KNP Mission

(proposed revision: Sept 2003)

In keeping with the SANParks mission, to maintain biodiversity in all its natural[1] facets and fluxes, to provide human benefits and build a strong constituency and to preserve as far as possible[2] the wilderness qualities and cultural resources associated with the Park

*New words in red; 1997 footnotes accepted but [1]add the notion "indigenous" to natural; [2] "detract as little as possible from" wording (as in 1997) possibly better.

Biodiversity Objectives

To maintain biodiversity in all its natural facets and fluxes.

- Ecosystem Objective (3)
  - Atmospheric effects
  - Water in the landscape
  - Terrestrial ecosystem
  - Alien impact
  - Threatened biota
- Legal and Statutory

Balancing Objectives

(= sustainable utilisation if defined broadly and holistically, e.g. Child)

To develop a thorough understanding of the integrated socio-ecological system (SES), especially in the regional context, for maintenance of a resilient SES and to balance human activities and development inside and around the KNP with the need to conserve ecosystem integrity and wilderness qualities by agreeing on a desired[1] set of future conditions, and by developing an adequate suite of principles and tools.

[1]These are (a) necessarily environmentally fluctuating and (b) realistic but aspirational

- Strategic Adaptive Management
- Balanced Development & Biodiversity Planning
- Appreciation and Inculcation of VSTEEP Framework
- Environmentally Responsible Practices
- Alignment of Business Operations and Plans

People Objectives

To provide human benefits and build a strong constituency, preserving as far as possible the wilderness qualities and cultural resources associated with the KNP.

- Tourism
- Wilderness qualities
- Direct Human Benefits
- Constituency Building
- Cultural Heritage

Enabling Objectives

To provide cross-cutting support services which enable KNP to achieve the line function biodiversity and people objectives, and balance these effectively.

NB : must be cross-linked with and is subject to growth depending on further demands from the other three objectives.

- Communication
- Infrastructure
- Human Resources
- Financial Resources
- Administration
- Knowledge Resource Management
- Core Subject-specific Support

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Biodiversity Objective

To maintain biodiversity in all its natural facets and fluxes.

Ecosystem Objective

To understand and manage the KNP as part of the lowveld savanna and its river catchment areas in such a manner as to conserve and restore its varied natural structure, function and composition over time and space, and its wilderness qualities, through an approach integrating the different scales and types of objectives.

Atmospheric Effects

To understand the major effects of climate (esp. rainfall) in influencing biodiversity, and therefore if, when and how to take management decisions (including the no-action decision) with this clearer context.

Water in the Landscape

To develop an integrated understanding of non-terrestrial ecosystem diversity and dynamics (including sub-surface water) and it's links with terrestrial systems, and to maintain the intrinsic biodiversity as an integral component of the landscape and maintain or where necessary restore or simulate natural structure, function, composition and processes.

Terrestrial Ecosystem

To develop an integrated understanding of ecosystem diversity and dynamics, and where necessary intervene with appropriate strategies, in order to conserve and restore terrestrial biodiversity and natural processes.

Alien Impact

To anticipate, prevent entry and where possible control invasive alien species, in an effort to minimise the impact on, and maintain the integrity of indigenous biodiversity.

Threatened Biota

To prevent extinction within the Kruger Park of any species on the IUCN's global critically endangered or endangered lists, and to work with other conservation initiatives to secure and strengthen the future of such species over their historic distribution ranges. To put in place appropriate monitoring and conservation efforts of other threatened species or lower taxonomic division, including considering recommendations of experts of invertebrate taxa for which no formal red-listing has been done, according to a realistic framework. Except in crucial instances for the survival of globally critically endangered species, management for system integrity and biodiversity must take precedence over species management.

Legal and Statutory Objective

To have a thorough working understanding of the legal and statutory framework influencing biodiversity in and around KNP, and to influence the framework's further development and content to the benefit of KNP objectives. KNP may often need to take a pro-active stance in many wider or generic legal and statutory issues, rather than await developments passively.

A question arises whether this whole block does not belong under "Balancing". At this stage, given the strong biodiversity influence in forthcoming legislation, it seems best here, with additional (often smaller) legal & statutory blocks elsewhere in the tree as necessary.

Ecosystem Objective

To understand and manage the KNP as part of the lowveld savanna and its river catchment areas in such a manner as to conserve and restore its varied natural structure, function and composition over time and space, and its wilderness qualities, through an approach integrating the different scales and types of objectives.

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Atmospheric Effects Objective

To understand the major effects of climate (esp. rainfall) in influencing biodiversity, and therefore if, when and how to take management decisions (including the no-action decision) with this clearer context.

Preamble

The incorporation of global climate change into an atmospheric systems objective in 1997, at a time when conservation organizations were not yet mainstreaming this idea, was no doubt the correct overall decision. Looking back at the way these 1997 objectives were framed, this gave us the advantage of heightened awareness, and of becoming involved early on in adaptation initiatives, such as AIACC. An interesting perspective arising from climate change realities is that the outcomes are so big, and relatively uninfluencable even in the medium-term, that for the first time we look at anthropogenic changes which we cannot summarily reverse. This, even with the best will, international co-operation, and the best contributions from our side, resulting in conservation targets that now have to be considered as moving ones.

We achieved relatively few of the exacting stipulations under the 1997 atmospheric pollution objectives, though some wet and dry nitrogen deposition measurements did take place. We return these objectives in this version, slightly more tightly focused, with renewed hope and vigour.

Something we have known intuitively for a long time, but for which recent research has provided more and more detailed evidence, is that rainfall remains the major driver of semi-arid savannas. What we see in these objectives for the first time is an explicit articulation of this reality.

Atmospheric Effects Objective

To understand the major effects of climate (esp. rainfall) in influencing biodiversity, and therefore if, when and how to take management decisions (including the no-action decision) with this clearer context.

Rainfall

To understand which components (mean, spatio-temporal variation at various scales, intensity, etc.) specifically affect which aspects of the geomorphic template, habitats and biodiversity, recognising the cardinal effects of rainfall in driving semi-arid ecosystems.

Rainfall Interactions

To understand which important interactions of rainfall with other drivers produce which outcomes under which circumstances; also to present this understanding in the context of a practical holistic management framework (xref to integrated obj)

Other Climate Components

To understand which other potentially or presumptively important aspects of climate (e.g. solar radiation, temperature) influence biodiversity in which important ways.

Climate Change

To consider explicitly the consequences of any significant findings evident in objectives 1-3, on biodiversity patterns and functions, pointing out which options may be available for future decisions in biodiversity management under climate change scenarios.

- To keep abreast with evolving knowledge on global climate change, especially the effects thereof on the Lowveld region and likely or anticipated effects on biodiversity.
- To activate the organisation and alert it to the impacts of global climate change and open the debate about how the organisation will deal with these challenges and threats.
- To evaluate predictions of the biodiversity effects of global climate change and position the KNP to face and/or deal with these realities.

Predictive Support

To offer predictive support to biodiversity research and management initiatives, in terms of forecasting those significant trends which influence diversity, so that research opportunities can be more effectively prepared for, and so that decisions can be taken as to whether management intervention is required and/or feasible.

Atmospheric Pollutants

To understand the effects of atmospheric pollution (industrial pollutants, acidic and N-deposition, noise, lights, dust, etc.) on biodiversity and recommend / implement appropriate counter-measures.

- To ensure internal management policies and practices are environmentally sensitive, striving for long-term reduction of atmospheric pollution (eg gas vs wood-burning). Xref Tech Serv obj.
- To keep abreast of research and knowledge as well as best practice options for reducing atmospheric pollution in the long term. Xref Enviro BP
- To engage in regional, national or international forums aimed at investigating and influencing long-term atmospheric pollution e.g. APINA (air pollution information network for Africa).

Weather / Climate Monitoring

To monitor climatic parameters in as continuous a manner as feasible, as background to developing understanding and to support understanding of unpredictable 'ecological surprises' (xref monitoring).

Note: weather/climate monitoring, along with hydrological monitoring, is seen as one of the few examples of monitoring taking place (irrespective of TPC setting) and therefore appears here.

Mapping of climatic parameters (xref land classifications)

Xref fire objectives - fire-related omissions

Atmospheric Effects Objective

Looking forward

The adaptation strategies around climate change are gearing up nationally and internationally, and although it is clear that action may take long to materialise (and very long to produce helpful outcomes for the planet), SANParks will need to work assertively on these committees over the next five years. Kruger may have to form a more humble opinion of its future geographic role under changed circumstances, and form a strong reliance on linking with, or building corridors into, areas offering buffer capacity to such change, such as the Kruger-to-Canyons initiative. A good five-year target may be to have concrete tentative plans on the table concerning landscape layout, in the hope that the implementation actions towards this can take place now but particularly also thereafter.

The re-assessed threats of nitrogen deposition, as well as some time horizon concerning this threat, will require settling over the next five-year period. The concomitant awareness will likewise need to be built.

The now explicitly stated mind shift in favour of recognizing rainfall effects as crucial will probably lead to a greater participation of research partners in this regard. This, together with the local reality that the rainfall effects of climate change are most likely to threaten our mission, will result in these efforts being particularly encouraged.

Water in the Landscape Objective

To develop an integrated understanding of non-terrestrial ecosystem diversity and dynamics (including sub-surface water) and it's links with terrestrial systems, and to maintain the intrinsic biodiversity as an integral component of the landscape and maintain or where necessary restore or simulate natural structure, function, composition and processes.

Preamble

The KNP Rivers Research Programme catalysed and focussed the KNPs aquatic, and particularly riverine, objectives and resulted in great detail and the identification of many specific goals in previous versions. This served to effectively focus both research and management action and many of these objectives and goals have been met and thus are no longer reflected in this revised version.

The 1997 Aquatic Ecosystem Objective identified three overall sub-objectives which were riverine, non-riverine and water distribution, with the main difference between the latter two focussing on natural surface water in the KNP (other than perennial rivers) and water-for-game aspects respectively. Revision of the water distribution objectives in 2001 resulted in an integration of the non-riverine and water distribution objectives. During the current revision, the riverine, non-riverine and groundwater objectives have been grouped under an overall "Water in the Landscape" objective. While this has not yet been fully integrated into the "Terrestrial" objectives, the shape and style of the objectives tree has been altered to more closely resemble the structuring of the terrestrial objectives and thus pave the way for overall integration in the next revision. The earlier distinct separation of research and management has been blurred in this version although "awareness" has still been highlighted as a distinct objective requiring attention due to the strong cross-border river management requirements.

Water in the Landscape Objective

To develop an integrated understanding of non-terrestrial ecosystem diversity and dynamics (including sub-surface water) and it's links with terrestrial systems, and to maintain the intrinsic biodiversity as an integral component of the landscape and maintain or where necessary restore or simulate natural structure, function, composition and processes.

Functional Processes

To understand the important ecological and evolutionary processes and the role that each one plays in maintaining biological diversity and function in the various water-related ecosystems in and around KNP in such a way that management implications can be responded to appropriately.

- -River health
- Reserve implementation
- Long term variability
- Succession
- Migration
- River rehabilitation
- Integrated catchment management
- -Groundwater cycling
- -Non-riverine surface water
- -Terrestrial-aquatic linkages

Composition, Structure & Pattern

To adequately inventorise riparian and non-riverine aquatic systems, understand the ecology of important elements and unnatural threats leading to compositional or structural changes deemed beyond acceptable flux limits, and respond appropriately.

- -Non-riverine aquatic system inventories
- -Riverine inventories and monitoring

Awareness

To promote and ensure a high level of awareness amongst and support from managers (internal and external), water users, action groups, politicians and the public.

Water in the Landscape Objective

Functional Processes Objective

To understand the important ecological and evolutionary processes and the role that each one plays in maintaining biological diversity and function in the various water-related ecosystems in and around KNP in such a way that management implications can be responded to appropriately.

River Health

To ensure implementation of the ecological reserve in all KNP river systems and where this is not meeting biodiversity or ecosystem health goals, to ensure refinement or revision of the reserve. Through promoting integrated catchment management, to ensure the role of rivers in landscape biodiversity is realised, allowing for fluctuations in time and space.

- **Reserve implementation**
  To ensure the setting and implementation of the IFR and environmental reserve for all perennial rivers flowing through the KNP.
- **Long-term variability**
  To better understand long-term variability of river systems to assist in understanding flow variability and environmental heterogeneity in the semi-arid lowveld.
- **Succession**
  To use existing knowledge and understanding of vegetation succession on the physical river template to aid our understanding of long-term river system functioning and the delivery of goods and services in a multi-scaled way.
- **Migration**
  To ensure that migration patterns and processes are retained or restored to allow movements between habitats based on connectivity over space and time.
- **River rehabilitation**
  To restore natural river ecosystem health and functioning by rehabilitating or redesigning redundant and other man-made structures.
- **Integrated catchment management**
  To facilitate water resource management in a sustainable manner in the lowveld to ensure ongoing river ecosystem health.

Groundwater Cycling

To evaluate the role and significance of ground water systems in local and broader ecological structure and function and the KNP landscape and to monitor long-term changes in the ground water-table level and its impact on surface water and woody vegetation.

Non-riverine Surface Water

To evaluate the role and significance of natural and artificial non-riverine surface water systems in local and broader ecological structure and function.

Artificial Water Provisioning

To understand and evaluate the role and consequences of artificial water provision and/or simulation of natural surface water availability in the KNP landscape and to develop management guidelines to facilitate restoration of natural processes.

Terrestrial-Aquatic Linkages*

* including nutrient cycling

To understand processes whereby elements such as nitrogen, phosphorus and carbon move through the aquatic systems and aquatic-terrestrial linkages.

Functional Processes Objective

River Health Objective

To ensure implementation of the ecological reserve in all KNP river systems and where this is not meeting biodiversity or ecosystem health goals, to ensure refinement or revision of the reserve. Through promoting integrated catchment management, to ensure the the role of rivers in landscape biodiversity is realised, allowing for fluctuations in time and space.

Reserve Implementation Objective

To ensure the setting and implementation of the IFR and environmental reserve for all perennial rivers flowing through the KNP.

Decision Support System Objective

To develop an active and meaningful DSS for river management, integrating monitoring data, desired states and TPCs to monitor and evaluate reserve implementation.

- To oversee IFR implementation and stimulate refinement where not meeting their objectives of promoting healthy river systems.
- To monitor against river TPCs and instigate strategic adaptive management processes when approaching thresholds.
- To develop predictive capacity to evaluate alternative management actions.

Strategic Objective

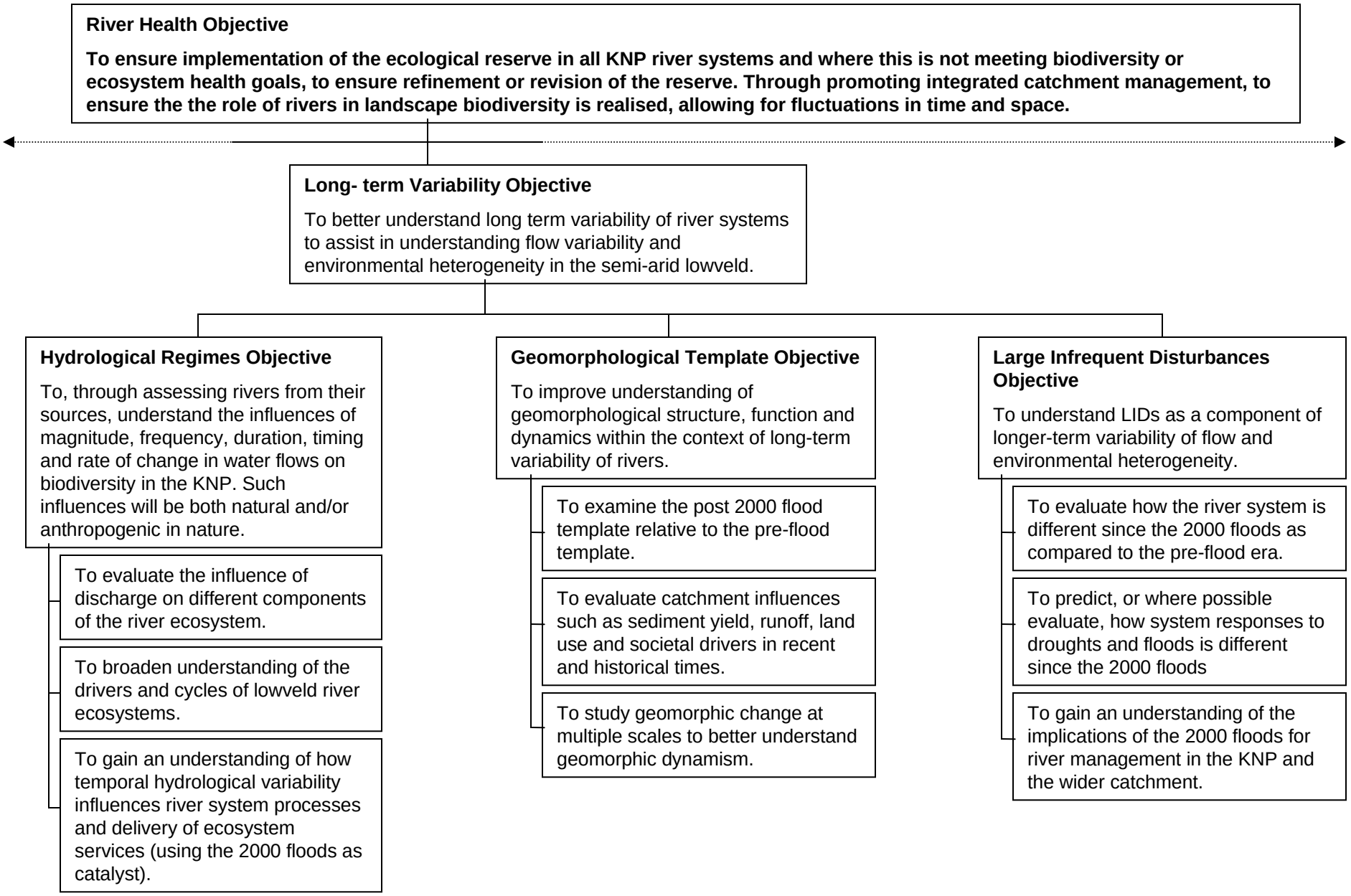
To promote the KNP's riverine needs and aspirations for achieving river management goals (i.t.o. flows, qualities, river health, etc).

