Prioritising Bird Species of Special Concern for monitoring and conservation action in Protected Areas

Esther Anna Mostert

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Supervisor: Professor Les Underhill

Co-supervisors: Professor Melodie McGeoch and Dr Leanne Scott

Plagiarism declaration

I know the meaning of plagiarism and declare that all of the work in this thesis, save for that which is properly acknowledged, is my own.

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Abstract

This thesis had an interdisciplinary nature, broadly incorporating the fields of Biology and Mathematics. Under the field of Biology, the key sub-disciplines were Conservation Biology and Ornithology, and within Mathematics, the sub-discipline was Operations Research, and in particular Multiple Criteria Decision Analysis. This thesis focused on developing an approach for prioritising Bird Species of Special Concern for conservation and monitoring action within the South African National Parks (SANParks). SANParks is in the process of developing a Species of Special Concern Monitoring Programme (SSC MP) which forms part of the larger SANParks Biodiversity Monitoring System. Birds are known to be good indicators of biodiversity for a number of reasons. The rationale behind this thesis was to develop a prioritisation approach using birds as a 'trial' taxon and then to provide input and feedback to the SSC MP being developed so that it could potentially be applied across a larger range of taxa.

There are many different approaches which have been developed and applied for prioritising species for conservation action. Multiple Criteria Decision Analysis is a decision support system which has been used in a number of different fields such as environmental management, energy policy analysis, food security and water management. However, as far as it is known, it has not been used specifically in the context of prioritising species for monitoring and conservation action. In this thesis an additive value function method (a specific approach within MCDA) was used. This approach specifically allows for the values of the decision maker to be explored and captured in the scoring process.

SANParks is the custodian of a public resource and when undertaking a prioritisation exercise (which is inherently subjective) a carefully considered, transparent process needs to be followed which also allows for input from experts from relevant fields. MCDA is a decision support system which is rigorous, participative and transparent and therefore encourages and allows for meaningful debate. It is for these reasons that an MCDA approach was selected for this prioritisation exercise.

As part of the decision making process, a one-and-half day Workshop was organised to which a number of stakeholders were invited. The participants were both from SANParks and outside of SANParks. Prior to the Workshop, a background document was sent out to the Workshop participants explaining the context of the decision problem as well as presenting

some provisional criteria to consider in this prioritisation process. After discussions in the Workshop, it was decided to focus only on biological criteria at this stage of the process. During the Workshop, the following four criteria were selected: Threat Status of a species – assigned using the IUCN threat status; the Range Size of a species – measured by the extent of an area that is occupied by a species; the Core Range of a species – measured by the area a species occupies of where it is most likely to occur; and the Taxonomic Uniqueness of a species measured by calculating a value based on the number of 'units' in the respective order, family and genus of a species.

An important part of the MCDA process is conducting a sensitivity analysis in order to determine the robustness of a Model and selected Criteria. From the sensitivity analysis conducted in this thesis, one Model was selected as best capturing the ordering of the selected Bird Species of Special Concern. The sensitivity analysis also showed, amongst other outputs, that the Taxonomic Uniqueness criterion was the most sensitive to shifts in weights, and that changing the shape of the value function (derived by consensus during the workshop) did affect the outcome of the ordering of the prioritised species.

This thesis also included the detailed outcome of a prioritised list of Bird Species of Special Concern for one selected national park – the Kruger National Park. Finally this thesis contained a short reflection on the prioritisation process applied as well as some future recommendations.

Layout of thesis and acknowledgement of contributions

This thesis consists of six chapters and four appendices. Five additional large appendices are available on the Animal Demography Unit (ADU) website. The theme of this thesis flows from chapter to chapter. This was dictated by the nature of the problem undertaken. Thus, unlike many modern theses, the chapters are not intended to be stand alone.

Chapter One provides an overview of a number of different aspects discussed in the thesis. These include the importance of biodiversity monitoring and conservation, the role of protected areas, the South African context relating to protected areas, methods of prioritising of species for conservation, and the dataset which was used in this thesis. Chapter One was written by Esther Mostert.

An introduction to Multiple Criteria Decision Analysis (MCDA), with a focus on the value function method used in this analysis, is presented in **Chapter Two.** This chapter was written by Esther Mostert with input from Leanne Scott.

Chapter Three focuses on the implementation of the method chosen for this prioritisation exercise. As part of this process a workshop was organised to which a number of stakeholders were invited. The design, execution and initial results of the workshop are presented in this chapter. The algorithm which implanted the online prioritisation tool was developed by Michael Brooks using 'smoothed' SABAP1 data based on the calculations of Francesca Little. This chapter was written by Esther Mostert with input from by Les Underhill and Leanne Scott.

Three of the four criteria selected during the workshop, have quite complex calculations by which the values for each alternative (species) were calculated. These were the criteria of Range Size, Core Range and Taxonomic Uniqueness. The detailed descriptions and some background to the calculations for these criteria are presented in **Chapter Four.** The ideas of calculating the Range Size, Core Range and Taxonomic Uniqueness were Les Underhill's. Michael Brooks programmed the queries which produced the Range Size and Core Range criteria.

