making meaning. This is a social process that is encouraged by interaction and dialogue and managers need to facilitate this.

Figure 17. The learning cycle of Kolbs (1984) Note the importance of the four processes: explore, analyse, decide *and* act

12 Lessons learnt

Over the years that KNP have experimented with the implementation of SAM a number of important lessons have emerged. These are summarised below:

1. **Management directed towards a desired state** has fundamentally re-orientated the management of Kruger, and staff and resource allocations. The development of objectives and sub-objectives are expressed as a measurable endpoint or TPC, which is the practical output of the desired state.
2. This desired state is not a stable state but has **variability** as an overarching characteristic which confers resilience.
3. The SAM system with its defined desired 'envelope' is seen as different from traditional 'target-setting' associated with management planning by conservation agencies.
4. In many cases, the **TPC envelope is a hypothesis**, and as such they need to be monitored and revised.
5. System dynamics need to be understood in the **broader context** of what is occurring inside and outside of the protected area.
6. River systems are common-property resources, viewed from a catchment perspective. This necessitates **participation** by stakeholders in multiple stakeholder platforms.
7. TPCs need to be **developed collaboratively** (research & management). This is a powerful motivation for monitoring staff (rangers & wardens) as a key link in the iterative SAM cycle.
8. **Get going**! The initial setting of TPC's can be a difficult - but is essential to initiate the SAM cycle – as a 'first generation'. This provides the basis for monitoring and highlights research gaps.
9. **Knowledge management** is a crucial part of the process.
    a. TPC monitoring can bring additional, unpredictable threads of information which need to be 'roped together' to benefit the organisation.
    b. The wealth of data generated by the SAM approach needs to be recorded, captured and made accessible.
    c. This knowledge needs to be shared for learning. Kruger has experimented with communities of practice from a core of enthusiasts who rework, improve and make accessible the SAM system.
10. The question of "**how many TPCs**?" is important. Initially Kruger was over ambitious and needed to scale-down.
11. The risk of a '**false alarm'** is an important consideration in that a response may be launched 'too early' under the SAM model- " the challenge is to blow the whistle before exceedence.."
12. There is a need for the **integration of programs**. The KNP has provided and tested a model that might be applicable to other research and management areas both locally and more widely.

Summary of Lessons learnt taken from the KNP case report

Glossary

Adaptive Management: Integrates research, planning, management and monitoring in repeated cycles of learning how to better define and achieve objectives. It is built on the assumption that natural systems are complex, our knowledge is imperfect but we can learn from purposeful, documented objectives and actions.

Adaptive planning process: A process for developing a sensible vision and translating into achievable objectives. It is adaptive in the sense that the process can be repeated at intervals to revise the objectives as experience and knowledge grow. It should be conducted as a co-operative exercise with stakeholders to develop a hierarchy of objectives that meets the needs of the National park as a common property resource

Biodiversity: Biodiversity is a complex concept that is often misunderstood and abused. We provide here a series of definitions of increasing correctness and therefore complexity to aid in understanding this concept. Biodiversity is NOT simply the number of species in a particular area as it incorporates habitat as well.

Desired Future State: refers to a state that is, in the case of the KNP, a product of visioning together with the objectives and measurable endpoints.

Determinant: A factor that ensures the persistence of a vital attribute. The flow regime is a determinant of wetland functioning.

Ecosystem integrity: Ecosystem integrity thus refers to the completeness of composition, structure and function of the system.

Global change: refers to the myriad of factors, primarily human driven, which alter our biological, social, and institutional environment. Examples are: (a) Biophysical changes (climate change, change in land use); (b) Socio-economic changes (demographic changes and urbanization, growing demand for food and fibre, new technologies, and the impacts of globalisation); and, (c) Institutional changes (participation, decentralisation, and cooperative arrangements for area management).

Hierarchy of Objectives: An Objectives Hierarchy begins with a "vision" at the top of the hierarchy. This vision is progressively disaggregated through a series of "objectives" of increasing focus. The finest level of the hierarchy is defined by achievable "targets" for tourism, building cooperation, biodiversity conservation and operations.