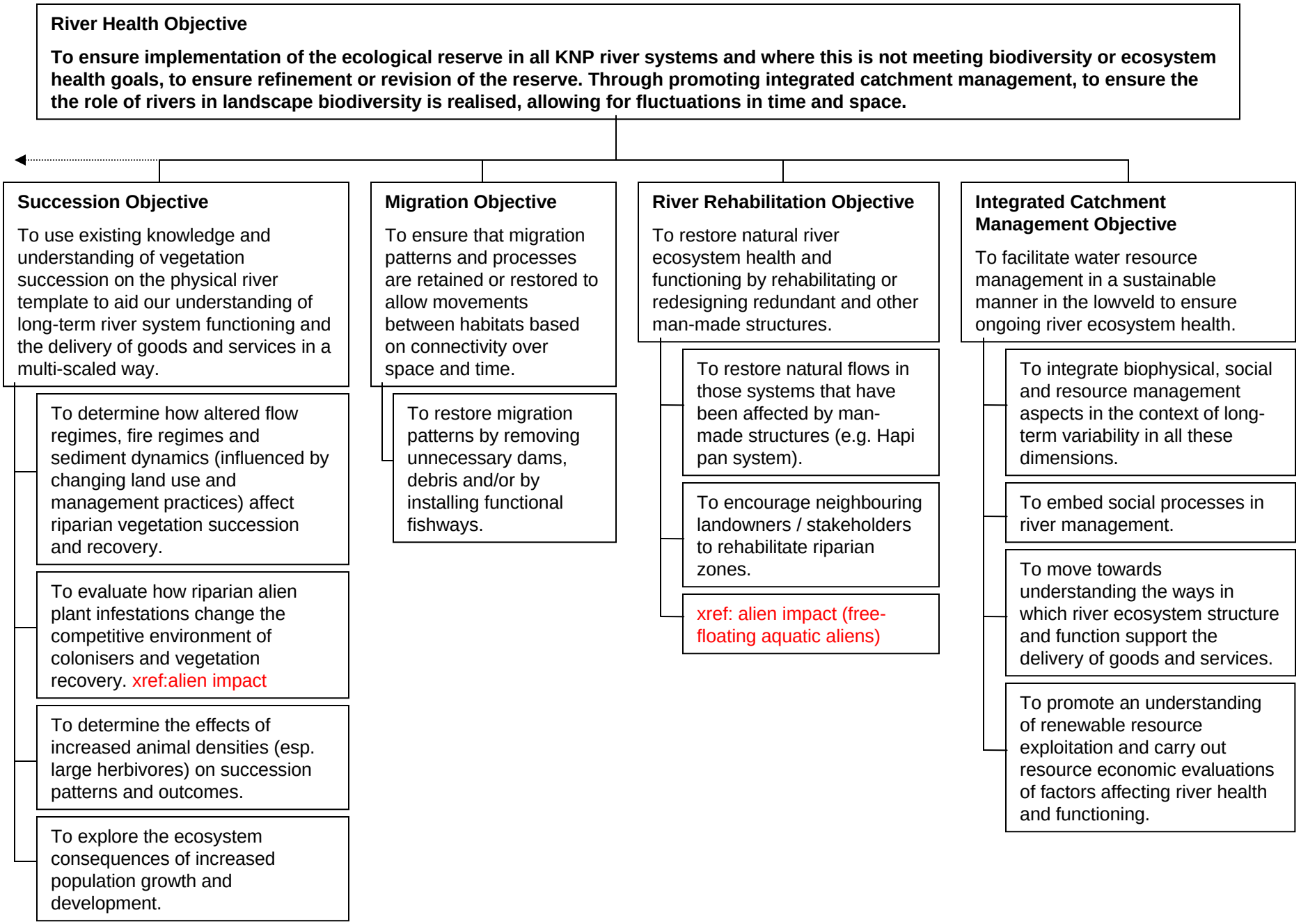
- To engage in CMA's and where needed drive the process towards establishment.
- To promote an understanding amongst all stakeholders of both the threats facing KNP rivers and biodiversity role and requirements. xref awareness
- To actively influence land-use planning outside the KNP in the catchments.
- To identify and actively target high level champions both within DWAF and otherwise to promote KNP river issues.
- To showcase KNP river management, rehabilitation and research efforts to exploit potential funding sources for management and research.
- To become a leader and example in water conservation measures (irrigation, dual-flush, low-flow showers, etc).

River Management Needs Objective

To develop and implement appropriate procedures and identify key personnel to address immediate river management requirements.

- To identify river champions within KNP for immediate needs of all rivers.
- To update and revive detailed procedures for anticipated contingencies and ensure that the river champions and KNP management are aware of these.
- To react speedily and professionally to all river-related pollution or other undesirable incidents and report back to KNP EXCO.


River Health Objective
To ensure implementation of the ecological reserve in all KNP river systems and where this is not meeting biodiversity or ecosystem health goals, to ensure refinement or revision of the reserve. Through promoting integrated catchment management, to ensure the the role of rivers in landscape biodiversity is realised, allowing for fluctuations in time and space.
Long- term Variability Objective
To better understand long term variability of river systems to assist in understanding flow variability and environmental heterogeneity in the semi-arid lowveld.
Hydrological Regimes Objective
To, through assessing rivers from their sources, understand the influences of magnitude, frequency, duration, timing and rate of change in water flows on biodiversity in the KNP. Such influences will be both natural and/or anthropogenic in nature.
To evaluate the influence of discharge on different components of the river ecosystem.
To broaden understanding of the drivers and cycles of lowveld river ecosystems.
To gain an understanding of how temporal hydrological variability influences river system processes and delivery of ecosystem services (using the 2000 floods as catalyst).
Geomorphological Template Objective
To improve understanding of geomorphological structure, function and dynamics within the context of long-term variability of rivers.
To examine the post 2000 flood template relative to the pre-flood template.
To evaluate catchment influences such as sediment yield, runoff, land use and societal drivers in recent and historical times.
To study geomorphic change at multiple scales to better understand geomorphic dynamism.
Large Infrequent Disturbances Objective
To understand LIDs as a component of longer-term variability of flow and environmental heterogeneity.
To evaluate how the river system is different since the 2000 floods as compared to the pre-flood era.
To predict, or where possible evaluate, how system responses to droughts and floods is different since the 2000 floods
To gain an understanding of the implications of the 2000 floods for river management in the KNP and the wider catchment.


River Health Objective
To ensure implementation of the ecological reserve in all KNP river systems and where this is not meeting biodiversity or ecosystem health goals, to ensure refinement or revision of the reserve. Through promoting integrated catchment management, to ensure the the role of rivers in landscape biodiversity is realised, allowing for fluctuations in time and space.
Succession Objective
To use existing knowledge and understanding of vegetation succession on the physical river template to aid our understanding of long-term river system functioning and the delivery of goods and services in a multi-scaled way.
To determine how altered flow regimes, fire regimes and sediment dynamics (influenced by changing land use and management practices) affect riparian vegetation succession and recovery.
To evaluate how riparian alien plant infestations change the competitive environment of colonisers and vegetation recovery. xref:alien impact
To determine the effects of increased animal densities (esp. large herbivores) on succession patterns and outcomes.
To explore the ecosystem consequences of increased population growth and development.
Migration Objective
To ensure that migration patterns and processes are retained or restored to allow movements between habitats based on connectivity over space and time.
To restore migration patterns by removing unnecessary dams, debris and/or by installing functional fishways.
River Rehabilitation Objective
To restore natural river ecosystem health and functioning by rehabilitating or redesigning redundant and other man-made structures.
To restore natural flows in those systems that have been affected by man-made structures (e.g. Hapi pan system).
To encourage neighbouring landowners / stakeholders to rehabilitate riparian zones.
xref: alien impact (free-floating aquatic aliens)
Integrated Catchment Management Objective
To facilitate water resource management in a sustainable manner in the lowveld to ensure ongoing river ecosystem health.
To integrate biophysical, social and resource management aspects in the context of long-term variability in all these dimensions.
To embed social processes in river management.
To move towards understanding the ways in which river ecosystem structure and function support the delivery of goods and services.
To promote an understanding of renewable resource exploitation and carry out resource economic evaluations of factors affecting river health and functioning.

Functional Processes Objective

Groundwater Cycling Objective

To evaluate the role and significance of ground water systems in local and broader ecological structure and function and the KNP landscape and to monitor long-term changes in the ground water-table level and its impact on surface water and woody vegetation.

- To evaluate the role and significance of boreholes on groundwater and the groundwater-associated environment.
  - To determine the significance of groundwater in alterations to flow exceedance curves, taking expected time lags into consideration.
  - To monitor a representative subset of (especially closed) boreholes for changes in water level over years, to establish directional changes in groundwater levels.
  - To examine past and model present/future long-term impacts of 20 to 50 year effects of groundwater abstraction.
  - To seek indicators for the trace effects of closure of waterholes on groundwater levels and ecological sequelae.
  - To examine “drawdown cones” (sensu du Toit) for possible adverse influences on vegetation composition and heterogeneity, and on riverflows and wetlands. Consider these drawdown cones as possible TPCs.
    - To repeat the du Toit survey (under normal conditions, though maybe also after a drought).
    - If candidate stressed areas are found by the objectives above, conduct detailed research to verify causal relations.
- To evaluate the role and significance of groundwater in the KNP landscape.
  - To establish links between groundwater levels in known unimpacted areas and climate change [groundwater “memory” can aggregate many years of conditions; do we have a big enough suitable area?]. xref: climate change
  - To examine “spring lines” for overall patterns of change, as potential barometers of groundwater change.
  - To examine interactions between soil moisture (esp. in the unsaturated zone), vegetation and climate [continuation of Lorentz-type work].

Functional Processes Objective

Non-riverine Surface Water Objective

To evaluate the role and significance of natural and artificial non-riverine surface water systems in local and broader ecological structure and function.

To place the physical aspects of water distribution in the KNP in relation to climate (specifically rainfall) e.g. Rutherford & Westfall (1986) moisture regions.

- To establish the spatial and temporal distribution of surface water in the KNP.
  - To establish the effects of upstream dams on seasonal rivers and the distribution of surface water (pool and floodplain replenishment).
  - To understand water resource evolution and persistence.
  - To model water sources to predict persistence of water levels.
- To classify surface water sources in the KNP based on type (pans, gravel pits, seasonal river and floodplain pools, etc), availability and suitability.
- To monitor the ground water table and determine (1) impacts on surface water, (2) impacts on woody vegetation. xref: ground water
- To evaluate current vs. historical water distribution (because of anthropogenic changes to water distribution and climate changes). xref: climate change

To understand the operational processes and relationships between surface water, vegetation and animals.

- To understand the role of small vertebrates and invertebrates in the non-riverine aquatic ecosystem regarding nutrient cycling, abiotic variables and parasites and diseases.
- To monitor the intensity and extent of piospheres around surface water.
- To conduct factorial experiments of vegetation, water and herbivores: waterpoints surrounded by palatable vegetation / waterpoints surrounded by unpalatable vegetation / palatable vegetation far from waterpoints / unpalatable vegetation far from waterpoints.
- To understand the interaction between sodic site ecology and water placement.
- To determine the role of extremes in rainfall on water availability and animals. xref: atmospheric
- To understand the role of larger animals on the water sources (pan formation, sediment stirring, etc).
- To develop a better understanding of the relationship between large herbivore distributions and water source type (e.g. pools in seasonal rivers vs. pans in the savanna, seasonal water sources vs. year-round water sources, etc).

To establish and maintain a surface water database.

Functional Processes Objective

Non-riverine Surface Water Objective

To evaluate the role and significance of natural and artificial non-riverine surface water systems in local and broader ecological structure and function.

Terrestrial-Aquatic Linkages* Objective

* including nutrient cycling

To understand processes whereby elements such as nitrogen, phosphorus and carbon move through the aquatic systems and aquatic-terrestrial linkages.

Artificial Water Provisioning

To understand and evaluate the role and consequences of artificial water provision and/or simulation of natural surface water availability in the KNP landscape and to develop management guidelines to facilitate restoration of natural processes.

Consequences of Water Provisioning Objective

To understand the system influences and changes brought about by artificial water provisioning.

- To undertake retrospective theoretical modeling of surface water associated biodiversity, especially large herbivores.
- To investigate the effects of seasonal and permanent water availability on diversity patterns and animal dispersal. This should include effects of temporary water sources created by dry season storms and water sources that only persist in high rainfall years.
  - To understand the role of water sources in migration of biota (especially migratory birds).
- To study the effect of different levels of water provision (Mozambique, KNP, private reserves) on animal numbers and biodiversity. This must take into account different management strategies that will affect population sizes and may confound interpretations about the influence of water provision.
- To document key system changes (especially biodiversity-linked) taking place as a result of removal of artificial water, including dams.
  - To incorporate the effects of borehole closure in the monitoring programme (vegetation and animals).

Management Guidelines Objective

To develop management guidelines to facilitate restoration of natural processes as far as possible and practical.

- To develop guidelines for the provision of water along boundary fences.
- To develop guidelines for the placement of waterholes in relation to tourist access.
- To investigate possibilities for the provision of artificial water on a seasonal basis (including the use of gravel pits rather than boreholes).
- To investigate methods of rehabilitating gravel pits that hold unnatural water.
- To influence public perception around the closure of artificial waterholes in the KNP. xref: awareness
- To draft a management plan for the removal of artificial waterpoints or operation of existing ones.
- To seek funding for the repair or rehabilitation of non-riverine aquatic systems (e.g. dambos).

- To ensure the intrinsic attributes and role of each river as part of landscape biodiversity, in such a way as to allow natural fluctuation over space and time in structure, function and composition.
- To establish the contribution of riverine ecosystems to overall biodiversity in the KNP, including the aquatic - terrestrial linkages

Water in the Landscape Objective

Composition, Structure & Pattern Objective

To adequately inventorise riparian and non-riverine aquatic systems, understand the ecology of important elements and unnatural threats leading to compositional or structural changes deemed beyond acceptable flux limits, and respond appropriately.

Non-riverine Aquatic System Inventories Objective

To inventorise non-riverine aquatic systems.

- To inventorise all non-riverine wetlands in terms of distribution, type, origin and permanence of water and degree of disturbance (possibly source WfWetlands funding?).
- To inventorise wetland-associated aquatic and terrestrial fauna and flora.
- To inventorise biodiversity associated with piospheres to include distant areas less affected by water points (refugia).

Riverine Inventories and Monitoring Objective

To inventorise riverine aquatic systems and meaningfully integrate monitoring efforts with those of other stakeholders.

- To catalogue riverine biodiversity.
- To establish long-term fluctuations in aquatic biotic and abiotic components across multiple scales.
- To establish TPC's for biodiversity and river health and integrate these to describe desired future conditions for the KNP rivers.
- To design and implement a practical monitoring programme taking cognisance of internal and external (e.g. National Biomonitoring Programme) needs.
- To link with DWAF's flow and quality monitoring programmes and ensure that data is used in the evaluation of TPCs.

Awareness Objective

To promote and ensure a high level of awareness amongst and support from managers (internal and external), water users, action groups, politicians and the public.

- To integrate river management with KNP management systems, action groups / interested & affected parties.
- To present a strategy for promoting and participating in integrated catchment management for each river.
- To generate a high level of awareness of the plight of KNP rivers amongst politicians.

Water in the Landscape Objective

Looking forward

River research, understanding and management has come a long way since the last objectives were drafted and there has been a clearer (although not yet complete) integration of aquatic and terrestrial ecosystem understanding which should grow in the next 5-year period. Although implementation of the new Water Act has been slow, it holds promise for Kruger's rivers. Nevertheless, the KNP cannot afford to be complacent and reserve implementation and refinement must remain highest on the agenda, attracting the most attention over the next 5-year period. Similarly, ongoing research and learning requirements are refocused here.

Since the biodiversity surveys of small vertebrates will include aspects such as non-riverine surface water habitats, these habitats will at least be dealt with at a refined scale in the identified sampling sites in the different environmental domains. The amphibian monitoring program already produced some classification of the non-riverine surface water in areas of the KNP.

The provision of artificial water is one of the tools available to management, however, to be able to use the tool efficiently we have to understand the consequences of water provision for biodiversity and ecosystem function. The sites selected for the biodiversity surveys represent a fairly wide distribution of distances from water and these surveys should render information on the influence of water provision on biodiversity and system function if a Tongway-type survey is included. Other factors that should be addressed are the effect of water provision on nutrient redistribution and long-term effects on vegetation and mammalian species composition.

Experts have been consulted to give inputs into the groundwater objective and these mostly involve using information collected by rangers on a regular basis to calculate the effect of water usage on the water table both in areas of open and closed water points and along drainage lines.

All the water in the landscape objectives recognise the cardinal roles of climatic, anthropogenic and global change impacts and it is hoped that this increased awareness will lead to better scenario-planning and predictive capabilities within the next 5-year cycle. This should aid our increased interaction with neighbouring and upstream land-use planning and catchment management activities as we appreciate more fully the interdependence of these systems.

Terrestrial Ecosystem Objective

To develop an integrated understanding of ecosystem diversity and dynamics, and where necessary intervene with appropriate strategies, in order to conserve and restore terrestrial biodiversity and natural processes.

Ecological Processes Objective

To understand the major processes which are, or should be, taking place in the ecosystems in and around KNP, articulating implications for management and responding appropriately in the interests of biodiversity management.

- Abiotic Processes
  - Terrestrial components of the hydrological cycle including rainfall, evapotranspiration, soil infiltration, groundwater cycling
  - Soil erosion
  - Fire
  - Decomposition, nutrient cycling and energy conversion
- Biotic Processes
  - Community Processes
    - Primary production
    - Competition and community dynamics
    - Herbivory
    - Predation
    - Disease and parasitism
    - Micro-organisms
  - Species Processes
    - Reproduction (including pollination and seed dispersal), survival and mortality.
    - Genetic processes
    - Migration, nomadism, dispersal, colonisation and reintroductions
    - Natural selection / natural extinction

Composition, Structure and Pattern Objective

To adequately inventorise our biodiversity heritage, understand the ecology of important elements and unnatural threats leading to compositional or structural changes deemed beyond acceptable flux limits, and respond appropriately.

- Land classifications
- Habitat patterns and structure
- Taxa listings
- Community listings
- Genetic documentation
- Autecology of selected species / taxa
- Aggregate descriptions e.g. biodiversity and complementarity indices

Terrestrial Components of the Hydrological Cycle Objective

To better understand the role of the terrestrial components of the hydrological cycle in the biotic and abiotic components of the KNP ecosystem.

Preamble

Fundamental to most terrestrial biotic components and processes are a number of abiotic processes, namely the hydrological cycle, soil formation and enrichment, and soil loss. Although the major importance of rainfall in the dynamics of the KNP ecosystem has been recognised, little is known about the complex soil-water-plant processes and dynamics taking place. A better understanding of the 'water budget' and the dynamics of the terrestrial component of the hydrological cycle, will allow for a better understanding of plant dynamics. Additional benefits will be information on the magnitude of both surface water runoff and deep percolation augmenting the groundwater aquifer. Studies will thus have to be undertaken at various scales, ranging from the individual plant (or a small group of plants) to catchments and geological formations.

At the soil surface, a number of processes take place and although strongly linked to those occurring deeper down, they are distinctly different and play crucial roles in the germination and survival of plant seeds until they become established and become more dependent on processes occurring deeper in the soil layer. These include aspects such as water availability, shading, light and energy availability, nutrient availability and seed predation.

