RESEARCH NEEDS OF THE SOUTH WEST SUB REGION OF THE WEST REGION

DEVELOPED BY S. G. MCKEAN
(REGIONAL ECOLOGIST SOUTH WEST)
(LAST UPDATED DECEMBER 2016)

PURPOSE

The purpose of this document is to list research needs for the achievement of Ezemvelo KwaZulu-Natal Wildlife's (Ezemvelo) objectives in the South West region (incorporating the Harry Gwala and Umngungundlovu district municipalities) and key protected areas such as Ntsikeni Nature Reserve, Impendle Nature Reserve, Karkloof and several other small but very important areas (19 Protected Areas) (Fig. 1). This excludes the uKhahlamba Drakensberg Park which is catered for separately. This area also includes a significant number of newly proclaimed Nature Reserves and Protected Environments proclaimed under the KZN Biodiversity Stewardship Programme (KZNBSP) (Fig. 1). This list will assist in focussing attention and limited funds on priority needs/knowledge gaps, and will also be made available to tertiary institutions for distribution to students looking to undertake applied research. This document is a "living document" - changes and additions are made from time to time.

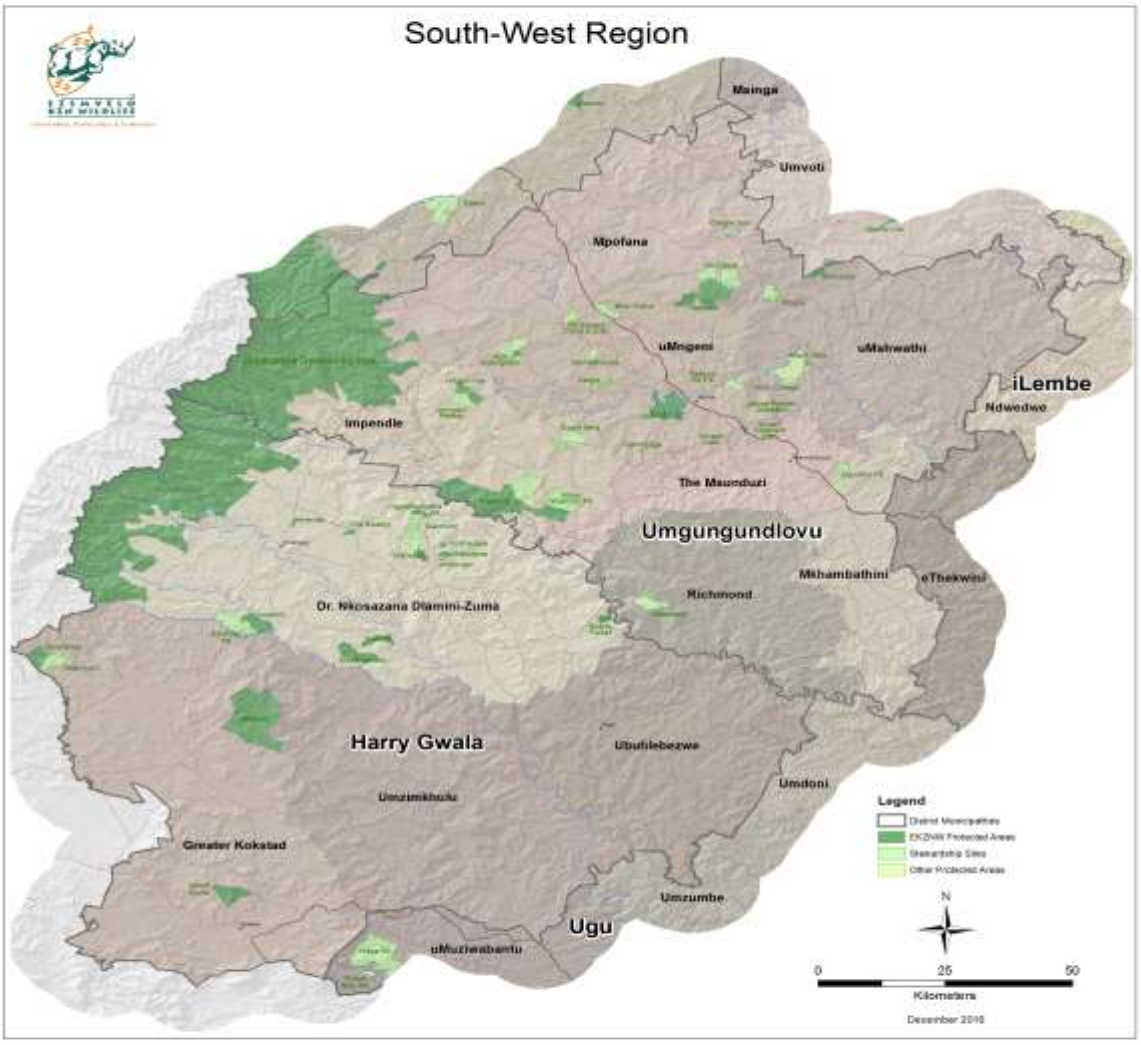

Figure 1. Map of South West management region (Harry Gwala and Umngungundlovu district municipalities showing Protected Areas.

PROCESS

This document was compiled by consulting various individuals with research experience in what is predominantly a grassland and forest dominated area, and previous research needs

documents, management plans and published papers to identify areas requiring additional research[1].

RESEARCH NEEDS

Research needs have been grouped into *Focus Areas* for ease of navigation. However, some research topics clearly span more than one focus area in which case they have been allocated to the main/dominant area. Research needs have not been prioritised.

FOCUS AREA SUMMARY:

Focus Area 1: Biodiversity planning
Focus Area 2: Investigating threats to biodiversity
Focus Area 3: Managing natural resource use
Focus Area 4: Management effectiveness
Focus Area 5: Understanding natural processes
Focus Area 6: Ecotourism
Focus Area 7: Ecosystem services
Focus Area 8: Cultural heritage
Focus Area 9: Social ecology
Focus Area 10: Climate change and adaptation
Focus Area 11: Biophysical inventory and mapping

Focus Area 1: Biodiversity planning

Research needs

1. District Management Plans.