Implementation: Step by step process to realise the targets of the management plan as developed above (policy, biodiversity, planning framework and zoning) with specific costing (including resources) and PA life cycle time frames

Objective: Objectives are qualitative articulations of the values defined in the vision, principles, context and vital attributes, which form a foundation for developing quantitative, operational outcomes. An objective is more precise than the vision but it is not necessarily achievable in the short term.

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

Protected Area: Any ecologically viable area declared as a Protected Area under the Protected Areas Act. Protected areas serve the purpose of conserving representative of South Africa's biodiversity and landscapes and seascapes.

Stakeholders: Anyone who is interested in, or influenced by, a particular decision.

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

Strategic Approaches to Ecosystem Management: Strategic management is not strategic planning (planning what to do in the future) it is *acting with a purpose*!

Strategic Adaptive Management (SAM): Strategic adaptive management (SAM) is a framework for management based on 'learning-by-doing'. At its heart lies the fact that we recognise that in complex systems we cannot know or predict everything and hence we adapt management actions as we gain experience.

Target: A target is what you hope to achieve when you are outside the desired state.

Thresholds of Potential Concern: Thresholds of Potential Concern are upper and lower levels along a continuum of change in selected environmental or biodiversity indicators. When this level is reached, or when modelling predicts it will be reached, it prompts an assessment of the causes of the extent of change. The assessment provides the basis for deciding whether management action is needed to moderate the change or recalibrate the TPC. TPCs provide management with strategic targets or outcomes against which to monitor the consequences of the activities. They are invariably hypotheses of limits of acceptable change in ecosystem structure, function and composition. As such their validity and appropriateness are always open to challenge and they must be adaptively modified as understanding and experience of the system being managed increases.

Values: Values are the principles we use to evaluate the consequences of actions or inaction, to propose and chose between alternative options and decisions. Values may be held by individuals, organisations or even society. A groups values must reflect the values of the individuals in that group.

Vision: A broad philosophical statement of intent. A vision is durable beyond changes in personnel and organizational structure. In this scheme vision is synonymous with mission.

Vital Attribute: A very important or vital characteristic/property of the system to be managed. For example: a grassland, a river and technical infrastructure impart different vital to the system. Vital attributes may be scientific, ecological, value judgements, legal, historic and socio-economic and may incorporate the concepts of conservation importance and ecosystem health.

V-STEEP: This is an acronym for Social, Technical, Ecological, Environmental and Political components of integrated solutions. V is added to the conventional STEEP because perspective of each of S, T, E, E, and P are all determined by the values of individuals and institutions.

Additional reading

Biggs, H.C. 2003. Integration o science: Successes, challenges and the future. P. 467-487. *In:* du Toit, K. Rogers & H. Biggs (Eds). The Kruger Park Experience – Ecology and Management of Savanna Heterogeneity. Island Press, Washington DC.

Biggs, H. and K. Rogers. 2003. An adaptive system to link science, monitoring and management in practice. P. 59 - 80. *In:* du Toit, K. Rogers & H. Biggs (Eds). The Kruger Park Experience – Ecology and Management of Savanna Heterogeneity. Island Press, Washington DC.

Braack, L. 1997. A revision of parts of the management plan for the Kruger National Park. Kruger Park Management Plan Vol. 7. SanParks, Skukuza, South Africa. http://www.parks-sa.co.za

Breen, C.M., N.W. Quinn and J.J. Mander. 1997. A description of the Kruger National Park Rivers Research Programme. Phase III. Pretoria. FRD.

Breen, C., M. Dent, J. Jaganyi, B. Madikizela, J. Maganbeharie, A. Ndlovu, J. O'Keeffe, K. Rogers, M. Uys and F. Venter. 2000. Contract report of the Kruger National Park Rivers research Programme (KNPRRP). Water Research commission Report TT 130/00.