Certain management actions such as veld burning and the provision of drinking water may have a considerable effect on the hydrological cycle by influencing surface runoff and soil infiltration. These in turn may have detrimental effects on aquatic systems (soil deposition) and on the groundwater reserve.

Soil Erosion Objective

To monitor soil erosion qualitatively and quantitatively in order to determine its effects on the terrestrial and aquatic ecosystems of the KNP.

Preamble

The decomposition of parent rock material to form soil releases nutrients that supplement those already in the soil, thereby enriching it. The rate at which these nutrients are added to the soil (and removed from it) in all likelihood vary over time and are probably strongly dependent on the climatic regime; with 'wet' and 'dry' rainfall cycles probably playing a major role.

As with the soil water budget, a 'soil budget' exists whereby soil is formed on the one hand, and lost on the other, via erosion; either as a result of natural processes or due to human activities. In the KNP, it is important to determine the extent and magnitude of the latter form of erosion in particular, and to take remedial action where this is necessary. A lack of awareness of the potential for erosion which may result from the actions of both staff members and others working in the KNP also needs to be addressed.

Terrestrial Ecosystem Objective

To develop an integrated understanding of ecosystem diversity and dynamics, and where necessary intervene with appropriate strategies, in order to conserve and restore terrestrial biodiversity and natural processes.

Ecological Processes Objective

To understand the major processes which are, or should be, taking place in the ecosystems in and around KNP, articulating implications for management and responding appropriately in the interests of biodiversity management.

Abiotic Processes

Terrestrial Components of the Hydrological Cycle (including rainfall, evapotranspiration, soil infiltration, groundwater cycling)

To better understand the role of the terrestrial components of the hydrological cycle in the biotic and abiotic components of the KNP ecosystem. xref: rainfall, evapotranspiration, fire, herbivory, surface water.

- To establish the water budget of the KNP for the major geological formations and river catchments using the ACRU or another suitable hydrological modelling procedure.
- Together with other factors (such as shade, solar radiation, light availability, seed predation, etc.), to understand the processes and importance of topsoil water in the successful germination and establishment of plants.
- To determine which factors and management actions influence water infiltration and surface runoff and the effects of above-ground processes such as abstraction on groundwater hydrology.

Soil Erosion

To monitor soil erosion qualitatively and quantitatively in order to determine its effects on the terrestrial and aquatic ecosystems of the KNP.

- To determine if management actions have an effect on accelerating soil erosion, as well as the severity and extent of this erosion.
  - To determine the most practical and/or feasible ways of minimizing man-made soil erosion, if necessary. Where this is as a result of ignorance of erosion prevention procedures on the part of staff members, this must be addressed by in-service training.
  - To compile guidelines and specifications for KNP departments and contractors who undertake earthworks of various kinds in the KNP.

Fire

To understand the role of fire as an ecosystem process and to evaluate and respond appropriately to fire threats facing infrastructure and human lives.

Decomposition, Nutrient Cycling and Energy Conversion

To understand the relationships between nutrients in the ecosystem, functional diversity and biodiversity. [This includes the control, provision, uptake or intake of materials required for essential life functions. In the case of plants, emphasis is placed on C, N, P, K, Ca, Mg, Na, S and climatic factors (with specific reference to implications of global climate change), while in the case of animals, the focus is mainly on energy and protein sources, macro-and trace-minerals and their interactions].

Terrestrial Components of the Hydrological Cycle Objective

&

Soil Erosion Objective

Looking forward

Linking in with the atmospheric effects objective and the recognition that rainfall effects are crucial in our ecosystem, and potentially threaten to change the system as we know it through global climate change mediated effects, this objective should attract increased attention. In particular, we would like to better understand the processes and importance of topsoil water in germination and plant establishment.

Unnatural or anthropogenically-induced soil erosion may have undesirable effects on both terrestrial and/or aquatic biodiversity. Where this is the case, appropriate management actions need to be considered, tested and evaluated.

Fire Objective

To understand the role of fire as an ecosystem process and to evaluate and respond appropriately to fire threats facing infrastructure and human lives.

Preamble

The revised objectives no longer state the foundations for our view on fire as clearly as the 1997 objectives. This is as a result of having moved on to specifics now, which was made possible through what we learnt from leveraging most of the 1997 objectives assertively. The summarised, and now somewhat matured, KNP view is that fires should vary widely over space and time at as many scales as possible, the belief being that this will lead to a range of fire types, intensities and effects, and that this will best maintain biodiversity. Certain confirmatory challenges to this view, or to underlying assumptions thereof, are contained in the current objectives. Also, the emergence of Fire Protection Associations in South Africa, and a will to prevent further tragic fires (such as the fatal one near Pretoriuskop in 2001), have led to more explicit emphases on fire safety as linked to the ecosystem fire management policy.

Remarkable focus was placed on the experimental burn plots between 1997 and present, so much so that their consideration for closure or down-scaling of the treatments, suggested by management in 1997, was put on hold.

Abiotic processes

Fire Objective

To understand the role of fire as an ecosystem process and to evaluate and respond appropriately to fire threats facing infrastructure and human lives.

Fire as an Ecosystem Process Objective

To understand the role of fire as a natural* process (and other important interacting co-drivers) in the KNP and its ecosystems to develop informed context for management.

* the word “natural” does not refer to the ignition sources. Man-made ignition is considered natural.

Fire Threats Objective

To evaluate fire threats particularly to wildlife, human infrastructure and lives realistically, generate realistic but responsible attitudes, and respond appropriately at the individual, organisational, and regional levels.

To establish and maintain a realistic fire security policy, well-integrated with the ecosystem fire policy.

- To consider the long-term ecological effects of repeated annual burning of firebreaks.
- To consider whether and how fire security risks can be lowered within concession areas, and KNP biodiversity goals still be achieved.
- To ensure field staff have adequate fire training to deal with both the fire ecosystem policy and fire threats.
  - To provide information to staff, local communities, institutions and tourists about KNP fire policy, the rationale behind it and fire research (via talks, pamphlets, etc). xref: awareness

To participate meaningfully in the regional Fire Safety Associations, and exert sufficient influence on policies within these FSAs to allow our biodiversity aims to succeed.

- To determine the KNP’s obligation and role wrt fires on the national and international boundaries (much of this detail is laid out in the developing GKFPA policy). xref: legal & statutory

Fire as an ecosystem process

To understand the role of fire as a natural* process (and other important interacting co-drivers) in the KNP and its ecosystems to develop informed context for management.

* the word “natural” does not refer to the ignition sources. Man-made ignition is considered natural.

- To determine whether effects produced by perimeter burns, at the scale of burn blocks and burn units, differ in ecological and biodiversity outcomes from those produced by point burns.
  - To determine topkill, degree of patchiness and other parameters on perimeter and point ignition burns.
- To determine to what extent and in which ways increased spatial heterogeneity of fire pattern supports greater biotic diversity.
  - To exploit parts of the Margules monitoring method which allow for determining the effect of fire on biodiversity.
- To establish the interacting role played by fire in creating particular tree structure, and different levels of tree-grass balance.

  xref: soil-water balance, germination, herbivory (esp. elephant)
- To form a realistic, or at least likely, reconstruction of fire patterns and effects in the region over the past 1000 years, including understanding the relative role of lightning vs. human-induced fires.

  Note: this must include indigenous knowledge systems and rainfall drivers.

  xref: rainfall
- To synthesise results from the initiative launched seven years ago on generating results from burnplot experimentation till 2002 and to develop a robust research context for continuation of burn plot research in the light of recent programmes such as LTER (SAEON) and TGP.
- To broaden the understanding of fire to include wider biodiversity elements (small vertebrates, invertebrates, soil erosion, soil fauna, alien plant invasions, nutrient cycling, decomposition).

  xref: erosion, nutrient cycling, decomposition, alien impact
- To combine the best updated knowledge emanating from the other 6 sub-objectives and recommend feasible fire management policies and procedures, with appropriate decision support elements incl. equipment.
  - To develop a usable fire DSS for fire managers that provides relevant information for on-the-ground decision-making. xref: core specific support

Fire Objective

Looking forward

The intra-organisational controversy concerning the experimental burnplots (represented by words such as “wrap-up phase” in the previous objectives) has, for the foreseeable future, been laid to rest. Many intellectually powerful and ecologically influential partners are now involved with or planning meaningful research on the burnplots, and Kruger is becoming known as an important international fire research location. We should not lose that status, while still keeping the work on track for SANParks.

From a fire policy point of view, it seems crucial that we verify the assumed link between patchiness over time and space, and our biodiversity mandate. If at all possible, we should thoroughly check the assumption that the more practical perimeter burns do not in fact produce this required patchiness.

Fire safety will be strongly influenced by the two local Fire Protection Associations in the making, and Kruger should continue its strong involvement there.

Decomposition, Nutrient Cycling and Energy Conversion Objective

To understand the relationships between nutrients in the ecosystem, functional diversity and biodiversity. [This includes the control, provision, uptake or intake of materials required for essential life functions. In the case of plants, emphasis is placed on C, N, P, K, Ca, Mg, Na, S and climatic factors (with specific reference to implications of global climate change), while in the case of animals, the focus is mainly on energy and protein sources, macro- and trace-minerals and their interactions].

Preamble

Nutrients are acknowledged as one of the main ecosystem drivers and system function cannot be understood without sufficient understanding of nutrient cycling. Nutrient concentrations are related to specific vegetation and soil types and although these systems may be easier to monitor, significant changes in nutrient cycling may be missed by such indirect monitoring systems. Furthermore, if changes in nutrient cycling can be detected before system changes occur, management can be adjusted, if these changes are anthropogenic in origin, before changes become irreversible. Examples of such changes are nitrogen deposition from atmospheric pollution, redistribution of nutrients as a result of the placement of additional artificial waterpoints and the loss of large trees.

Including nutrient cycling objectives in the objectives hierarchy in 1997, stimulated and enhanced research on nutrient cycling and increased awareness of the importance of nutrients in the Lowveld system. Several projects addressing sub-objectives on the link between herbivores and nutrients and carbon and nitrogen budgets, were completed.

The updated objectives hierarchy reflects our improved understanding and knowledge of the system and the importance of linking the terrestrial and aquatic systems. Decomposition has been included under nutrient cycling, as it is believed to be such an integral part of nutrient cycling that it cannot be discussed as a separate objective without extensive repetition.

Abiotic processes

Decomposition, Nutrient Cycling and Energy Conversion Objective

To understand the relationships between nutrients in the ecosystem, functional diversity and biodiversity. [This includes the control, provision, uptake or intake of materials required for essential life functions. In the case of plants, emphasis is placed on C, N, P, K, Ca, Mg, Na, S and climatic factors (with specific reference to implications of global climate change), while in the case of animals, the focus is mainly on energy and protein sources, macro- and trace-minerals and their interactions].

Nutrient Distribution and Movement Objective

To understand biotic and abiotic factors influencing distribution and movement of nutrients through different trophic levels (aquatic and terrestrial) in the lowveld ecosystems (includes climate, especially thunderstorms, global climate change, erosion, SOM, fire, herbivore density including invertebrates, microbes and mycorrhiza).

To develop an understanding of the link between terrestrial and aquatic nutrient flows.

- To develop a quantified flow diagram of nutrients cycled between rivers and adjoining terrestrial habitat e.g. through hippo foraging and piscivorous birds. xref: water
- To develop a quantified flow diagram of the hydrological cycling of nutrients between rivers and adjoining terrestrial habitat (boundary effects). xref: water

To understand the effect of specific pollutants known or suspected to affect nutrient cycling.

- To develop an understanding and maintain awareness of potential effects of herbicides, parasiticides and ecotoxins, including aquatic pesticides, on nutrient cycling. xref:social ecology

To understand changes in nutrient cycling that are related to management actions.

- To implement the Tongway survey method and evaluate its use in measuring changes in nutrient cycling associated with management actions.

Education and Awareness

- To maintain awareness of the impact potential of solid waste and implement methods to minimize this impact. xref: enviro best practice
- To maintain awareness of the impact of heavy metals on fixation of essential minerals with consequent effect on soil pH, or heavy metal pollution of rivers with resulting toxic effects.
- To implement educational awareness programmes and ways of limiting use of such pesticides if significant impact due to such products becomes evident.

Nutrient Distribution and Movement Objective

To understand biotic and abiotic factors influencing distribution and movement of nutrients through different trophic levels (aquatic and terrestrial) in the lowveld ecosystems (includes climate, especially thunderstorms, global climate change, erosion, SOM, fire, herbivore density including invertebrates, microbes and mycorrhiza).

- To understand the sequestration and budgets of C, N, P and other essential nutrients at the landscape to patch scale, and if possible at the regional and catchment level. xref: fire
- To understand the processes that increase N and P availability and absorption as well the role of N and S deposition in the lowveld ecosystem.
- To understand the biotic processes that limit and/or increase nutrient availability to plants.
  - To understand the role of fire and herbivores, such as mound-building termites, and large herbivore concentrations on soil nutrient cycling and the effect on the associated vegetation. xref: habitat pattern, herbivory
    - To understand the role of large herbivores in creating and maintaining sodic sites. xref: herbivory
    - To understand the effect of different fire regimes on soil and plant nutrients. xref: fire
  - To model the nutrient contribution and effects of long-term removal of material (firewood, thatching, bone meal, ivory, etc.) from the KNP system. Relate the results to adjoining high-intensity use areas.
  - To understand the role of vegetation e.g. tall trees (>10m) in soil nutrient cycling and the effect on the associated vegetation. xref: habitat pattern
- To understand how nutrient availability and cycling influence plant and herbivore (including small vertebrates and invertebrates) habitat, communities and population structure.
  - To understand herbivore (including small vertebrates and invertebrates) distribution and movements, reproduction, behaviour, disease and mortality in terms of available nutrients at appropriate spatial scales. xref: habitat pattern
  - To understand plant distribution (including patch diversity) and vegetation dynamics in terms of climate, soil nutrients, other soil properties, patch dynamics and nutrient flows. xref: habitat pattern
  - To understand the role of mound-building termites in influencing grazing patterns of large herbivores. xref: habitat pattern, herbivory
  - To understand the pathways and consequences of high-density grazing (of different types of herbivores) and veld burning in terms of nutrient cycling. Comparative studies in areas with different management practices outside the KNP may improve our understanding. xref: habitat pattern, herbivory
  - To understand the role of nitrogen fixation in different vegetation types. xref: atmospheric
- To develop an understanding of silt-mediated nutrient aggregation and movement in the floodplains of rivers e.g. the Limpopo and Levuvhu rivers. xref: water
- **Decomposition Objective**

  To understand the factors that affect and determine decomposition rates of plant and animal detritus and formation of soil organic matter.

Decomposition Objective

To understand the factors that affect and determine decomposition rates of plant and animal detritus and formation of soil organic matter.

- To understand and quantify the relationship between decomposition, nutrient cycling and environmental factors in various terrestrial and aquatic ecotypes in the KNP.
  - To determine the effect and dynamics of climate and microclimate (including temperature, moisture, solar effects) on decomposition rate. xref: atmospheric
  - To understand the interaction between rate of decomposition and nutrient availability in terrestrial and aquatic ecosystems. xref: water
  - To understand the role of microbes and mycorrhizae in decomposition and nutrient availability in terrestrial and aquatic ecosystems. xref: water, micro-organisms
- To understand the interaction between decomposition and the dynamics and distribution of biodiversity in terrestrial and aquatic ecosystems.
  - To understand and quantify the role of termites in decomposition and the return of nutrients to the soil in the lowveld system. xref: herbivory
  - To understand and quantify the role of herbivore dung and dung beetles in decomposition and the return of nutrients to the soil in the lowveld system (i.e. do herbivores create nutrient-rich grazing lawns?). xref: herbivory, habitat pattern
  - To understand the dynamics of decomposition in aquatic ecosystems and the role of aquatic organisms in decomposition. xref: water
  - To understand and quantify the role of invertebrates, small vertebrates and microbes (incl. bacteria, fungi) in decomposition and the return of nutrients to the soil in the lowveld system.
  - To understand the role of decomposing material as habitat for vertebrate and invertebrate animals in various ecosystems.
- To understand the effect of large infrequent disturbances on decomposition dynamics in terrestrial and aquatic environments. xref: water
  - To understand the effect of annual and infrequent large floods on decomposition in river systems, e.g. accumulation and persistence of debris piles in riparian ecotones. xref: water
  - To understand the interaction between fire and decomposition and its role in accumulation of soil carbon. xref: fire
  - To understand the effect of drought on decomposition in different ecosystems.

Decomposition, Nutrient Cycling and Energy Conversion Objective

Looking forward

As the objectives listed here are very comprehensive, and several studies on N-cycling have been undertaken, we suggest that the N aspect of the listed objectives should be prioritised for the next 5 year cycle. Studies based on available data and literature to model N-cycling should also help to improve our knowledge of nutrient cycling in the Lowveld within a reasonable time-frame.

Apart from examining the nutrient content of pollutants as discussed under the Atmospheric Objective, links between nitrogen deposition and species composition need to be understood to evaluate the effects of nitrogen pollution on this ecosystem. It will also be important to work towards estimating the carbon that is fixed in the KNP system as part of evaluating the size of carbon sinks in South Africa. The factors influencing nutrient cycling such as large trees and herbivore concentrations (insects to large mammals) should also receive more attention in the next 5 years.

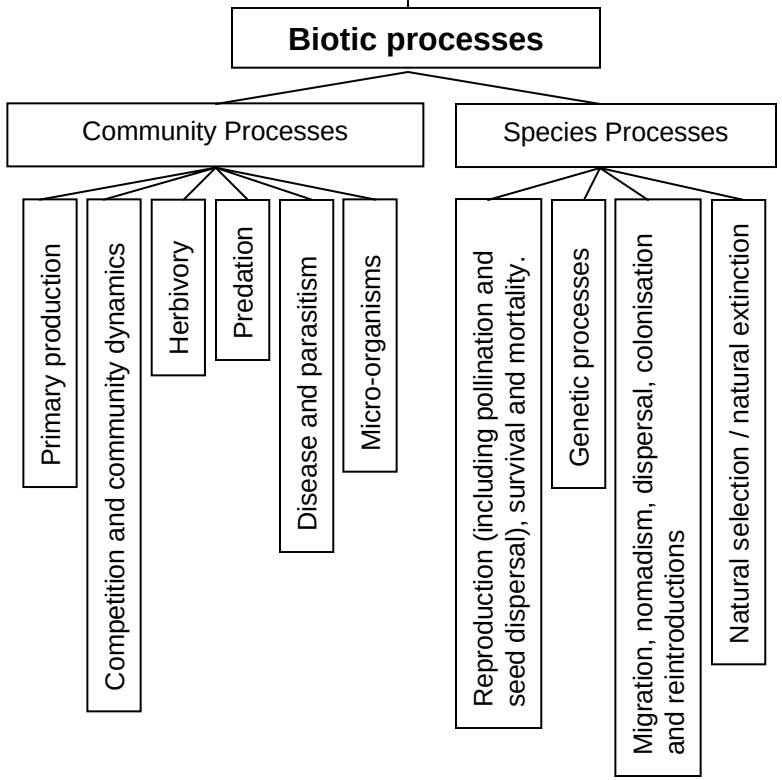
To be able to address this objective from the KNP perspective, simple and inexpensive techniques to measure the important aspects of nutrient cycling should be investigated. Tongway's soil condition assessment, for example, is a well developed technique that uses simple field measurements to calculate an index of soil stability, infiltration/runoff and nutrient status/cycling that could be developed as a TPC.