   Develop on the basis of the KZN Biodiversity Conservation Assessment and integrate these into the Integrated Development Plans of the 2 District Municipalities of the region.

2. Species distribution modelling.

   Model the distribution of priority species in the region, such as Oribi, Blue Swallow, Wattled Crane, priority medicinal plants based on available knowledge of habitat requirements.

Focus Area 2: Investigating threats to biodiversity

Rationale

[1] The documents that have been consulted include the Integrated Management Plans, Concept Development Plans, Fire Management Plans, Biodiversity Management Plans.

To address and manage the ever changing and increasing suite of threats to biodiversity, knowledge on the nature and extent of the threats is needed. This Focus Area aims to obtain the required knowledge to better manage threats specific to biodiversity in this region.

Research needs

1. Accelerated soil loss

- Monitor the extent of soil loss through erosion.

2. Alien species invasions

- Quantify the impacts of different densities of invasion by both indigenous (e.g. bracken and bush encroachment) and exotic (e.g. *Rubus cuneifolius*) species on various components of biodiversity (particularly the forbs and invertebrates).

    - Determine the extent of the threat posed by various alien invasive species to the biodiversity and water quality of fresh water ecosystems in KZN.
    - Determine how fire might be integrated into alien plant control (*e.g.* bramble, Curries Post weed)?
    - Determine the effectiveness of fire as a tool for alien plant eradication by assessing the effect of fire versus other clearing methods on various alien plant species.
    - Investigate the impact of shading from alien tree plantations on grassland and associated biodiversity neighbouring the plantations.
    - Determine the effect of alien invasive plants on invertebrate diversity and distribution.

      Determine i) how bramble surrounding the lower edges of forests influences invertebrates that depend on forest edge habitats for breeding, foraging and ii) how alien invasive plants alter fire behaviour and what the consequences are for (especially forest) invertebrates?

3. Disease

- Quantify the extent of Chytridiomycosis infection in frog populations in the protected areas of the South West, particularly the important wetland areas like Ntsikeni, Umgeni Vlei.

4. Pollution.

5. Modification of natural processes.

- Investigate the impacts of illegal dog hunting on Oribi populations.