In **Chapter Five**, the methods and outputs of the sensitivity analysis undertaken are presented. Conducting a sensitivity analysis is an important part of the Multiple Criteria Decision Making (MCDA) process therefore these detailed analyses and outputs are presented in a separate chapter. At the start of this chapter, an outline for the chapter content is presented because of the complex nature of this chapter. Chapter Five had input from Leanne Scott and Les Underhill.

Chapter Six is the chapter which contains a brief reflection on the prioritisation approach used in this thesis. Some future recommendations are also contained in this chapter as well as a conclusion. This chapter was written by Esther Mostert, with input from Les Underhill.

Acknowledgements

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Acronyms

ADU	Animal Demography Unit
BMS	Biodiversity Monitoring System
KNP	Kruger National Park
MCDA	Multiple Criteria Decision Analysis
MP	Monitoring Programme
PA	Protected Area
QDGC	Quarter Degree Grid Cell
SABAP	Southern African Bird Atlas Project
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SSC	Species of Special Concern
V·I·S·A	Visual Interactive Sensitivity Analysis

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CHAPTER 1

Introduction

This thesis had an interdisciplinary nature. This introduction seeks to give an overview of the two disciplines comprising the thesis. Viewed from afar, the thesis lies at the interface between Biology and Mathematics. Within biology, the key sub-disciplines used were Conservation Biology and Ornithology. Within Mathematics, the sub-discipline was Operations Research, and in particular Multiple Criteria Decision Analysis (MCDA).

This chapter therefore introduces the diversity of components which make up this thesis. It describes the importance of protected areas; it sets the context for the national parks within South Africa and the plan for biodiversity monitoring plans within the parks; it mentions the need for prioritisation in a conservation context and provides a brief description of two prioritisation approaches which have been used in the South African context. The focus then shifts to one taxon in particular – that of birds. A brief description is given of why birds are good indicators of biodiversity and the background to the bird atlas project which was used in this thesis is also presented. Finally, the focus and aim of this thesis is described, which brings all of these components together.

Protected Areas, Biodiversity Conservation and Monitoring

Protected areas play a very important role in the conservation of biological diversity (Brandon et al. 1998, Oates 1999, Terborgh 1999, Carey et al. 2000, Gaston et al. 2006, 2008, Freitag-Ronaldson et al. 2010, Greve et al. 2011). The IUCN (1996. p. 2) defines a protected area as "an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means". Throughout the world, protected areas are increasingly coming under threat from a number of different factors such habitat destruction or alteration, pollution, poaching or illegal harvesting, invasive species, overharvesting and impacts of adjacent land use (Carey et al. 2000, Hockings 2003, Hansen & Defries 2007).

Biodiversity is fundamental for the maintenance of ecosystems and the ecosystem services which they provide (Diaz et al. 2006, Naeem et al. 2009, Freitag-Ronaldson et al. 2010). The current loss of biodiversity is well documented (Singh 2002, Koh et al. 2004, Mace et al. 2007, Freitag-Ronaldson et al. 2010) and given the vital role that protected areas play in the conservation of biological diversity it is important that protected areas continue to conserve the biological diversity within their borders. It is also important to assess how effective protected areas are in the maintenance and conservation of biodiversity (Margules & Pressey 2000, Gaston et al. 2002, 2006). One way to assess the ecological effectiveness of protected areas biodiversity conservation is through biodiversity monitoring (Gaston et al. 2006, 2008).

Protected Areas in South Africa: SANParks and biodiversity monitoring

The importance of biodiversity monitoring is central to the South African National Parks (SANParks). SANParks manages 19 national parks in South Africa. The total SANParks 'Estate' covers 3% of the land surface of South Africa and 54% of the nation's formally protected area network (Freitag-Ronaldson et al. 2010). As a governmental organisation, SANParks is mandated by national legislation, international policy and its own adaptive management philosophy to conserve and manage biodiversity within the parks (McGeoch et al. 2011). Nationally this is specified in the National Environmental Management: Protected Areas Act (Republic of South Africa 2003, Act 57 of 2003) and the National Environmental Management: Biodiversity Act (Republic of South Africa, 2004, Act 10 of 2004) which specify what the requirements for biodiversity monitoring are (McGeoch et al. 2011).

To address the issue of biodiversity monitoring, SANParks has developed a strategic framework to guide the structure and development of a Biodiversity Monitoring System (BMS) for SANParks (McGeoch et al. 2011). Within the BMS, 10 Biodiversity Monitoring Programmes (BMPs) were selected that provide a broad coverage of the high-level biodiversity objective of the parks (McGeoch et al. 2011). A set of principles was agreed on to direct the development of all the BMPs (SANParks 2011). One of these BMPs, which relates directly to the research conducted in this thesis, is the Species of Special Concern Monitoring Programme (SSC MP) (Figure 1.1). The aim of this specific Monitoring Programme is to 'provide the background and rationale for monitoring Species of Special

Concern (SSC) within SANParks, and thereby to support the effective management and successful conservation of these species' (SANParks 2011, p. 4). The SSC MP document provides an outline of the approach, methods and procedures required for biodiversity monitoring, and aims to achieve a standardisation of concepts and approaches for monitoring SSC as far as it is appropriate, and to facilitate the collation of information both within and across parks, as well as to contribute to the national reporting on SSC (SANParks 2011, Figure 1.1).