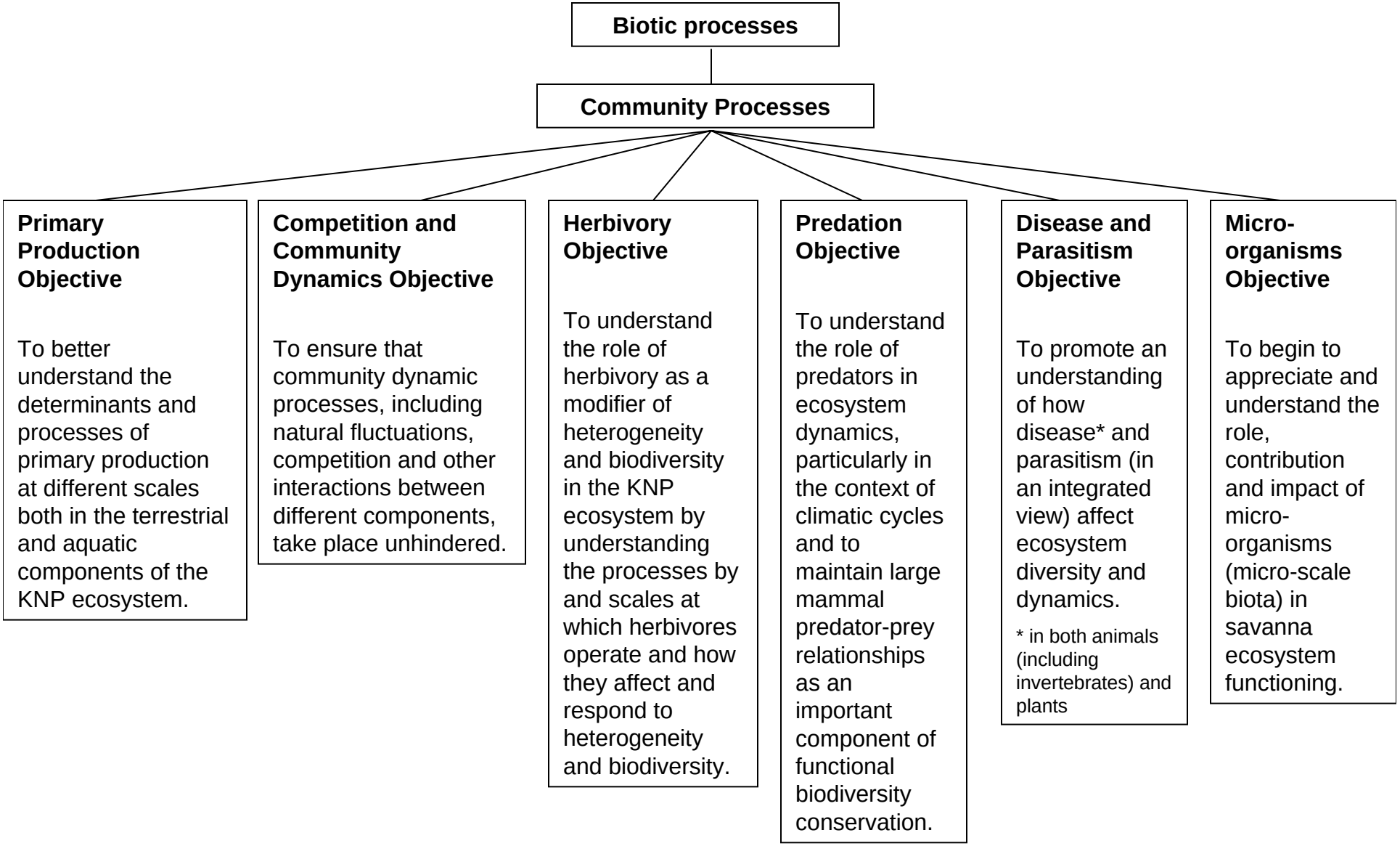
Terrestrial Ecosystem Objective

To develop an integrated understanding of ecosystem diversity and dynamics, and where necessary intervene with appropriate strategies, in order to conserve and restore terrestrial biodiversity and natural processes.

Ecological Processes Objective

To understand the major processes which are, or should be, taking place in the ecosystems in and around KNP, articulating implications for management and responding appropriately in the interests of biodiversity management.




Biotic processes
Community Processes
Primary Production Objective
To better understand the determinants and processes of primary production at different scales both in the terrestrial and aquatic components of the KNP ecosystem.
Competition and Community Dynamics Objective
To ensure that community dynamic processes, including natural fluctuations, competition and other interactions between different components, take place unhindered.
Herbivory Objective
To understand the role of herbivory as a modifier of heterogeneity and biodiversity in the KNP ecosystem by understanding the processes by and scales at which herbivores operate and how they affect and respond to heterogeneity and biodiversity.
Predation Objective
To understand the role of predators in ecosystem dynamics, particularly in the context of climatic cycles and to maintain large mammal predator-prey relationships as an important component of functional biodiversity conservation.
Disease and Parasitism Objective
To promote an understanding of how disease* and parasitism (in an integrated view) affect ecosystem diversity and dynamics.
* in both animals (including invertebrates) and plants
Micro-organisms Objective
To begin to appreciate and understand the role, contribution and impact of micro-organisms (micro-scale biota) in savanna ecosystem functioning.

Primary Production Objective

To better understand the determinants and processes of primary production at different scales both in the terrestrial and aquatic components of the KNP ecosystem.

Preamble

Primary production (carbon assimilation by plants through photosynthesis) is an important ecosystem parameter conventionally expressed as dry-matter production over a given period of time (Scholes & Walker 1993). Because of the close relationship between carbon assimilation and primary production, the effects of global climate change and increasing levels of CO_2 in the atmosphere can be expected to be reflected in primary production. In addition, since primary productivity plays a fundamental role as food and habitat for a wide variety of organisms, as well as fuel for fire, a measure of primary production and its spatial and temporal distribution provides essential basic information for the better understanding of the functioning of the ecosystem in general. Other than routine measurements of primary productivity during the annual veld condition assessment surveys, the important determinants of primary production have received little attention in the past, as have those factors having a modifying role on production such as global climate change, herbivory, fire and the deposition of N_2 and other substances via atmospheric deposition.

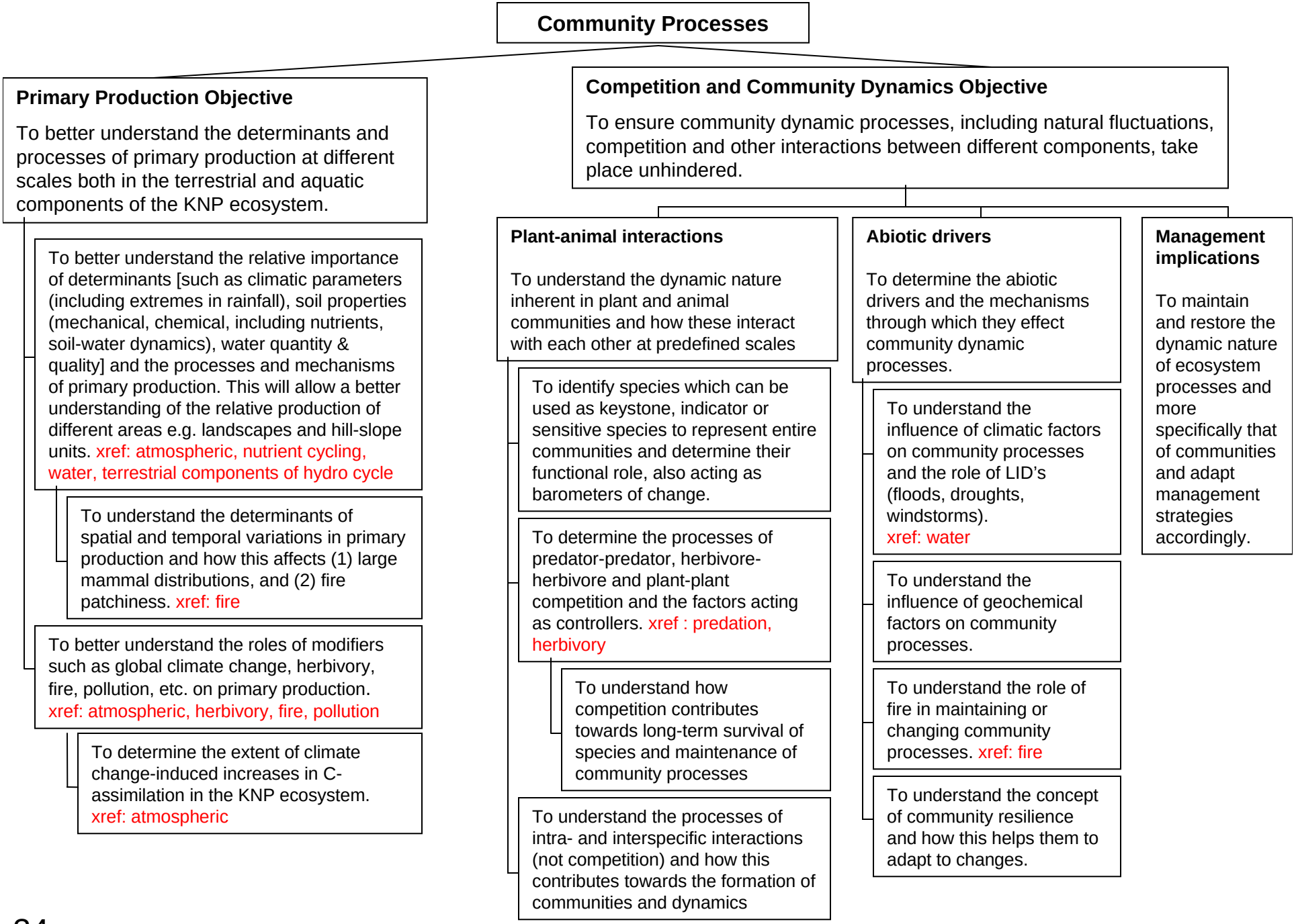
Competition and Community Dynamics Objective

To ensure community dynamic processes, including natural fluctuations, competition and other interactions between different components, take place unhindered.

Preamble

These objectives seem to be closely related to the community listings objectives and, in fact, might even share some sub-objectives. However, under these particular objectives the emphasis is on processes and how different biotic components interact with each other at the community level. The main focus is on understanding the actual processes in terms of actions and reactions, or responses, between the different components of communities and also between these and the abiotic environment. This would require a more holistic approach with system functioning constituting the core emphasis.

The previous objectives hierarchy did not have a specific objective dealing with community dynamics, as proposed here. Most research had a species-specific focus, particularly zoological studies. Vegetation dynamic studies usually included multiple species but very rarely, if ever, entire communities. Plant autecological studies did not receive much attention either.


Community Processes
Primary Production Objective
To better understand the determinants and processes of primary production at different scales both in the terrestrial and aquatic components of the KNP ecosystem.
To better understand the relative importance of determinants [such as climatic parameters (including extremes in rainfall), soil properties (mechanical, chemical, including nutrients, soil-water dynamics), water quantity & quality] and the processes and mechanisms of primary production. This will allow a better understanding of the relative production of different areas e.g. landscapes and hill-slope units. xref: atmospheric, nutrient cycling, water, terrestrial components of hydro cycle
To understand the determinants of spatial and temporal variations in primary production and how this affects (1) large mammal distributions, and (2) fire patchiness. xref: fire
To better understand the roles of modifiers such as global climate change, herbivory, fire, pollution, etc. on primary production. xref: atmospheric, herbivory, fire, pollution
To determine the extent of climate change-induced increases in C-assimilation in the KNP ecosystem. xref: atmospheric
Competition and Community Dynamics Objective
To ensure community dynamic processes, including natural fluctuations, competition and other interactions between different components, take place unhindered.
Plant-animal interactions
To understand the dynamic nature inherent in plant and animal communities and how these interact with each other at predefined scales
To identify species which can be used as keystone, indicator or sensitive species to represent entire communities and determine their functional role, also acting as barometers of change.
To determine the processes of predator-predator, herbivore-herbivore and plant-plant competition and the factors acting as controllers. xref : predation, herbivory
To understand how competition contributes towards long-term survival of species and maintenance of community processes
To understand the processes of intra- and interspecific interactions (not competition) and how this contributes towards the formation of communities and dynamics
Abiotic drivers
To determine the abiotic drivers and the mechanisms through which they effect community dynamic processes.
To understand the influence of climatic factors on community processes and the role of LID's (floods, droughts, windstorms). xref: water
To understand the influence of geochemical factors on community processes.
To understand the role of fire in maintaining or changing community processes. xref: fire
To understand the concept of community resilience and how this helps them to adapt to changes.
Management implications
To maintain and restore the dynamic nature of ecosystem processes and more specifically that of communities and adapt management strategies accordingly.

Primary Production Objective

Looking forward

This newly formulated objective should attract increased attention in the next 5-year cycle as the implications of climate change and pollution gain momentum. Increasingly, research partners are interested in conducting work in the KNP often using a combination of satellite and ground-based observations to refine predictive models. A strong linkage between this objective and the atmospheric objectives will be encouraged and integrative research promoted.

Competition and Community Dynamics Objective

Looking forward

Understanding major ecological processes calls for a systems approach rather than a species approach. Communities consist of individuals of several species and the interaction between these differ from one to the next. In its entirety, a community is a complex system in terms of not only composition and structure but also function. Even though a single species may be the focus of a study, attempts should be made to keep the scope wide enough to allow various other factors to be included as well. This will ensure that findings can be interpreted in the context of a larger system, consisting of multiple factors. Importantly, a community has a spatial aspect and therefore can be expressed at many different scales. Thus, for example, habitat under the canopy of a tall tree may consist of several communities of organisms, depending on the scale of the focus. When interpreting their results, researchers should not ultimately have to excuse themselves for not been able to include a whole lot of other factors to be measured. We often tend to make systems look simpler than they are for the sake of convenience and other reasons. This could compromise the study as a whole and lead to lack of trust in such results.

Herbivory Objective

To understand the role of herbivory as a modifier of heterogeneity and biodiversity in the KNP ecosystem by understanding the processes by and scales at which herbivores operate and how they affect and respond to heterogeneity and biodiversity.

Preamble

Most of the sub-objectives under the old herbivory objective are incorporated in the new objective but are somewhat reformulated. No longer are we distinguishing between an animal and plant facet, suggesting the close interrelationship between these two components. Instead, distinction is made between the major architects of ecosystem changes on the one hand and interactions between different herbivore, predator and plant species on the other. Thus, even though a more integrated systems approach is followed, certain individual species will still be receiving special treatment, especially those of particular importance.

Most of the herbivory-related studies were conducted on the northern plains where habitat changes caused by bulk grazers are assumed to be the main reason for the decline in roan antelope numbers. The northern plains is an area of high interest where herbivory, amongst others, can be studied in more detail. However, it must be kept in mind that this area is not representative of the entire KNP in terms of composition and structure but forms part of a larger mosaic of landscapes.

Predation Objective

To understand the role of predators in ecosystem dynamics, particularly in the context of climatic cycles and to maintain large mammal predator-prey relationships as an important component of functional biodiversity conservation.

Preamble

Predator-prey relationships amongst the larger mammals in the KNP ecosystem are one of the most important functional components of biodiversity in Kruger because of its size. There are few areas left in the world where these can be given the freedom of expression they can in Kruger. Considerable research has been done in this field and an adequate basic knowledge of the major mechanisms and processes is available for management.

Community Processes

Herbivory Objective

To understand the role of herbivory as a modifier of heterogeneity and biodiversity in the KNP ecosystem by understanding the processes by and scales at which herbivores operate and how they affect and respond to heterogeneity and biodiversity.

Major architects

To identify the major architects and understand their function in ecosystems at different spatial and temporal scales.

- Based on differential elephant impact zones, to understand the effects of elephants on heterogeneity and biodiversity at different spatial and temporal scales.
- To identify other herbivores acting as major architects at the broad scale and quantify their specific impacts.
- To understand the interaction between fire and herbivory and how this affects tree mortality. xref: fire
  - To specifically understand the role of elephants in tree mortality in conjunction with fire.
- To determine the effect of fire on herbivore distribution and how herbivory affects burnt/unburnt areas. xref: fire
  - To specifically understand the role of fire in distributing grazers and taking pressure off unburnt areas.

Mechanisms

To understand the mechanisms of herbivore-plant, herbivore-herbivore and herbivore-plant-predator interactions.

- To establish the magnitude of vegetation consumption by all classes of herbivores (elephants to invertebrates).
- To understand the mechanisms/processes by which different types of herbivores create and maintain different types of patches and effects on keystone/indicator/sensitive species.
- To understand the role of herbivores in plant dispersal and establishment.
  - To evaluate and understand the role of seedling herbivory on selected woody plant species recruitment processes.
- To determine the waterhole closure mediated effects on vegetation and this interaction with predator-prey cycles, especially rare antelope. xref: predation, water
- To understand the effect of water provision on herbivore composition and distribution and how this affects heterogeneity and biodiversity. xref: water
  - To determine the effects of waterhole closure on vegetation on the northern plains. xref: water

Predation Objective

To understand the role of predators in ecosystem dynamics, particularly in the context of climatic cycles and to maintain large mammal predator-prey relationships as an important component of functional biodiversity conservation.

- To understand the factors which determine prey selection by predators. xref: disease
  - To study the role of predators in controlling the spread of disease.
- To develop an understanding of the reciprocal impact between predator and prey.
- To understand the importance of the KNP as a habitat for resident, migratory, nomadic or seasonal predators, both as a feeding area and as a breeding ground. xref: migration
- To develop an understanding of the food and habitat requirements for rare or other predators deemed to be important. xref: threatened biota

Herbivory Objective

Looking forward

The issue of elephants and their broad-scale impacts on vegetation is covered under several objectives. The herbivory objective deals with vegetation utilization by elephants and will require attention and further development as this potentially controversial issue could be the decisive factor determining the way in which elephants will be managed in the KNP. This objective will hopefully also lead to defining so-called keystone/indicator/sensitive species that can act as barometers for general vegetation and environmental health.

Seedling herbivory plays an important role in the recruitment process of many woody plant species and could be one of the reasons for declining numbers in certain woody plant populations. This is a field for which not too much information is available and should therefore receive more recognition and attention.

The long-term effect of waterhole-closure on vegetation is a point that needs more investigation. The interaction between this effect and predator-prey cycles also requires understanding. This might provide further insights to the roan antelope decline in KNP and may assist with the conservation of low density and/or rare antelopes in future.