Focus Area 3: Managing natural resource use

Rationale

Modern thinking around biodiversity and protected area management permits, and even encourages, sustainable utilisation of natural resources. A good knowledge of the natural history, abundance and ecological processes is required to make informed decisions about sustainable resource use. To plan and manage resource use it is necessary to understand and predict demand, and to know enough about the relevant use and belief systems. There is increasing emphasis on co-management of natural resources, including sustainable use of natural resources, but for this to be a reality it is necessary to be able to predict the impacts of harvest regimes and to be able to quantify quotas/harvest rates. A neglected aspect of resource use is understanding the potential indirect or linked impacts associated with the use on one species - so while it may be possible to define the sustainable harvest rates of a single species, the associated impacts on other components of biodiversity are poorly understood. Natural resource managers require explicit advice on harvestable species, harvest quantities and demographic classes, harvest methods, as well as a measure of certainty around the sustainability of any such harvest.

There is still much work to do in the policy and strategy arena, especially reconciling traditional belief and use systems with modern realities of human population increase and resource scarcity.

Resource economics is emerging as a critical field in conservation – it is increasingly important to be able to demonstrate the values of protected areas and natural areas outside of formal protected areas to society and the economy. This includes quantifying the values of services provided to humanity (ecosystem services) which they require for livelihoods or for which they would otherwise have to pay (Focus Area 7).

Research needs

1. Sustainable harvest.
    - Determine sustainable off-takes of priority plants.
      Determine the distributions, densities and economic values of wild populations of priority species and the trends in their status. Determine the demand on the resource and what levels of use are likely to be ecologically as well as socially and economically sustainable in the long term.
    - Determine the sustainability of use of forest trees.
      Assess the presence, extent of use and distributions of priority utilised forest species and assess the impact of harvest on tree species and forest

structure. Determine the influence of different levels and methods of bark removal on bark regrowth rates in priority medicinal tree species.

2. Understand and predict the impacts of harvesting on biodiversity.

- Undertake surveys at markets to determine whether these provide sufficient information on demand and supply of priority species, both plant and animal.

Species level research on the autecology of priority species to allow better understanding of their resilience to harvest. Determine the recruitment rates and potential longevity (through carbon isotope analysis) of popular species of plants sought after for their traditional medicinal and other value (e.g. *Eucomus* spp., *Merwilla* spp. and *Ocotea bullata*).

3. Socio-economics of resource use.

- Determine whether market trends can be used as indicators of sustainable medicinal plant and animal use.
- Determine what the socio-economic factors are that influence sustainability of use of plant and animal species.

The socio-economic factors that influence sustainable use need to be determined to implement appropriate strategies to address the over-use of priority species. Projects include i) the monitoring of the medicinal plant and animal markets, ii) looking at the influence of land tenure and/or traditional resource use management methods on the ability and willingness of people/communities to use natural resources sustainably, iii) identifying what knowledge and/or management systems rural people have developed for sustainable use of resources and whether conservation management programmes can incorporate indigenous knowledge and vice versa?

4. Co-management and ownership models.

- Identify what resource management alternatives there are for meeting resource demand and simultaneously conserving biodiversity and investigate alternatives to use of wild plant and animal populations.
- Identify what knowledge and/or management systems rural people have developed for sustainable use of resources and determine whether conservation management programmes incorporate indigenous knowledge and *vice versa.*

Focus Area 4: Management Effectiveness

Rationale

Just because an area of land is set aside for conservation does not automatically mean that the biodiversity features there are conserved in perpetuity. It is necessary to measure and quantify the effectiveness of management activities in conserving biodiversity so that a realistic picture of gaps in the protected area network can be calculated.

Research needs

1. Improve status assessments and trends analyses.
   Assess Protected Areas' biological monitoring plans in terms of their effectiveness in providing information on population status and trends.
2. Develop biodiversity management plans / recovery plans.
   Develop management plans for priority threatened species and develop recovery plans for species with a negative population growth.
3. Understand the minimum requirements for the integrity of protected areas to be maintained.
   - Assess the impacts of fire management.
     Determine the magnitude of impact of the use of Gramoxone on tracer lines and the method of its application. Assess the impacts on grass species cover and diversity of firebreaks burnt in the same location annually.
     Compare the fire history of Protected Areas to the availability of resources to determine whether there is a link between, for example, the extent of arson fire and lack of funds or trained staff.
4. Co-management.
   - Determine the effectiveness of local boards.
     Determine whether the implementation of local boards and neighbour liaison committees is an effective management strategy in terms of increased awareness of, and support for, management objectives.