Carruthers, J. 1995. The Kruger National Park: a social and political history. Pietermaritzburg. University of Natal Press

Davies, B.R. and J.A. Day. 1998. *Vanishing Waters*. University of Cape Town Press, Cape Town. 487 Pp.

Gaylard, A., N. Owen-Smith and J. Redfern. 2003. Surface water availability: Implications for heterogeneity and ecosystems processes. P. 171-188. *In:* du Toit & H. Biggs (Eds). The Kruger Park Experience – Ecology and Management of Savanna Heterogeneity. Elsevier Press.

Jewitt, G. P. W., G.L. Heritage, D.C. Weeks, J.A. Mackenzie, A. van Niekerk, A.HM. Gorgens, J. O'Keeffe, K. Rogers and M. Horn. 1998. Modelling abiotic-biotic links in the Sabie River. Report to the Water Research Commission No. 777/1/98. WRC, South Africa.

Kolb,D.A. 1984. Experiential Learning: Experience as the Source of Learningand Development. Prentice Hall, Englewood Cliffs

Lave, J and E. Wenger. 1991. Situated Learning. Legitimate peripheral participation, Cambridge: University of Cambridge Press.

Mabunda, D., D.J. Pienaar and J. Verhoef. 2003. The Kruger National Park: A century of management and research. P. 3-21. *In:* du Toit, K. Rogers & H. Biggs (Eds). The Kruger Park Experience – Ecology and Management of Savanna Heterogeneity. Island Press, Washington DC.

Meffe, G.K,,L.A. Nielson, R.L. Knight and D.A Schenborn. 2002. Ecosystem management: Adaptive community-based conservation Island Press, Washington

O'Keeffe, J.H. and K. Rogers. 2003. Heterogeneity and the management of lowveld rivers. P. 447-466. P. 370-388. *In:* du Toit, K. Rogers & H. Biggs (Eds). The Kruger Park Experience – Ecology and Management of Savanna Heterogeneity. Island Press, Washington DC.

Pollard, S. R., C. Shackleton and J. Carruthers. 2003. Beyond the fence: People and the Lowveld landscape. P. 422-446. *In:* du Toit, K. Rogers & H. Biggs (Eds). The Kruger Park Experience – Ecology and Management of Savanna Heterogeneity. Island Press, Washington DC.

Republic of South Africa (1998) *The National Water Act, Act 36 of 1998*, The Department of Water Affairs & Forestry. Government Gazette 1982, Government Printer, Pretoria. 36.

Russell, I.A. and K.H. Rogers. 1989. The distribution and composition of fish communities in the major rivers of the Kruger National Park. *In:* S. Kienzle and H. Maaren. Eds. *Proc. 4th S. Afr. Nat. Hydrol. Symp.* University Pretoria.

Rogers, K. 2003. Adopting a heterogeneity paradigm: Implications for management of protected savannas. P. 41-58. *In:* du Toit, K. Rogers & H. Biggs (Eds). The Kruger Park Experience – Ecology and Management of Savanna Heterogeneity. Island Press, Washington DC.

Rogers, K.H. 2005. Biodiversity Custodianship in SANParks: A protected area management planning framework. Report to South African National Parks, Pretoria.

Rogers K.H. and R. Bestbier. 1997. Development of a protocol for the definition of the desired state of riverine systems in South Africa. Department of Environmental Affairs & Tourism, South Africa.

Rogers, K. and H. Biggs. 1999. Integrated indicators, endpoints and value systems in the strategic management of rivers of the Kruger National park. Freshwater Biology 41: 439-451.

Salafsky, N., R. Margoluis and K. Redford. 2001. Adaptive Management: A Tool for Conservation Practitioners. Biodiversity Support Program, Washington 2001

Van Wilgen, B., W.S.W. Trollope, H. Biggs, A. Potegieter and B. Brockett. 2003. Fire as a driver of ecosystem variability. P. 149-170. *In:* du Toit, K. Rogers & H. Biggs (Eds). The Kruger Park Experience – Ecology and Management of Savanna Heterogeneity. Island Press, Washington DC.

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