Predation Objective

Looking forward

No specific projects on predation stand out as priorities at present. Logistically these studies are difficult and expensive to undertake in this habitat and may be more aptly undertaken elsewhere. We are wary of constructing or enabling wish lists of impractical and/or less important projects (this is not how the 4th sub-objective should be read).

Disease and Parasitism Objective

To promote an understanding of how disease* and parasitism (in an integrated view) affect ecosystem diversity and dynamics.

* in both animals (including invertebrates) and plants

Preamble

Objectives for disease and parasitism was never properly developed or integrated into the systems thinking process currently encouraged by SANParks research and management.
This objective hierarchy group therefore is aimed at dealing with this short coming and we understand that there is much work that is required to align this. This is our first attempt at doing so on this very understudied and documented field and with further input from various sources and interested parties this will be developed further.

The veterinary division was historically not very well consolidated and was driven by operational requirements with very diverse and non specific goals and objectives. This has now been addressed and attempts are being made to rectify the previous absence of the veterinary involvement with the objectives hierarchy.

Micro-organisms Objective

To begin to appreciate and understand the role, contribution and impact of micro-organisms (micro-scale biota) in savanna ecosystem functioning.

Preamble

Micro-organismal diversity and function has in the past not been recognised explicitly in the KNP ecosystem functioning. Through this objective, we recognise that our understanding of the microbial world (particularly the SLiME - Subsurface Lithoautotrophic Microbial Ecosystems) is almost non-existent and that we are not even remotely close to understanding microbial diversity or its role in ecosystem functioning.

Community Processes

Disease and Parasitism Objective

To promote an understanding of how disease* and parasitism (in an integrated view) affect ecosystem diversity and dynamics.

* in both animals (including invertebrates) and plants

Disease Objective

To determine the most ecologically influential diseases (which have positive feedback to the ecosystem) occurring amongst the KNP indigenous biota. xref: alien impact, veterinary-wildlife-human interface

- To understand the role and impact of indigenous disease in savanna ecosystem dynamics. xref: predation
- To understand silent infection in traditional hosts with special reference to the potential impact of silent invasions, increased pathogenicity due to mutation and crossing over the species barrier (e.g. foot and mouth disease, African swine fever).
- To understand inherently fatal diseases such as anthrax and their role in the ecosystem.
- To understand and quantify the potential impact of re-incursion of indigenous diseases (e.g. trypanosomiasis / nagana). xref: veterinary-human-wildlife interface
- To understand the ecological impact of non-infectious diseases with special reference to pollution, mineral deficiencies and excesses.
- To identify plant diseases and their causal agents and evaluate their role in the ecosystem. xref: taxa listings
- To understand maintenance mechanisms of disease which allow ecological persistence.

Parasitism Objective

To determine the influence of parasitism on host fitness.

- To make available the KNP as a source of potential biocontrol agents for alien invasive species from southern Africa currently invading other parts of the world. xref: alien impact
- To understand if there is, and how, a relationship exists between increased parasitism and underlying disease – quantify?

Micro-organisms Objective

To begin to appreciate and understand the role, contribution and impact of micro-organisms (micro-scale biota) in savanna ecosystem functioning.

Fungal and Other Pathogens Objective

To identify the major micro-organism architects and understand their function in ecosystems.

- To explore the interactions between dung beetles and fungi.
- To expand our knowledge on the effect of veld fires on fungal biodiversity of savanna systems. xref: fire
- To understand why pathogens and parasites are restrained in their influence on hosts in their system of origin as compared to their influence when imported into a foreign system.

Microbial Processes Objective

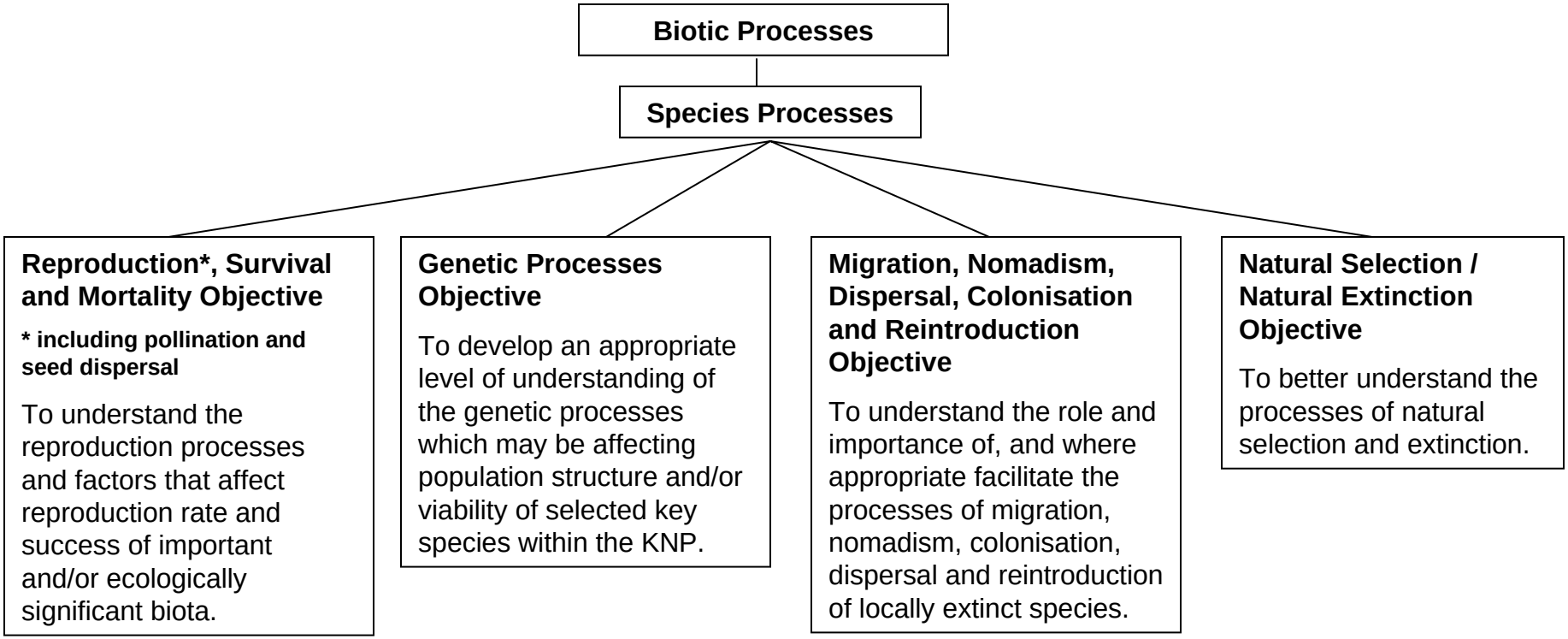
To increase our awareness, knowledge and understanding of the role of micro-scale biota in the KNP.

Disease and Parasitism Objective

Looking forward
Opportunistic soliciting for the referred objectives will be encouraged for the fundamental understanding of disease and parasitism in the terrestrial ecosystems objective. We therefore would look at all incoming or offered projects relative to the stated objectives.

Micro-organisms Objective

Looking forward
Besides understanding the microbial processes we are already aware of, there are no doubt also numerous other as yet undiscovered and/or undocumented processes. With this new objective we recognise the potentially huge gap in our understanding of particularly the subsurface microbial world. However, most likely this facet of the KNP objectives will receive relatively little or at best opportunistic attention in the next 5 years.


Biotic Processes
Species Processes
Reproduction*, Survival and Mortality Objective
* including pollination and seed dispersal
To understand the reproduction processes and factors that affect reproduction rate and success of important and/or ecologically significant biota.
Genetic Processes Objective
To develop an appropriate level of understanding of the genetic processes which may be affecting population structure and/or viability of selected key species within the KNP.
Migration, Nomadism, Dispersal, Colonisation and Reintroduction Objective
To understand the role and importance of, and where appropriate facilitate the processes of migration, nomadism, colonisation, dispersal and reintroduction of locally extinct species.
Natural Selection / Natural Extinction Objective
To better understand the processes of natural selection and extinction.

Reproduction*, Survival and Mortality Objective * including pollination and seed dispersal

To understand the reproduction processes and factors that affect reproduction rate and success of important and/or ecologically significant biota.

Preamble

Species reproduction is a theme that is closely linked to, and part of, several other objectives and therefore will be better dealt with under the latter. Not much attention has been given to studies relating to species reproduction and in particular how this is affected by the many factors listed in the objective. Species reproduction per se *was not covered anywhere in the 1997 objectives tree but has now come to be regarded as an objective on its own. Even though this objective will primarily be addressed by other related objectives, the hierarchical process will enable backtracking to the different links at various levels.*

Of particular interest is the reproduction rate of some of the rare antelope species seen against the background of declining population numbers. This is a topic that needs more attention and should be taken further in future. Pollination received attention in the past as an objective with sub-objectives. However, few studies, if any, were conducted to understand pollination processes and relationships between pollinators and hosts. Unless such studies are conducted soon, the importance of pollination in the survival of important or ecologically significant species in the KNP will remain unanswered.

Genetic Processes Objective

To develop an appropriate level of understanding of the genetic processes which may be affecting population structure and/or viability of selected key species within the KNP.

Preamble

Genetic processes were not explicitly recognised in the 1997 objectives tree, although some limited genetic work has been conducted since then. Increasingly, however, the KNP must take cognisance of genetic issues, particularly where conservation and/or management implications exist. In particular, meta-population management initiatives that the KNP is involved in (e.g. black rhino and possibly roan antelope at a later stage) will necessitate this type of research and the KNP should position itself to partake in and support such work.

Biotic processes

Species Processes

Reproduction*, Survival and Mortality Objective

*** including pollination and seed dispersal**

To understand the reproduction processes and factors that affect reproduction rate and success of important and/or ecologically significant biota.

Factors and Processes Objective

To identify the factors and processes (incl. rainfall, competition, nutrition, seed dispersal, disease, predation, fire, water provision, pollution, climate change) that affect the reproductive success and survival of important biota. xref: other objectives as listed

- To investigate the combined effects of environmental change on reproduction of important or charismatic or declining or rare species. xref: threatened biota

Pollination Objective

To understand the mechanism of pollination and the relationship between pollinators and their hosts as well as the life history and population dynamics of pollinators.

- To understand the importance of pollination in the survival of ecologically significant species.
- To identify the factors affecting populations of important pollinators, including interspecific competition, parasitism, spatial distribution of host plants (distance and density) and phenological patterns (quantity of flowers, seasonal shifts due to climate change). xref: parasitism, competition, climate change
- To evaluate the effect of the exotic varroa mite on the effectiveness of bee pollination. xref: alien impact

Genetic Processes Objective

To develop an appropriate level of understanding of the genetic processes which may be affecting population structure and/or viability of selected key species within the KNP.

- To support, and where necessary solicit, appropriate studies on the phylogenetic structure and/or phylogenetic associations of species and determine the conservation/management implications thereof (flag: hippo).

  * this could include genetic introgression studies (e.g. feral cats)
- To evaluate the conservation implications of genetic structuring and heterozygosity levels within and/or between populations of key species or charismatic translocated species.
- To determine the genetic consequences of management actions on population viabilities of selected species (e.g. roan antelope). xref: threatened biota
- To engage in meta-population management programmes for those key species that require artificial gene-flow through translocations (e.g. roan antelope, black rhino).

  * this will be moderated by the threatened biota objective. xref: game capture, threatened biota, disease (translocating biological packages)
- To monitor, and where appropriate, integrate the growing body of literature addressing abiotic factors driving evolutionary processes on the African continent. This is important when animals/plants are moved around for management reasons and broader evolutionary impacts will have to be assessed. There are several studies indicating biogeographic provinces in Southern Africa and these findings can be extrapolated for precautionary recommendations.

Reproduction, Survival and Mortality Objective * including pollination and seed dispersal

Looking forward

Some of the more interesting issues that should receive attention in future include the effect of global climate change, reduced water provision and outbreak of different diseases on species reproduction. Attempts to conserve species which are declining in numbers due to large scale uncontrollable changes brought about by external factors, could be futile. This is a controversial point as many people might disagree with the notion of allowing such affected species to disappear from the system (in some instances, such losses are mediated by the threatened biota objective).

Species reproduction can be affected by many factors simultaneously, therefore, attempts should be made to investigate the combined effect rather than individual effects, of environmental factors, thus adopting a holistic approach. Here one could single out specific or important species that are sensitive enough to indicate a certain degree of change in environmental conditions. Single-species approaches should only be accepted if they can provide answers to a wider variety of problem issues, or are in line with the threatened biota objectives.

Genetic Processes Objective

Looking forward

Understanding and acceptance of the role and importance of genetic processes in conservation management is growing. The implications of these processes cannot be underestimated in the management of particularly rare and/or fragmented populations of both plants and animals. This new objective provides some context to the KNP for engaging in such work. While the KNP may only solicit limited genetic studies, it does have an obligation to contribute towards wider-scale studies and insights through providing access to material where possible and appropriate (although the costs of sample collection will mostly lie with the research institutions).

Migration, Nomadism, Dispersal, Colonisation and Reintroduction Objective

To understand the role and importance of, and where appropriate facilitate the processes of migration, nomadism, colonisation, dispersal and reintroduction of locally extinct species.

Preamble

This is a new objective which is of relevance to the outward-looking strategy being employed by the KNP. It is based on the philosophy that Kruger is not an island and that wherever possible we must look for linkages and opportunities to ensure that this is not so. It is also of relevance to the development of the TFCAs and in light of the predicted changes we may experience through Global Climate Change to this phenomenon as well.

Biotic Processes

Species Processes

Migration, Nomadism, Dispersal, Colonisation and Reintroduction Objective

To understand the role and importance of, and where appropriate facilitate the processes of migration, nomadism, colonisation, dispersal and reintroduction of locally extinct species.

Migration

To understand the importance of and to maintain the KNP as a location for migratory species (recognising the potential changes to be brought about by climate change scenarios).

- To theoretically reconstruct terrestrial migration patterns no longer possible and to attempt to restore them. xref: water
- To identify and maintain the integrity of migration routes presently still functional.
- To establish the importance of the KNP as a destination for aerial migrants and to help maintain the functional integrity of these relationships.

Nomadism

To establish the importance of the KNP as a habitat for nomadic species (e.g. red-billed queleas, locusts) and to understand the functional significance of these phenomena.

Colonisation

To make the KNP accessible to and a provider of indigenous colonising species and to understand the process of colonisation, especially in the context of global climate change. xref: atmospheric

- To address fence issues, look for ways of improving habitats outside the KNP for certain species, and for setting up corridors, e.g. riparian vegetation along rivers.
- To look towards predicting changes in habitat and species composition due to global climate change and ways of encouraging colonisation of suitable species that may become better adapted to the changing environment.
- To provide exit routes for colonising species from the KNP, especially into the TFCA.

Dispersal

To understand the mechanisms of dispersal of certain important species and to minimise conflict with neighbours. xref: human benefits

Reintroduction

To investigate possibilities for the reintroduction of locally extinct species, and where possible, to implement these in accordance with IUCN principles and guidelines.

- To establish which species could be reintroduced into the KNP, to review past reintroductions and the reasons for success or failure, and to implement reintroduction programs when required.
- To provide species for reintroduction into other protected areas. xref: genetic processes

Migration, Nomadism, Dispersal, Colonisation and Reintroduction Objective

Looking forward

This objective mainly rests on the successful management of the integrity of Kruger and progress that is made with the establishment of the Kruger-to-Canyons Biosphere Reserve and the Greater Limpopo Transfrontier Park. Certain research aspects would help to better understand how the Kruger ecosystem functions, but none are seen as priorities, as these relationships are nested within the functioning of a healthy ecosystem. Conflict with neighbours is dealt with under the objective “Direct human benefits”. With regard to reintroductions, the question regarding the desirability of maintaining Lichtenstein’s hartebeest in Kruger needs to be addressed.

Natural Selection and Extinction Objective

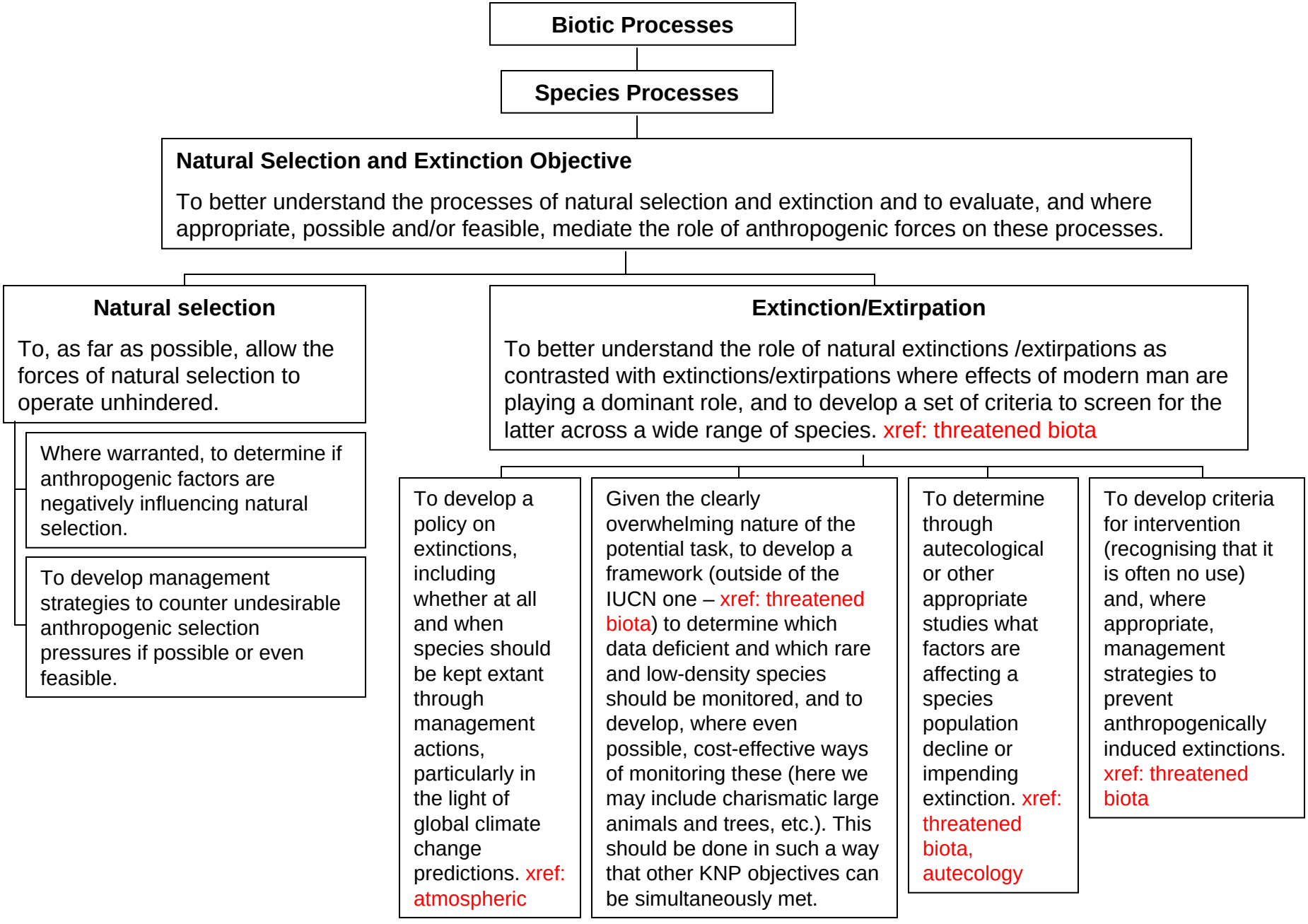
To better understand the processes of natural selection and extinction and to evaluate, and where appropriate, possible and/or feasible, mediate the role of anthropogenic forces on these processes.