Investigate the outcomes of selected culling of damage causing animals and/or specific age/sex classes and whether the objectives of the removal have been achieved.

a. E.g. (1) Does shooting dominant male troop leading vervet monkeys, that are typically the first to invade homes, reduce the problem or does it release the sub-dominant males in the troop to procreate with the females, so increasing overall troop numbers and thereby the extent of the problem of home invasions?
b. E.g. (2) Does the shooting of bushpig in rural areas solve the problem of crop raiding or temporarily relieve the symptom with the original animal quickly being replaced by another from what is effectively an open system?
c. E.g. (3) Does the shooting of crop raiding bushpig encourage increased litter size as has been found to occur with jackal?

6. Determine the impacts of removals of different age and sex classes on the population structure and productivity of different species of game.

Focus Area 5: Understanding natural processes

Rationale

Biodiversity management requires making decisions in the absence of knowledge of all components of biodiversity. It is often necessary to make the assumption that if important natural processes are operating in their natural fluxes (frequency, amplitude and timing) then biodiversity, broadly, will be conserved. Where these processes have broken down, then attempts are made to reinstate or simulate these processes – so called Process-based Management. These same processes are those that have generated as well as maintained biodiversity, and will allow for ongoing evolution and adaptation.

Therefore it is important to understand what the key ecological processes are, quantify their magnitude and how they function, and to ascertain whether they are still operating effectively in a human-dominated landscape. Where processes are not functioning there can often be system-wide repercussions. Accordingly it is necessary to understand what has been the impact on the processes and whether it is possible to reinstate or simulate them.

The extent to which natural systems can be pushed (natural, management) before they switch to another state are generally poorly understood (concept of resilience, State and Transition models, domains of attraction). It is increasingly important to be able to build and parameterise conceptual and computer models of how systems function.

Research needs

1. Disturbance ecology.
    - Determine how the population biology of species of special concern responds to differences in fire regimes?

      Investigate the impacts of fire on threatened or endemic species to determine which fire regime the species is best suited to in terms of fire frequency, season of burn and intensity of fire.
    - Identify what structures/habitats are used as refugia by invertebrates and what factors influence the effectiveness of these refugia?

      Assess forest, grassland and aquatic communities to address the research need.

      Determine the impacts that the loss of large/old trees to ring-barking or general illegal harvesting (e.g. for building material, firewood or timber) have on species that depend on them for nesting (e.g. bats, Cape parrot).

2. Natural processes and dynamics.

Quantify the impacts of different forms and intensities of mammalian herbivory and their associated effects (e.g. defecation and trampling) on invertebrate assemblages.

- Grassland vegetation dynamics.

  Research grassland vegetation dynamics in response to multiple drivers, investigating the relative influence of the main drivers (climate, soils, radiation, fire, grazing, land use) on the stability and resilience of grassland, through study of long-term burning and grazing trials and fence line comparisons.

- Mammal population trends.

  Research mammals in response to multiple drivers, investigating possible determinants of population trends of the common large mammal species, based on previous studies and long-term monitoring.

- Fire impacts on erosion.

  Determine the relationship between post-fire erosion (by wind and water) and fire regime and setup formal experiments to measure direct rates of movement.

3. Restoration ecology.

- Determine the most effective method of rehabilitation/restoration of mid to high altitude mesic grasslands.

  Determine the most effective method of re-vegetating mid to high altitude grasslands, forests and wetlands particularly following alien plant removal and areas affected by erosion.

4. Fire ecology.

- Landscape-level fire behaviour.

  Research landscape-level fire behaviour by examining the main controls over landscape-level spatial and temporal patterns of fire in the mid to high altitude mesic grasslands, based on long-term records and the empirical investigation of landscape behaviour of fire.

- Computerised decision support tool:

  Develop a computerised decision support tool linked to GIS that will be included in the Fire Management plan for each protected area, to assist in the annual planning of burns. This rule-based tool must ensure that Park-wide and area-specific fire management objectives can be simultaneously achieved wherever possible, and must allow for flexibility in response to unplanned fires.

- Fire preclusion

Investigate the long-term impact of fire preclusion on transformation of grassland to woody vegetation.