Preamble

Natural selection and extinction are closely related processes. Over time, entire species develop inherited adaptations (traits) which best promote their survival in their particular environments. Since the environment is constantly changing, living organisms must accommodate themselves to this dynamic situation by changing also. The mechanisms of such adaptation are mutation and natural selection. The hereditary traits which arise through mutation and which favour survival, tend to be perpetuated by being passed on to subsequent generations, and the species becomes increasingly better adapted to its environment.

Extinctions occur when a population's set of inherited traits prove inadequate for continued survival under the prevailing or altering set of environmental conditions, and all members of that population die out. All species will eventually become extinct. Some will evolve into "new" species through natural selection, but others may become extinct before this can happen. The die-off of a whole species is known as extinction, while the die-off of a local population of a species is known as extirpation.

As natural selection and extinction are both natural processes, they should (in theory) be allowed to function unhindered by management, but from a monitoring or management point of view, the difficulty comes in trying to distinguish between "natural" and "anthropogenic" forces driving selection and/or those driving a species to extirpation. Natural selection is an extremely slow, ongoing process, which perhaps puts it beyond the realms of normal monitoring. Extirpation on the other hand may occur over just a few generations and can more easily be monitored by census techniques.


Biotic Processes
Species Processes
Natural Selection and Extinction Objective
To better understand the processes of natural selection and extinction and to evaluate, and where appropriate, possible and/or feasible, mediate the role of anthropogenic forces on these processes.
Natural selection
To, as far as possible, allow the forces of natural selection to operate unhindered.
Where warranted, to determine if anthropogenic factors are negatively influencing natural selection.
To develop management strategies to counter undesirable anthropogenic selection pressures if possible or even feasible.
Extinction/Extirpation
To better understand the role of natural extinctions /extirpations as contrasted with extinctions/extirpations where effects of modern man are playing a dominant role, and to develop a set of criteria to screen for the latter across a wide range of species. xref: threatened biota
To develop a policy on extinctions, including whether at all and when species should be kept extant through management actions, particularly in the light of global climate change predictions. xref: atmospheric
Given the clearly overwhelming nature of the potential task, to develop a framework (outside of the IUCN one – xref: threatened biota) to determine which data deficient and which rare and low-density species should be monitored, and to develop, where even possible, cost-effective ways of monitoring these (here we may include charismatic large animals and trees, etc.). This should be done in such a way that other KNP objectives can be simultaneously met.
To determine through autecological or other appropriate studies what factors are affecting a species population decline or impending extinction. xref: threatened biota, autecology
To develop criteria for intervention (recognising that it is often no use) and, where appropriate, management strategies to prevent anthropogenically induced extinctions. xref: threatened biota

Natural Selection and Extinction Objective

Looking forward

The scale and magnitude of anticipated impacts of global climate change will force the KNP to adopt a pragmatic approach towards natural selection and extinctions in particular. The realities of these impacts, which are way beyond our control, will necessitate a “moving target” approach to these species-based processes and Kruger will have to position itself in the broader potentially changed landscape. Kruger will have to become involved in broader land-use planning initiatives in the region and consider its contribution to the biodiversity estate under these changed conditions. Some local extinctions will have to be tolerated under these changed scenarios and the KNP should position itself in the next 5 years to make use of predictive modeling advances to ensure that resources are not wasted on single species (except in line with the threatened biota objective) conservation efforts.

Terrestrial Ecosystem Objective

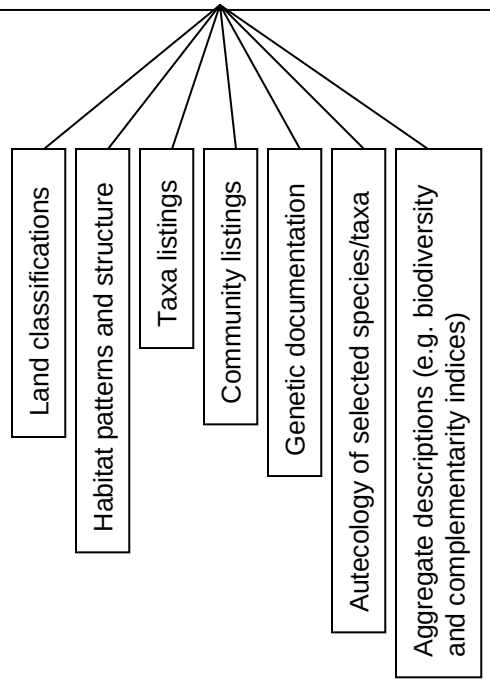
To develop an integrated understanding of ecosystem diversity and dynamics, and where necessary intervene with appropriate strategies, in order to conserve and restore terrestrial biodiversity and natural processes.

Ecological Processes Objective

To understand the major processes which are, or should be, taking place in the ecosystems in and around KNP, articulating implications for management and responding appropriately in the interests of biodiversity management.

Composition, Structure and Pattern Objective

To adequately inventorise our biodiversity heritage, understand the ecology of important elements and unnatural threats leading to compositional or structural changes deemed beyond acceptable flux limits, and respond appropriately.



Terrestrial Ecosystem Objective

Composition, Structure and Pattern Objective

To adequately inventorise our biodiversity heritage, understand the ecology of important elements and unnatural threats leading to compositional or structural changes deemed beyond acceptable flux limits, and respond appropriately.

Land Classifications

To generate further understanding of the intricate relations between the geological, pedological and botanical features of the KNP at appropriate scales, in order to provide appropriately suitable background information for a better understanding of the relations between the abiotic and biotic components of the KNP ecosystem.

Habitat Patterns and Structure

To inventorise significant habitat patches at appropriate scales, understand their structural and functional roles in the ecosystem and identify unnatural threats to them and recommend effective counter measures where appropriate.

Taxa Listings

To maintain comprehensive and correct taxa lists of all biota which occur in the KNP (including alien and red data species, parasites, microbes and pathogens). [These are essential in confirming identifications, biodiversity research, preparation of inventories, etc.].

Community Listings

To prepare an inventory of important or relevant animal, plant, disease and parasite communities at different spatial and temporal scales; understand interactions between and/or within the communities and identify any unnatural threats affecting the communities, and respond if necessary.

Genetic Documentation

To gain a broad understanding of the genetic diversity within the KNP and to develop guidelines governing it's potential use and/or exploitation.

Autecology of Selected Species/Taxa

To determine the autecology of certain keystone, threatened and 'sustainable use' taxa.

Aggregate Descriptions (e.g. biodiversity and complementarity indices)

To examine various compound aggregate measures of terrestrial species diversity or surrogates thereof (such as habitat surveys*) with a view to securing a composite measure of species diversity across the park and wider system boundaries.

*like the geomorphology TPC for rivers

Land Classifications Objective

To generate further understanding of the intricate relations between the geological, pedological and botanical features of the KNP at appropriate scales, in order to provide appropriately suitable background information for a better understanding of the relations between the abiotic and biotic components of the KNP ecosystem.

Preamble

The classification of a variety of biotic and abiotic features of the KNP ecosystem is a basic essential in the characterisation of the ecosystem and in the determination of similarities, differences and relations, both between these components, and their fauna. These features include (but are not limited to) the geology, terrain morphology, land systems and land types, soils, rainfall and other climatic parameters on the one hand, and vegetation on the other. The first attempts at classification were understandably undertaken at a very basic level of detail because little was known of the area. As ecological knowledge increased however, the need for more detailed classifications increased and this led to the relatively detailed classification of geology, terrain morphology, land systems and land types of the KNP (Venter 1990). The vegetation was also classified and mapped at increasing levels of detail, the most widely-used being the landscapes of the KNP (Gertenbach 1983). Phytosociological studies at the community level have also been undertaken in specific areas (van Rooyen 1978; Coetzee 1983 and Gertenbach 1978, 1987). Although these products are used for a variety of purposes (and will continue to be used well into the future), the point has now been reached where, as knowledge of the KNP ecosystem increases, so too does the required level of detail and scale of classification. Objectives are consequently shifting from the more extensive level to the more intensive, local level to include aspects such as hill-slope units and plant communities, or specialised habitat maps for specific purposes.

Composition, Structure and Pattern Objective

Land Classifications Objective

To generate further understanding of the intricate relations between the geological, pedological and botanical features of the KNP at appropriate scales, in order to provide appropriately suitable background information for a better understanding of the relations between the abiotic and biotic components of the KNP ecosystem.

- To expand the delineation and mapping of geophysical and botanical features to include aspects such as hillslope units and plant communities at different scales.
- To determine the most suitable GIS methods for mapping and interpolating climatic parameters and indices as well as composition, cover and standing crop of the herbaceous layer. xref: biodiversity support
- To ensure that at least 20% of all land types and landscapes are included in the wilderness zone category; and develop a selection framework for the inclusion of more sensitive landscapes or landtypes. xref: wilderness

Land Classifications Objective

Looking forward

The interpolation and mapping by GIS of a variety of climatic parameters (especially rainfall, which we have recognised as a cardinal driver of our semi-arid system), is a specialized field which requires further development and within which we will pursue collaboration in the next 5 years. Similarly, interpolation techniques and indices for evaluating and estimating composition, cover and standing crop should receive added attention as these efforts could reduce the intensity (and associated time and costs) of field measurements in future.

The mapping and delineation aspects are already receiving increased attention and different studies are underway at various scales. This includes work on the important riparian-upland boundary which has been relatively neglected in the past.

Recognizing the unique role which the KNP's wilderness areas can play in conserving the land and vegetation types in a pristine form, attention will have to be given to the incorporation of representative portions of such areas as far as possible in the wilderness areas.

Habitat Patterns and Structure Objective

To inventorise significant habitat patches at appropriate scales, understand their structural and functional roles in the ecosystem and identify unnatural threats to them and recommend effective counter measures where appropriate.

Preamble

The status of most organisms depends in one way or another on sufficient habitat availability and intactness. Organisms usually decline in numbers when habitats get fragmented or shrink in size. Therefore habitats are often used as surrogates for species presence/absence. The habitat preferences of many plant and animal species may be known to a large extent, however, the effect of seasonal shifts, global climate change, fire policy, elephant impacts and various other factors will need more attention than in the past. At the micro- to medium-scale, habitat patterns and structure are readily changed by fire regime and elephant impacts, whereas large-scale changes, usually at a landscape level or higher, might be caused by climatic changes.

Identifying and characterizing different habitat patch types constitutes the spatial aspect of the inventory phase and also includes the listing of endangered types in terms of extent and rarity. The inclusion of the Mozambican part of the Greater Limpopo Transfrontier Park has caused a change in the status of certain landscape-level habitat patches. The status of all these landscapes (as per Gertenbach 1987 definition) needs to be reassessed and redefined.

Composition, Structure and Pattern Objective

Habitat Patterns and Structure Objective

To inventorise significant habitat patches at appropriate scales, understand their structural and functional roles in the ecosystem and identify unnatural threats to them and recommend effective counter measures where appropriate.

To distinguish between different habitat patches in terms of pattern, structure and conservation status.

- To identify and characterise different habitat patches at varying spatial scales and their characteristic temporal variation.
  - Scale 1: To determine large scale habitat patches and their spatial arrangement (landscape class proportions).
  - Scale 2: To determine medium scale habitat patches and their spatial arrangement (terrain unit proportions).
  - Scale 3: To determine small scale habitat patches and their spatial arrangement (e.g. rocks, logs, loose bark, etc).
  - To determine the temporary requirements for certain habitat patches of some organisms in order to survive.
- To develop methods of identifying potential rare and endangered habitat patch groupings such as landscapes, topographical units, etc.

To understand the processes of interaction between the different components of habitat patches and the roles of juxtaposition, aggregation, corridors, competition and complementarity. xref: aggregate descriptions

- To establish habitat preference of, where possible, at least all important biota in the KNP (desktop study, followed by field verification). This may require the use of surrogate measures.
- To, where feasible, carry out systematic species mapping (current distribution data and knowledge of habitat preference) in order to predict species habitation (improvement of species distribution maps).
- To determine the reaction of biota (key, important or rare) to habitat patches in terms of breeding, dispersal, feeding, etc. (e.g. large scale - regional migration of birds; medium scale – feeding in foot slope pans; small scale – nest at certain height in tree). xref: threatened biota, autecology
- To better understand the role and importance of critical but ephemeral (not continually used or relied upon) habitats in ensuring key species survival.

To understand the mechanisms of change as caused by unnatural threats.

- To monitor effectively in order to recognise major changes in habitat structure at medium and large scales.
- To monitor habitat structure (surrogate for species presence/ absence) to determine changes in faunal diversity and abundance (using probability indices). xref: aggregate descriptions
- To identify current and potential significant threats to habitat pattern groupings, e.g. global climate change, elephant impact zones, fire policy effects and the way in which they influence these. xref: fire, herbivory, atmospheric
- To investigate possible management options to ameliorate or reverse these threats, where possible and appropriate.

Habitat Patterns and Structure Objective

Looking forward

The hierarchical patch dynamic concept should be more actively promoted when habitat related studies are to be conducted. This implies that habitats need to be defined in terms of spatial and temporal scales so that the inherent processes responsible for creating, maintaining and changing these patterns can be isolated and investigated.

The so-called gradsect method (as developed by Margules) is geared to assessing the availability of habitat types or patterns by using structure as a surrogate for species absence or presence.

Alien plant and animal invasions might jeopardize the existence of certain species by adversely affecting preferred habitats. The underlying mechanisms will need to be understood so that effective counter measures can be implemented without further jeopardizing habitat intactness and availability.

An important focus area in the near future will be the evaluation of elephant, fire and other drivers of habitat pattern and structural changes. These questions will need to be addressed in an explicit and structured manner to begin providing much-needed insights into these issues.

Taxa Listings Objective

To maintain comprehensive and correct taxa lists of all biota which occur in the KNP (including alien and red data species, parasites, microbes and pathogens). [These are essential in confirming identifications, biodiversity research, preparation of inventories, etc.].

Preamble

Although taxa lists were added as an appendix to the 1997 KNP masterplan, objectives for taxa listing were never included in the masterplan. Since then the necessity to include such objectives has been realised as taxa lists are essential in confirming identifications, in biodiversity research and in the preparation of inventories. Objectives for compiling distribution lists have been included here as they are not covered elsewhere. As far as practically possible, we aim to play a facilitatory role only for the listings of lower taxa, parasites, microbes and pathogens.

Community Listings Objective

To prepare an inventory of important or relevant animal, plant, disease and parasite communities at different spatial and temporal scales; understand interactions between and/or within the communities and identify any unnatural threats affecting the communities, and respond if necessary.

Preamble

Development of this new objective shows that the community concept still needs acknowledgement and further promotion. From a floristic and geomorphological point of view, several broad-scale classifications have seen the light and are used as templates for many studies. There might be times when additional inventory-type surveys need to be conducted in order to produce new classifications at other, probably finer, spatial scales.

The concept of hierarchical patch dynamics has emerged recently and provides context for species interactions with all components of the environment. The aim of this objective will be to focus on mechanisms that control and define communities in terms of interactions between biotic as well as between biotic and abiotic components. Understanding how the different components of communities interact with each other on defined spatial and temporal scales is important also when it comes to identifying unnatural threats and understanding how these affect such communities.

Composition, Structure and Pattern Objective

Taxa Listings Objective

To maintain comprehensive and correct taxa lists of all biota which occur in the KNP (including alien and red data species, parasites, microbes and pathogens). [These are essential in confirming identifications, biodiversity research, preparation of inventories, etc].

To compile taxa lists which are standardised, revised and updated on a continuous basis according to recognised principles and procedures. * Lists should be compiled by the Curator: Biological Reference Collection or the appropriate counterpart in Veterinary Wildlife Services or other disciplines, to ensure standardisation and taxonomic correctness.

- To ensure that all taxa lists are verified by specialists.
  * This can only be done with specimens.
- To annually or bi-annually supplement taxa lists with new annotated records.
- To ensure that official taxa lists are based on collected and annotated specimens (KNP) which are housed in the Skukuza Biological Reference Collection or other museums/collections. In the case of birds and small mammals where not all specimens are housed in the collection but where sightings have been confirmed by specialists, the taxa names will be added to the lists.

  * Ensure that the Biological Reference Museum has a list of all specimens housed in other museums with their accession numbers.
- To make a concerted effort, as far as is practically possible, to compile comprehensive invertebrate taxa lists. *Due to the fact that not all the specimens are housed in the collection, literature records need to be consulted and presence needs to be confirmed with collections in other museums or relevant institutions.
- To make a concerted effort, as far as is practically possible, to compile taxa lists of the lower taxa e.g. fungi, protozoa, etc. xref: micro-organisms

To evaluate the spatial and temporal data in order to assess current species distributions.

- To collate all distribution records into a GIS database in order to create distribution maps.
- To analyse distribution maps in order to identify gaps in areas where collection has not taken place, or has been poorly collected.
- To sample or facilitate sampling, as far as is practically possible, for specimens in identified spatial and temporal gaps.
- To initiate museum searches for literature-referenced records related to the KNP.
- To interlink with and cross-reference other institutes and organisations with reference to micro-organisms, pathogens, etc (e.g. Department of Animal Health).

Community Listings Objective

To prepare an inventory of important or relevant animal, plant, disease and parasite communities at different spatial and temporal scales; understand interactions between and/or within the communities and identify any unnatural threats affecting the communities, and respond if necessary.

- To identify, classify and describe the relevant communities.
  - To develop a system of identifying when we need this type of work to be done.
- To understand the mechanisms that control the interactions between species, and define the communities.
- To ensure the integrity of communities and the relationships of species making up communities.

Taxa Listings Objective

Looking forward

Taxa lists of vertebrate species and flora are relatively complete, and at this stage it is essential that more time be spent on the compilation of the invertebrate taxa lists. The lower taxa lists i.e protozoa etc. are lists which we eventually aim for but which are not a priority at this stage. Currently the distribution databases are receiving attention for the flora, vertebrate and some of the invertebrate taxa however distribution maps still need to be generated from the databases. From these maps the spatial and temporal gaps will be identified thus aiding in identifying areas where collection needs to be done. The exception would be identified priority or notifiable pathogens and their vectors.