- Determine how long various fire-tolerant grassland wild flower species (those wild flowers that survive fire by resprouting from underground organs) are able to remain dormant underground due to shading by moribund grass swards before they become locally extinct?
- Impacts of fire on forest

  Test the predictions generated by the Forest Biodiversity Research Unit regarding the impact of fire on forests in terms of expansion or contraction.
- Determine the effect of fire on re-colonization and re-establishment of invertebrate communities and how this differs for flying and flightless taxa?
- Determine the effects of fire (smoke) on cliff nesting birds during the breeding season.
- Determine the effects of different fire regimes on wetland plant diversity?
- Quantify the impacts of different frequencies, intensities, extents and seasons of fire on various invertebrate guilds (showing similar life-form and life-history characteristics) across environmental gradients (particularly rainfall and temperature).
- Determine how various plant life-form and life-history strategies influence their response to different frequencies, intensities and seasons of fire.
- Quantify the role of the various invertebrate herbivore guilds in the cycling of plant material in different habitats across environmental gradients (particularly rainfall and temperature).

5. Grazing
   - Determine the role of forest antelope and in particular bushbuck on forest gap dynamics as determined by their impacts on seedling and sapling communities and the availability of individuals to recruit into gaps.
   - Determine the impact of stocking ungulate species in different combinations and at different densities on the invertebrate and plant diversity of rangelands across environmental gradients.
   - Determine the impacts of the extra-limital introduction of mid-to-large herbivores on various components of biodiversity (particularly the forbs and invertebrates).

6. Rare / threatened species ecology

- Understand the intra African migration route/s and stop over points of Blue Swallow and threats faced by the birds at these points.

7. Other
    - Test the effectiveness of different seasons and intensities (number of cuts) of mowing with a brush cutter on the control of bracken stands.
    - Determine the risk posed by the uncontrolled introduction of genetic material of indigenous plants sourced from the horticultural trade that are planted in protected area resort and staff accommodation gardens and on surrounding privately owned properties to the genetic purity of native genetic strains.
    - Quantify the risks of maintaining small, genetically unviable, populations of game (particularly black wildebeest, red hartebeest, blesbok) in small protected areas in-terms-of the return realized from the population (i.t.o. reproductive success and physical quality of offspring) and the risk posed to the broader gene pool of the species concerned.
    - Identify pure strains of popular commercial crop cultivars of indigenous species for gene banking before the native genes are swamped by hybridised stock (e.g. *Chloris gayana*, *Cynodon dactylon*, *Digitaria eriantha* and *Eragrostis curvula*).
    - Establish genetically minimum viable population numbers for the species of native game in KZN and develop a strategy for translocating animals in support of evolutionary processes to overcome the problems associated with maintaining small populations as commonly occurs in the metropolitan municipalities.
    - Determine the role of caracal in the reported disappearance of blue duiker from midlands forests and the potential for further losses as caracal expand their range.
    - Determine the impact of rising vervet monkey numbers in suburban areas on the indigenous bird populations.

Focus Area 6: Ecotourism

Rationale

Tourism related activities are often flagged as beneficial to protected areas and indeed, required to ensure or contribute to economic viability of the area. There is limited information available on the potential impacts (positive and negative) of tourism related activity on the biodiversity of protected areas in the South West of KZN and even less on how tourism could possibly be made a viable option in many of these areas.

Research needs

1. Impacts of tourism activities on biodiversity.
    - Determine the impact of human activities on the nesting success of large raptors.

The extent to which recreational activities such as flying, hiking and mountain climbing close to vulture nest sites impacts on their nesting success requires investigation – particularly at Ntsikeni.

- Investigate the 'greening' of resorts.
  Establish the effectiveness of various mechanisms that would make resorts self sufficient or more efficient in energy and water use and in minimising the carbon footprint.

2. Economic and social value of nature-based tourism.
   - Assess the values of tourism activities in different protected areas to the local communities and the country as a whole.
   - Determine the intensity of trail usage in the protected areas of the region.
   - Determine the carbon footprint of the resorts in the region and investigate interventions required to achieve a carbon neutral status, including the use of energy- and water-efficient devices in all infrastructure and the generation of off-grid electricity.

Focus Area 7: Ecosystem services

Rationale

Protected areas are believed to provide many services to society, but these have not been quantified, and are hence not recognised. Greater appreciation of the values of protected areas would help secure political support and funding. There are also opportunities for conservation to be (partially) funded through trade in ecosystem services such as carbon sequestration and water production. In order to start capitalising on these opportunities requires baseline data on production/storage in relation to habitats, management activities, and across a range of land use types and intensities. The tradable portion of these services is the positive difference between the services generated from protected areas and those from other land uses.