Community Listings Objective

Looking forward

Most of the classifications produced so far are indicative of the broad-scale pattern of vegetation, climate and geomorphology. Understanding the underlying processes that maintain and control these broad-scale patches is something we need to focus on more intensely. However, by promoting more patch dynamic studies aimed at very fine spatial scales, one could get a clearer understanding of such dynamics at coarser scales. For this purpose, the scientific exclosures lend themselves ideally to investigating the interactive processes not only on the savanna-river boundary but also between other topographical units.

Biogeochemical processes include soil-water-plant-animal interactions that can be investigated at various depths, scales and sites, depending on the objectives of such studies. This would obviously link up with other relevant objectives listed and described elsewhere. This has specific relevance to non-infectious diseases related to nutritional, toxins and other abiotic factors at various scales of community and landscape.

Genetic Documentation Objective

To gain a broad understanding of the genetic diversity within the KNP and to develop guidelines governing it's potential use and/or exploitation.

Preamble

This is a new objective for the KNP and expresses the increasing awareness and understanding for genetic issues and the growing national and international pressure for sustainable utilisation, bioprospecting and associated intellectual property issues. We have tried to articulate this growing realisation and need, not only for the KNP but for SANParks as a whole.

Autecology of Selected Species/Taxa Objective

To determine the autecology of certain keystone, threatened and 'sustainable use' taxa.

Preamble

For widely varying reasons, the status of a number of plant and animal organisms is giving rise to varying levels of concern. Essentially, these organisms can be allocated to one (or all) of three groups: (1) threatened or locally rare biota (Red Data List, 'Kruger Red, Amber and Grey' taxa); (2) impacted and declining biota (impacted by animals and fire, or by human activities). The latter group includes 'keystone species' and biota that are perceived to be or are actually declining, either as a result of utilization by herbivores (especially elephant) and/or fire (at the juvenile or sub-adult level), or as a result of competition for food, exacerbated by sub-optimal rainfall cycles; and (3) 'human value' organisms - those organisms which have medicinal or other potential value for human use, predominantly plants.

It is important to obtain bio-ecological information on these organisms so that the trends in their populations and threats can be determined. In the case of 'human value' plants, it would be prudent to have information on their status, distribution, abundance and harvestable quantities so that a potentially very difficult situation can be pre-empted if and when requests for such material are received. As a first step however, lists of the taxa in the various groups will have to be compiled or reviewed in the case of existing lists. Thus far, only a very small percentage of these organisms have received any autecological attention.

Composition, Structure and Pattern Objective

Genetic Documentation Objective

To gain a broad understanding of the genetic diversity within the KNP and to develop guidelines governing it's potential use and/or exploitation with reference to the Biodiversity and other relevant Acts.

- To develop policy guidelines governing the research and potential exploitation of the KNP's genetic diversity (including commercialisation) xref: intellectual property, indigenous knowledge, veterinary research
- To, where appropriate, collaborate with recognised and respected bioprospecting institutions, e.g. CSIR. [This in recognition of their professionalism and insights, but to be governed by MOUs].
  - To compare genetic footprints of wild plants with propagation material and/or material used by traditional healers.
- To link with, and where appropriate, influence controlling organisations (provincial, national, etc.) who give authorisation for propagation of wild materials. Cognisance should also be taken of potential problems associated with hybridisation.
- To, where appropriate, engage in and/or support projects aimed at protecting certain KNP gene-pools (through breeding and other means, including through establishment of a genetic bank) e.g. buffalo breeding project. xref: game capture (biobanking), extinction, threatened biota
- To support projects aimed at understanding or documenting the genetic diversity in the KNP biota.
- To gain insights into the genetic distinctiveness and phylogenetic relationships of internationally recognised rare and endangered species, or species endemic to the KNP and/or lowveld region (e.g. golden mole project). This is not confined to animal species. xref: threatened biota

Autecology of Selected Species/Taxa Objective

To determine the autecology of certain keystone, threatened and 'sustainable use' taxa.

- To determine the 'keystone', 'threatened' and 'sustainable use' plant and animal taxa of the KNP and to develop a procedure for prioritizing these taxa in terms of the urgency for further research attention. xref: threatened biota
- To undertake autecological studies of high priority taxa in order to determine their population dynamics and threats.
- Based on research results and surveys, to where necessary, develop appropriate monitoring programmes for the most 'important' of these taxa.
- T conduct baseline monitoring over time of genetic change of selected important pathogens (especially BTB, F&MD, brucellosis, theileriosis).
- To establish genetic equivalence (or non-equivalence) of new geographic foci of selected important pathogens (especially BTB, F&MD, brucellosis, theileriosis, avian influenza).

Genetic Documentation Objective

Looking forward

The importance of some of the issues highlighted here will no doubt receive increasing attention over the next 5 years. However, serious thought and effort will need to be put into the development of policy guidelines as a first step. Already we are faced with increasing requests for bioprospecting and possible commercialisation “surveys” and these need to be evaluated in an appropriate and informed SANParks policy context as a matter of urgency. The genetic monitoring of pathogens is required for the understanding of selected important diseases inside and outside of KNP.

Autecology of Selected Species/Taxa Objective

Looking forward

This objective links tightly with the threatened biota and extinction objectives. It should be noted that we recognise the need for such single-species studies, but only within a broader framework as outlined there. Similarly, species-specific monitoring programmes should try to meet multiple goals wherever possible.

Aggregate Descriptions Objective

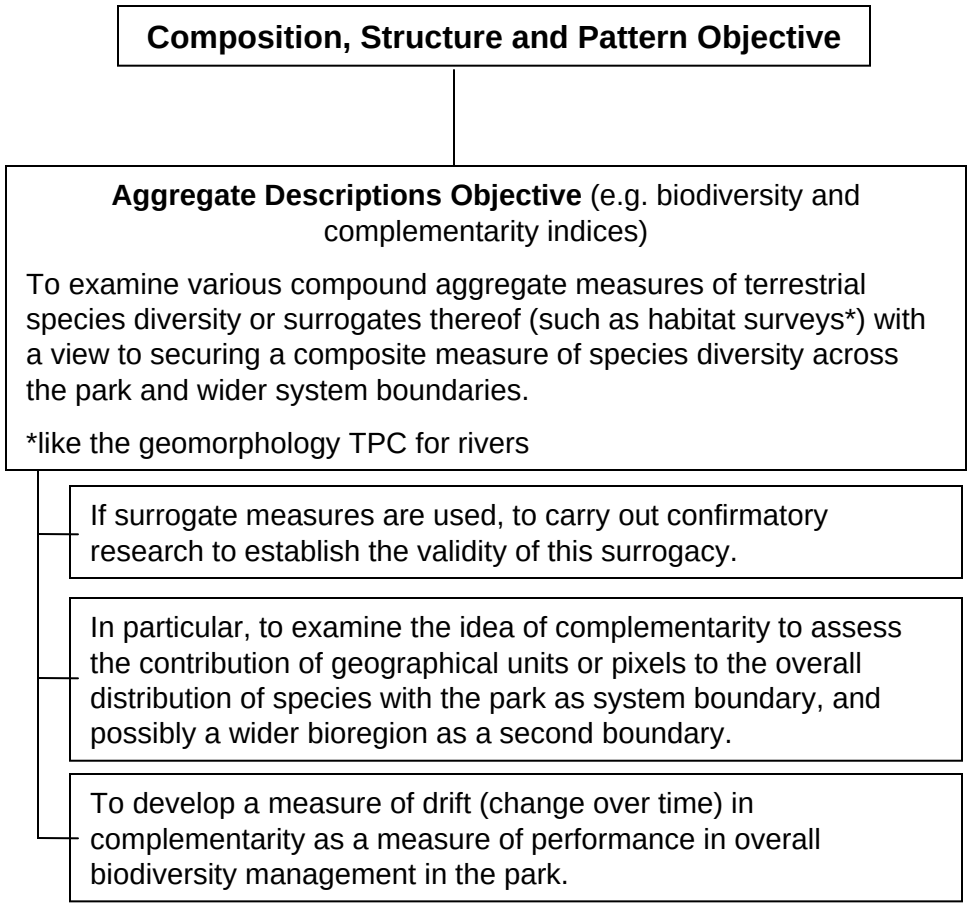
(e.g. biodiversity and complementarity indices)

To examine various compound aggregate measures of terrestrial species diversity or surrogates thereof (such as habitat surveys*) with a view to securing a composite measure of species diversity across the park and wider system boundaries.

*like the geomorphology TPC for rivers

Preamble

This new objective highlights the wider systems approach in Kruger and our need for monitoring overall system change through the use of potential surrogates. Great progress has been made with such measures in the riverine world, but the terrestrial system still requires attention, evaluation and testing.


Composition, Structure and Pattern Objective
Aggregate Descriptions Objective (e.g. biodiversity and complementarity indices)
To examine various compound aggregate measures of terrestrial species diversity or surrogates thereof (such as habitat surveys*) with a view to securing a composite measure of species diversity across the park and wider system boundaries.
*like the geomorphology TPC for rivers
If surrogate measures are used, to carry out confirmatory research to establish the validity of this surrogacy.
In particular, to examine the idea of complementarity to assess the contribution of geographical units or pixels to the overall distribution of species with the park as system boundary, and possibly a wider bioregion as a second boundary.
To develop a measure of drift (change over time) in complementarity as a measure of performance in overall biodiversity management in the park.

Aggregate Descriptions Objective

(e.g. biodiversity and complementarity indices)

Looking forward

Work has already begun on testing a complementarity approach to assessing biodiversity system changes over time and this will surely lay the foundation for such work in future. This objective will likely receive some attention in future, particularly as we search for ways of evaluating overall biodiversity management.

Alien Impact Objective

To anticipate, prevent entry and where feasible and/or necessary control invasive alien species in an effort to minimize the impact on, and maintain the integrity of indigenous* biodiversity.

*Indigenous: notion or understanding of indigenous to be developed in the regional KNP context

Note: Alien Impact Objectives include all alien organisms and diseases (plants, diseases, fish, birds, insects, etc.)

Preamble

The incorporation of the 'Alien Biota Objectives' into the 1997 objectives hierarchy was the first high level recognition of the seriousness of invasive alien species in the KNP. This was a milestone in the KNP management's history and a critical step to ensuring future developments on the invasive alien species front. In addition, invasive species issues have been embraced by management due to the fact that invasive species were streamlined into overall KNP management in such a way that demanded attention rather than being considered a sideline issue.

Although stated as "alien biota" objectives in 1997, they were largely interpreted as being alien plant orientated. This has been taken a step further in the current objectives which incorporate all forms of biological invasions. The 1997 objectives were quite far thinking in that they embodied, before widely discussed and appreciated, the wide range of issues necessary in a comprehensive invasive species plan (such as found in the Global Invasive Species Programme book: A toolkit of best prevention and management practices). The current objectives strive to evaluate the 1997 objectives and couple those with emerging strategies to provide a more holistic and complete approach to invasive species management.

The emergence of the basic philosophy that invasive species are undesirable in a national park has filtered through most of the KNP, even to non-conservation orientated persons. This has assisted management in control in a number of developed areas (notably residences such as Skukuza). Acknowledgement of the fact that invasive species are a part of the system and will remain so has also been accepted and allowed efforts, in certain areas, to concentrate on the most damaging species only, not taking a broad and costly approach at attempting to control everything. This is recognised in the change of a higher level objective from "eradication" to "control", and acknowledges both long-term maintenance and rapid response control.

In the 1997 objectives, the "eradication", "prohibit/discourage" and "awareness" objectives were reasonably well engaged, with the "strategic" " perhaps a bit less and "research" objectives somewhat less well covered (until recently however where much energy has been placed on this), and little done on the "prevention" objective.

Alien Impact Objective

To anticipate, prevent entry and where feasible and/or necessary control invasive alien species in an effort to minimize the impact on, and maintain the integrity of indigenous* biodiversity.

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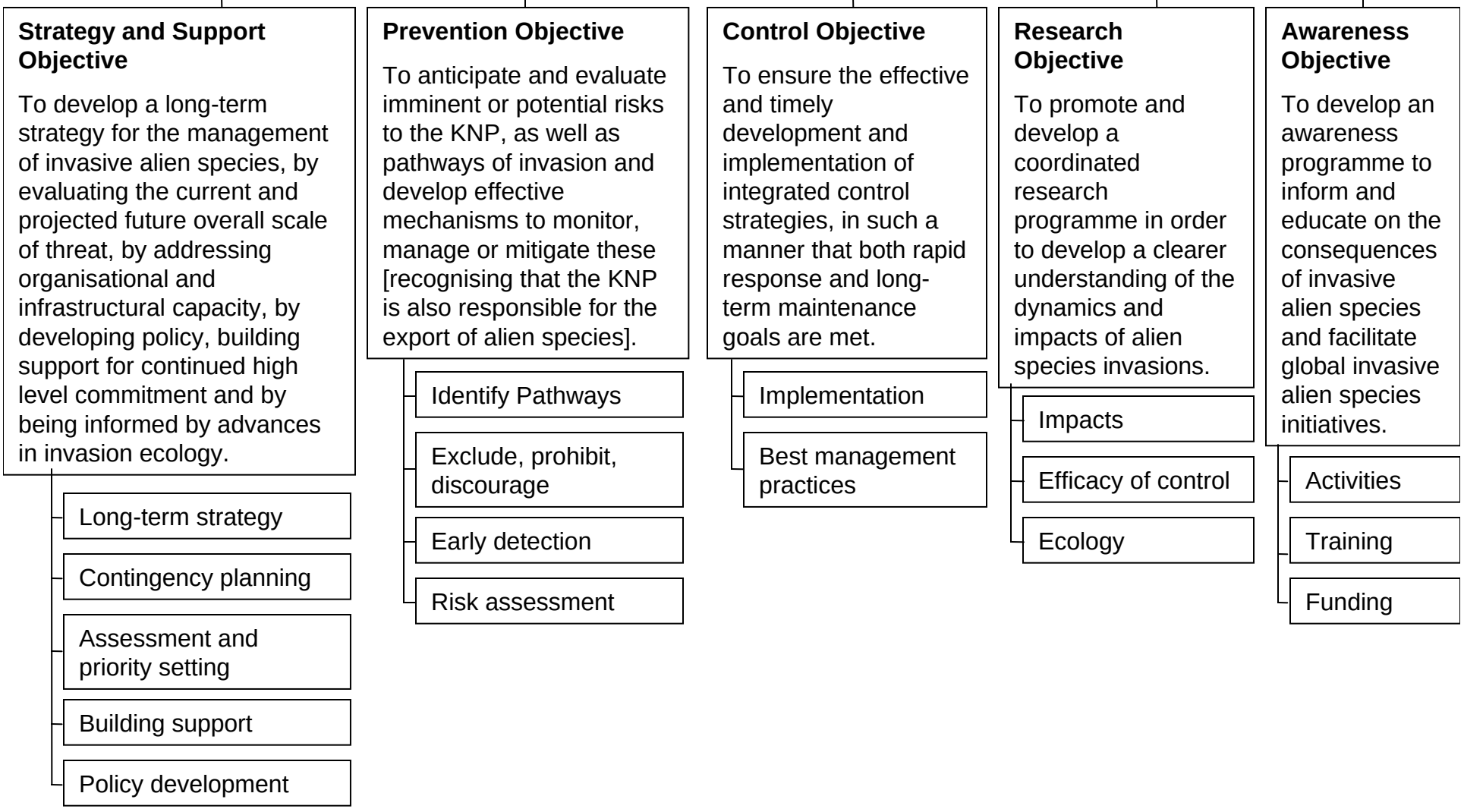
Note: Alien Impact Objectives include all alien organisms and diseases (plants, diseases, fish, birds, insects etc.)



Alien Impact Objective

Strategy and Support Objective

To develop a long-term strategy for the management of invasive alien species, by evaluating the current and projected future overall scale of threat, by addressing organisational and infrastructural capacity, by developing policy, building support for continued high level commitment and by being informed by advances in invasion ecology.

Long-term Strategy

To develop, in consultation with other regional initiatives, a comprehensive long-term strategy to direct future work and funding requirements.

To develop, based on the overall long-term strategy, short- and medium-term strategies and annual plans of operation.

To develop long-term strategies, awareness and communication programmes for diseases, especially those with no attention to date.

Contingency Planning

To develop contingency plans in order to address problems in the short-term and allow for maximizing long-term management responses and resources.

* In the past disease management was undertaken by Dept of Agriculture, but this role needs to be taken up more by SANParks in future.

To acquire funding to support implementation of contingency plans at short notice.

Assessment and Priority Setting

To assess and rank the risk probabilities of alien species currently outside the KNP boundaries invading the KNP.

To develop a risk assessment protocol and implement screening of species risk profiles. In terms of diseases, liaise with State Vet Services, but also develop capacity within SANParks to do this.

Building Support

To develop a support network at national and local scales, including government and private institutions, to further awareness of the problems associated with invasive species and the aims of management in the KNP and surrounding areas.

Institutions

To develop and maintain a network of specialist researchers from a range of institutions to provide advice and input into research and management issues.

National and provincial government

To develop and/or maintain ties with government to support invasive alien species issues inside and outside the KNP.

Awareness committees

To develop appropriate awareness at all levels, including at scientific and general public levels.

Scientific advisory groups

To develop, where necessary, groups of specialists to provide advice and support for KNP initiatives e.g. BTB; IAPs.

General awareness committees

To ensure better coordination of existing fragmented groups and various disciplines relating to invasive species, and identify and appropriately address specific target groups.

Policy Development

To develop a policy framework to guide management of invasive species and diseases.

xref: global climate change

xref: legal and statutory

Alien Impact Objective

Prevention Objective

To anticipate and evaluate imminent or potential risks to the KNP, as well as pathways of invasion and develop effective mechanisms to monitor, manage or mitigate these [recognising that the KNP is also responsible for the export of alien species].

Identify pathways

To identify those pathways that may lead to harmful invasions of animals, plants or their pathogens, and set up effective measures to manage the risk associated with these.

Exclude, Prohibit, Discourage

To, where possible and/or feasible, prevent the entry of new potential alien invasive species into the KNP, or exit of these organisms from the KNP.

- To utilise existing (e.g. State Veterinary Services) or develop effective entry/exit permit systems.
- To, wherever possible, prevent the entry (and exit) of new alien species into the KNP and manage these appropriately.
- To prohibit the use of alien plant and animal species and discourage the use of such species in adjacent land uses or in the KNP in favour of indigenous species.
- To influence national legislation and policy in the development of preventative measures.

Early Detection

To detect through regular surveillance, monitoring and other means, non-indigenous species, to assess their risk and react appropriately.

Risk Assessment

To assess and rank the risks of invasive species already present in the KNP, or liaise with other institutions in order to prioritise them for management, where this is possible.