Research needs

1. What ecosystem services are being provided and where on the landscape are they provided? Who and where are the beneficiaries of ES located for each PA? What is the economic value of these services?

Do Protected Areas contribute to improving water quality and quantity? If so, which PAs?
To what extent do Protected Areas contribute to C sinks?

1. Identify and quantify ecosystem services.
   - Determine the economic value of the provision of Ecosystem Services and its contribution to the local and regional economy.

- Identify and assess provision of ecosystem services from all protected areas and determine who benefits and where they are located. Valuing these services can follow on from this.
- Quantify and qualify water production and carbon storage and sequestration – particularly I key wetland areas such as Ntsikeni, Umgeni Vlei. Model water production and quality, carbon storage and sequestration under different management scenarios to assess feasibility of implementing a "payment for ecosystem services" for different areas. Produce water production management guidelines by including resource economics.
- Determine how C accumulation in soil differs with altitude, slope, and aspect and in different vegetation types.

2. Develop payment/trading mechanisms and incentives for biodiversity-friendly management, particularly in areas neighbouring key protected areas.
    - Produce business plans to implement 'Payment for Ecosystem Services' models in appropriate areas.

Focus Area 8: Cultural Heritage

Rationale

As land managers Ezemvelo is responsible for the management of cultural heritage. Ezemvelo staff are not well equipped to perform this function and require support and recommendations based on an understanding of cultural, physical and spiritual factors.

Research needs

1. Spiritual/metaphysical (living heritage).
    - Undertake thorough anthropological studies, incorporating participatory research, on the various living heritage sites (*e.g.* pilgrimage, graves, renewal of ancient sacred sites in the region) and incorporate the relevant indigenous knowledge into the management plans/strategies of the relevant sites both for conservation management and tourism purposes.
    - Determine the distribution and value of sacred pools, rivers and landscapes.
    - Determine the importance of biodiversity protection and endangered species values to local healers and their communities.

Focus Area 9: Social Ecology

Rationale

Society and the environment cannot be treated in isolation from each other. A social-ecological system can be framed according to the needs of different players and contexts of a system or landscape, from a business, government department or community operating in

a particular geographical area or base in the landscape, such as a watershed. All of these have a range of biophysical, human and institutional elements – including socio-economic and political elements - that work together to drive changes and decision-making within that system.

An understanding of the broader context in which challenges lie, helps to identify sustainable solutions that, in turn, will lead to improved conservation management and mutual benefit to people and protected areas.

Research needs

1. Benefits of protected areas to neighbouring communities.
   Determine what socio-economic benefit the South West protected areas provides to neighbouring communities.
2. Understanding attitudes and behaviour of people to conservation and key species.
   By conducting research into the reasons for neighbours attitudes and behaviour appropriate interventions can be implemented.

Focus Area 10: Climate change and adaptation

Rationale

Climate variability and change affect virtually all physical, biological and human systems on the planet. A major research challenge is to provide relevant information to managers, policymakers on vulnerability, impacts and adaptation in the context of a changing climate and to do so in a coherent, coordinated and practically implementable way.

Research needs

1. Understand and predict the impacts of climate change.
   Undertake research to predict biotic and physical impacts of climate change in South West protected areas and stewardship sites and suggest strategies to adapt to the changes or mitigation.
2. Refugia and resilience.
   Identify areas that can act as refugia for priority species. Identify those species resilient to the impacts of climate change.

Focus Area 11: Biophysical and Biodiversity inventory and mapping

Rationale

Biodiversity cannot be effectively managed and conserved without knowing what species and habitat types are present and how they are distributed. Research on this broad topic is required to inform management in all of the South West protected areas and Stewardship sites.

Research needs

1. Species and habitat distribution and status.

- Ground truth and correct the vegetation maps for all protected areas. Where such maps don't exist for South West protected areas and Stewardship sites, develop them.
- Determine the population status and distribution of priority species such as ground hornbill, oribi, Verreaux's eagle, grey rhebuck, otter, Cape Parrot, Blue Swallow, Wattled Crane. Eurasian bittern, White winged flufftail, Karkloof blue butterfly.

2. Physical pattern mapping (soil, geomorphology, hydrology).
    - Generate soils maps for all protected areas based on predictive catenas.

Focus Area 12: Other

Rationale

Research that does not fit comfortably into any of the above Focus Areas.

Research needs

None identified.