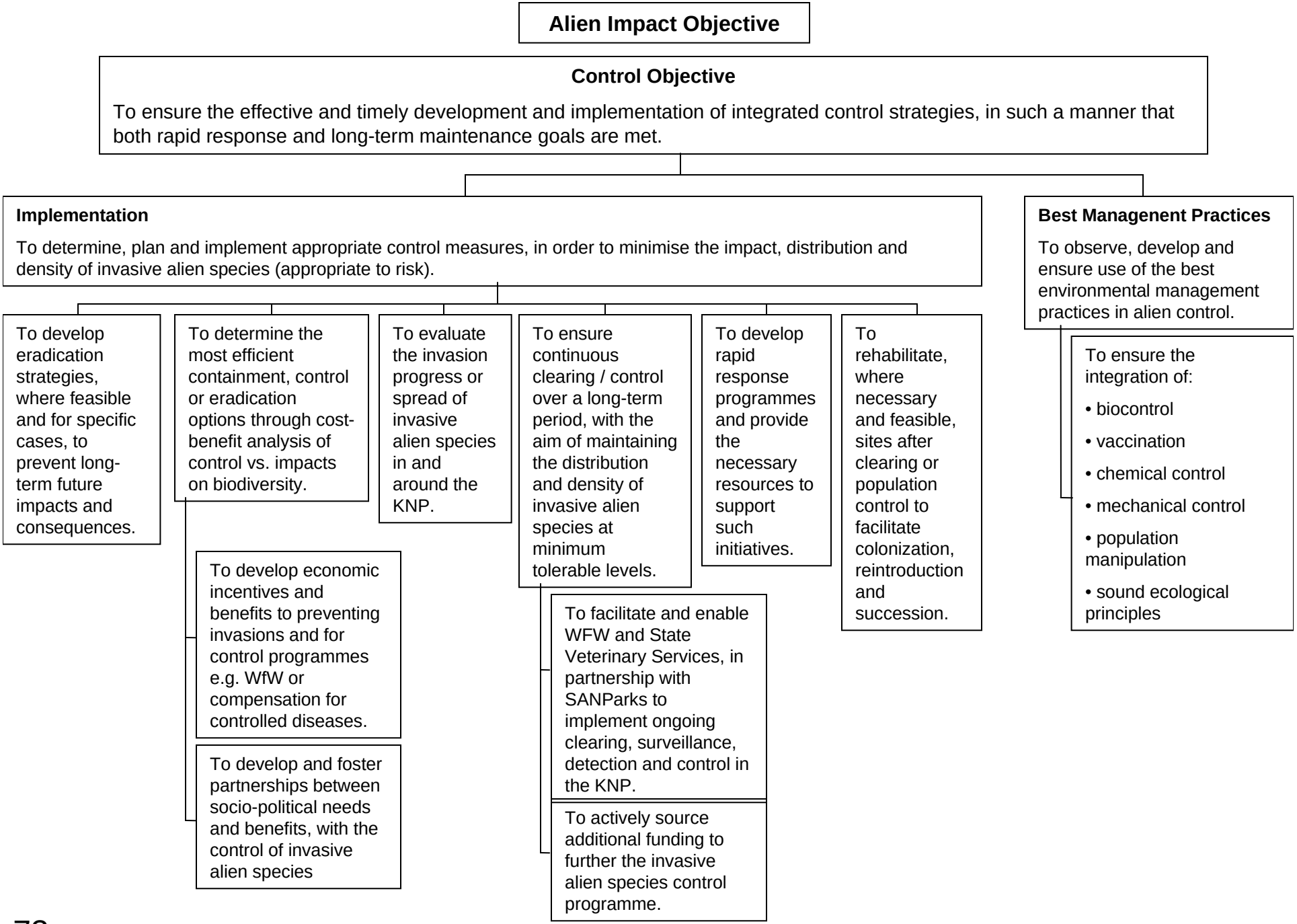
[This still needs to be unpacked for disease.]

xref: legal & statutory

xref: rapid response and contingency planning

xref: spp allowed- e.g. certain lawn species

xref: water use in KNP- should be a move back to indigenous natural gardens in camps, not water intensive lawns and flower beds


Alien Impact Objective
Control Objective
To ensure the effective and timely development and implementation of integrated control strategies, in such a manner that both rapid response and long-term maintenance goals are met.
Implementation
To determine, plan and implement appropriate control measures, in order to minimise the impact, distribution and density of invasive alien species (appropriate to risk).
Best Managenent Practices
To observe, develop and ensure use of the best environmental management practices in alien control.
To develop eradication strategies, where feasible and for specific cases, to prevent long-term future impacts and consequences.
To determine the most efficient containment, control or eradication options through cost-benefit analysis of control vs. impacts on biodiversity.
To evaluate the invasion progress or spread of invasive alien species in and around the KNP.
To ensure continuous clearing / control over a long-term period, with the aim of maintaining the distribution and density of invasive alien species at minimum tolerable levels.
To develop rapid response programmes and provide the necessary resources to support such initiatives.
To rehabilitate, where necessary and feasible, sites after clearing or population control to facilitate colonization, reintroduction and succession.
To ensure the integration of:
• biocontrol
• vaccination
• chemical control
• mechanical control
• population manipulation
• sound ecological principles
To develop economic incentives and benefits to preventing invasions and for control programmes e.g. WfW or compensation for controlled diseases.
To develop and foster partnerships between socio-political needs and benefits, with the control of invasive alien species
To facilitate and enable WFW and State Veterinary Services, in partnership with SANParks to implement ongoing clearing, surveillance, detection and control in the KNP.
To actively source additional funding to further the invasive alien species control programme.

Alien Impact Objective

Research Objective

To promote and develop a coordinated research programme in order to develop a clearer understanding of the dynamics and impacts of alien species invasions.

Impacts
To determine the impact of all invasive alien species in the KNP in terms of biodiversity: structure, composition and function.

- To evaluate the long-term impacts of invasive alien species.
- To evaluate the impact of knock-on effects of undesirable impacts of invasive species.
  - To determine the effect of changing species composition on higher trophic levels (including those species not directly linked to the alien organism).
- To evaluate the impacts of invasive alien species on ecosystem services.
- To determine the impacts of invasive alien species on specific threatened or valuable species and quantify the extent where required. xref: threatened biota
- To determine the impacts of invasive species on biodiversity structure, function and composition e.g. fish, insects, birds, mammals.
- To predict likely increases of invasive species (density and distribution) and their impacts through predictive modeling under varying scenarios such as global climate change, nutrient availability, etc. xref: atmospheric, nutrient cycling

Ecology
To promote an understanding and predictive capacity of the dynamics of invasive alien species and integrate short-term practical and strategic long-term research.

Invasion dynamics
To develop an understanding of the dynamics of alien invasions.

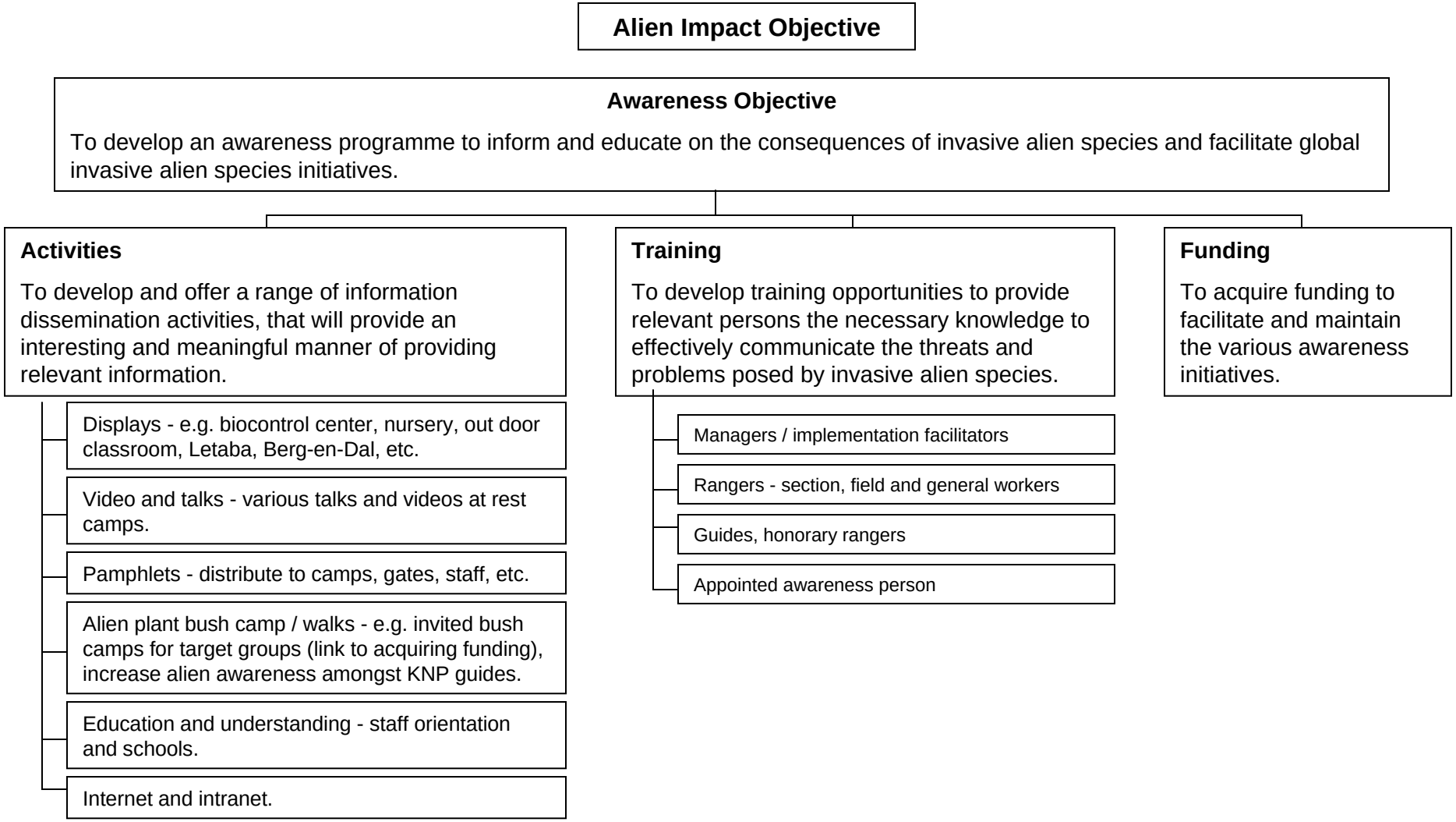
- To investigate patterns, processes and rates of invasion in the KNP.
- To develop an understanding of large infrequent disturbances (e.g. floods, droughts, etc.) and their impacts on invasive alien species and ecosystem recovery.
- To develop an understanding of modified disturbance regimes, and the impacts thereof on invasive alien species dynamics.
- To develop an understanding of dispersal and transmission.
- To develop and carry out risk analysis.

Autecology and disease epidemiology
To develop knowledge on specific species, invasion capabilities, and ultimately how to better manage them.

- To develop an understanding of reproduction, transmission and dispersal.
- To investigate competition (and allelopathy in the case of plants) and the interactions between invasive and indigenous species.
- To investigate changes in food web dynamics and the potential consequences thereof for ecosystem functioning.
- To investigate and quantify alien plant seed banks and seed dormancy.
- To evaluate and quantify age / time to seed production.
- To evaluate and quantify alien plant growth rates.
- To understand disease epidemiology of high priority exotic diseases.

Efficacy of control
To enhance the implementation of control programmes through developing an understanding of the associated negative impacts of control and further developing techniques for improved control and rehabilitation.

- To evaluate and quantify the potential impacts of control on non-target (indigenous) species.
- To evaluate and quantify the efficacy of control measures.
- To carry out cost/benefit analysis of control options.
- To evaluate and quantify the impacts / effects of control on specific areas under control and after control.
- To develop rehabilitation strategies and monitor these to determine the long-term efficacy thereof.
- To evaluate the establishment and success of new biological control agents following their release/use.
- To determine the impacts of biological control and quantify its contribution to integrated management over a range of time scales.
- To develop detection, diagnostic and vaccination strategies that are safe and effective.


Alien Impact Objective
Awareness Objective
To develop an awareness programme to inform and educate on the consequences of invasive alien species and facilitate global invasive alien species initiatives.
Activities
To develop and offer a range of information dissemination activities, that will provide an interesting and meaningful manner of providing relevant information.
Displays - e.g. biocontrol center, nursery, out door classroom, Letaba, Berg-en-Dal, etc.
Video and talks - various talks and videos at rest camps.
Pamphlets - distribute to camps, gates, staff, etc.
Alien plant bush camp / walks - e.g. invited bush camps for target groups (link to acquiring funding), increase alien awareness amongst KNP guides.
Education and understanding - staff orientation and schools.
Internet and intranet.
Training
To develop training opportunities to provide relevant persons the necessary knowledge to effectively communicate the threats and problems posed by invasive alien species.
Managers / implementation facilitators
Rangers - section, field and general workers
Guides, honorary rangers
Appointed awareness person
Funding
To acquire funding to facilitate and maintain the various awareness initiatives.

Alien Impact Objective

Looking forward

Although perhaps presented as a wide-ranging list of objectives, resembling “remote aspirations”, if an overall invasive species plan is to be successful, the objectives will have to be engaged on all levels, incorporating all objectives. Priority ratings will be a moving target for the various categories of invasive aliens and the shift of priority will be triggered by the monitoring mechanisms put in place and will follow the process described.

The “control” objectives are relatively well developed for invasive plant species and should not require as much energy to develop further. However, much needs to be done here on other invasive species. With reference to alien diseases BTB has been identified as the invasive alien organism requiring priority attention. BTB is an example of a priority alien organism that does not have practical control tools developed yet and requires priority attention. “Strategy and support” is at varying levels of development and needs to be unified in its approach and across the various problems (e.g. invasive plants and diseases).

At present, much energy is being placed on research across all fronts, although the balance of funding and resource allocation has not been adequately distributed to the different types of priority invasive species. **A high priority for research over the next five years is to develop an understanding of mechanisms and the impacts of biological invasions in the KNP context, with an explicit link to monitoring objectives.**

Development of the “prevention” objectives requires attention as this has been neglected almost completely to date (perhaps due to the complexity of the issue). There is also perhaps much disparity in this issue across fields (e.g. disease –state veterinary departments and red line corridors- compared to plants, where not much has been done).

The KNP must be viewed in the regional context, as an “island” approach will not achieve much success. The objectives will only be achieved if there is commitment and support from all involved in the KNP. Further, invasive species management will need to be strongly embodied within the adaptive management framework of the KNP if future learning and development is to take place.

Invasive species management in the KNP is widely recognised and efforts should be made to maintain and improve that status, due to the important position of the KNP as a public icon and role model.

Threatened Biota Objective

To prevent extinction within the Kruger Park of any species on the IUCN's global critically endangered or endangered lists[1], and to work with other conservation initiatives to secure and strengthen the future of such species over their historic distribution ranges. To put in place appropriate monitoring and conservation efforts of other threatened[2] species or lower taxonomic division[3], including considering recommendations of experts of invertebrate taxa for which no formal red-listing has been done, according to a realistic framework. Except in crucial instances for the survival of globally critically endangered species, management for system integrity and biodiversity must take precedence over species management.

[1] Until such time as the plants have been assigned the latest IUCN criteria they will be evaluated on the old system; [2] Threatened includes critically endangered, endangered and vulnerable according to IUCN classification; [3] Includes sub-species, variant or population

Preamble

As a member of IUCN, SANParks has a commitment to supporting the IUCN Species Survival Commission in its endeavours to prevent species extinctions due to anthropogenic causes. Although the maintenance of biodiversity in all its facets and fluxes is the prime ecological objective in Kruger, allocation of time and resources for species conservation is permissible. It is imperative that a realistic framework of threat for the various biota is established, in order to allocate resources sensibly and according to priorities.To this end threatened biota need to be classified into red, candidate amber, amber and grey species according to fixed criteria, or where these are unknown on the advice of experts. This has been achieved for mammals and birds and to a greater or lesser degree for plants, reptiles and amphibia. Only two red mammal species (black rhino and wild dog) are known to occur in Kruger and adequate research and monitoring programs and TPCs have been established for these. Some of the amber and grey mammals and birds are/have received greater or lesser amounts of attention, but decisions on monitoring and research on these and other biota need to be finalised.

Threatened Biota Objective

To prevent extinction within the Kruger Park of any species on the IUCN's global critically endangered or endangered lists[1], and to work with other conservation initiatives to secure and strengthen the future of such species over their historic distribution ranges. To put in place appropriate monitoring and conservation efforts of these and other threatened[2] species or lower taxonomic division[3], including considering recommendations of experts of invertebrate taxa for which no formal red-listing has been done, according to a realistic framework. Except in crucial instances for the survival of globally critically endangered species management for system integrity and biodiversity must take precedence over species management.

[1] Until such time as the plants have been assigned the latest IUCN criteria they will be evaluated on the old system; [2] Threatened includes critically endangered, endangered and vulnerable according to IUCN classification; [3] Includes sub-species, variant or population

To better understand rarity and low density occurrence (use Ladd-type frameworks).

To assign relevant species or lower taxonomic divisions to a framework of threat such that

- "red" are globally critically endangered or endangered species ["double red" are those red species restricted in distribution to the KNP],
- "candidate amber" are globally vulnerable species, or regionally critically endangered or endangered species (or lower taxonomic division) or species which seem to be 'obviously declining' in KNP, and
- "amber" are those candidate amber species which 'pass' the cut-off in the criteria of importance rating system (see below),
- "grey" are regionally vulnerable species or lower taxonomic division, but globally not threatened and candidate amber species that 'fail' the cut-off in the criteria of importance rating system.

Consider the inclusion of other taxa not formally red-listed on recommendations of experts.

To apply criteria of importance to species to help prioritise which ones to monitor or apply conservation actions to (see postview).

To conduct relevant autecological studies on red and relevant amber species in order to establish and monitor TPCs and, if necessary, to conduct Population Viability Assessments. Look towards practical ways of keeping track of other amber and grey species. xref: autecology

To assist, where possible, in assessing the status of data-deficient biota in the KNP as a contribution to evaluating the global or regional status of the biota.

To evaluate the suitability of the KNP as a priority area for the conservation of specific rare biota in comparison with other areas, including the possible impact of global climate change. xref: atmospheric

Threatened Biota Objective

Looking forward

The issues surrounding the establishment of a framework of threat for biota other than birds and mammals need to be addressed and research and monitoring programs for identified species of all biota need to be implemented.

Proposed criteria of importance for choosing which species to monitor or conserve:

1. Framework of threat: red, amber, grey
2. Role in KNP ecosystem: driver, keystone species, indicator
3. Distribution: KNP endemic, regional endemic, widespread
4. Suitability of KNP as a refuge for the species: in centre of distribution range, marginal
5. Sensitivity to illegal harvesting
6. Tourism value
7. Suitability of KNP for conserving the species in relation to other protected areas
8. Taxonomic distinctiveness
9. Financial feasibility
10. Chance of success
11. Nature of threat: is the threat reversible?