For the approach, a four– step process is described for monitoring SSC at an individual park level, as well as SANParks as an estate (Table 1.1). Step 2 is the most important in relation to the research presented in this thesis.

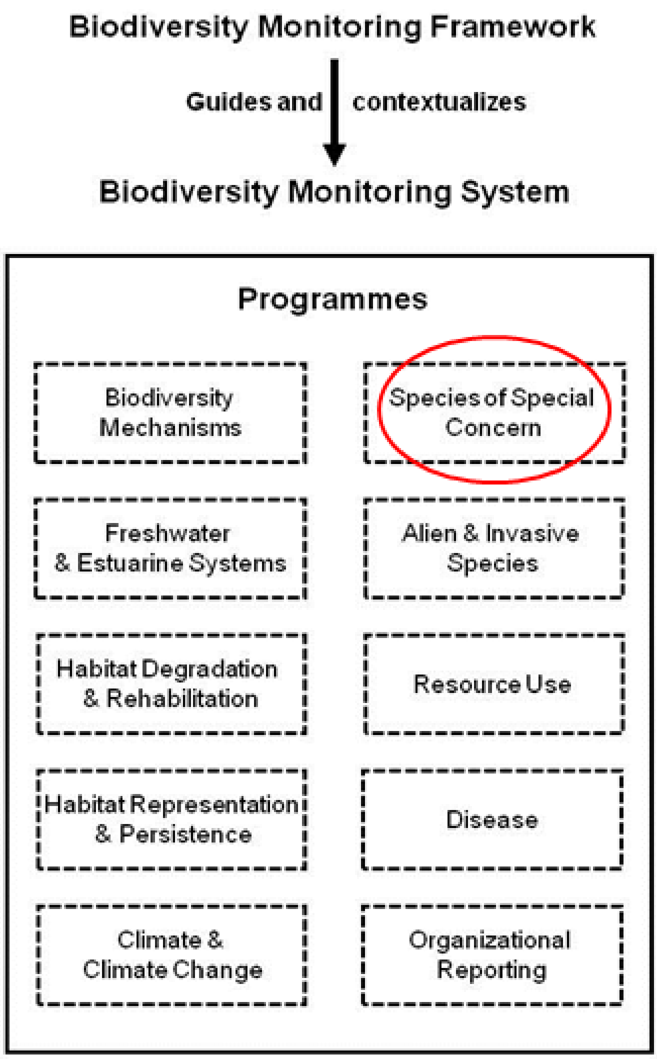


Figure 1.1. Monitoring Programmes comprising the SANParks Biodiversity Monitoring System (BMS). The Species of Special Concern Monitoring Programme (SSC MP) is highlighted and this research relates directly to this component (taken from McGeoch et al. 2011)

Table 1.1. Four steps of Species of Special Concern Monitoring Programme (SSC MP) approach (McGeoch et al. 2011)

STEP 1	Identification and listing of SSC for the biodiversity estate (all national parks) and for each park using a set of standard and transparent criteria
STEP 2	Prioritizing the SSC (across all national parks and within each park) for monitoring action
STEP 3	Monitoring these 'target' SSC using standard approaches and measuring a series of predefined variables
STEP 4	Making decisions and taking action based on the above, which will be incorporated into the Biodiversity Lower Level Plans for parks

Species Prioritisation approaches

Conservation of species is important, but because in most circumstances financial and human resources are limited, some form of prioritisation needs to take place (Dunn et al. 1999, Mehlman et al. 2004). This is an important first step to develop a conservation strategy and is clearly captured in Step 2 of SANParks' Species of Special Concern Monitoring Programme (Table 1.1). Deciding how undertake this process of to prioritising species for conservation action and what criteria to base decisions on, are topics which have been widely discussed and debated (Miller et al. 2006, Mace et al. 2007, Arponen 2009).

Mace and Lande (1991) describe this process of setting priorities for conservation action as a 'societal process' which involves the consideration of a number of aspects such as biological, logistical, ethical, social and financial factors (Mace & Lande 1991). This is different to assessing the extinction risk of a species which Mace and Lande (1991) describe as a 'scientific undertaking' and cannot be used directly to set conservation priorities (Keller & Bollmann 2004). The factors (mentioned above) which need to be considered in a priority setting exercise may have a lot of subjectivity attached to them and this can be contentious when arguments are made about why some criteria should be included and others not, or how to measure or assess the importance of the criteria. It is therefore important develop or use a prioritisation method in which a transparent and rigorous process has been followed.

According to Jiménez-Alfaro et al. (2010) there are two main groups into which priority setting exercise tools can be classified: categorical and cumulative systems. Categorical systems include the rule-scored and qualitative methods (Regan et al. 2004) of which the most well-known is the system used by the IUCN whereby a species is assigned a threat status according to a number of 'rules' (IUCN 2001), which are explicitly defined. The

IUCN approach was designed to assess the extinction risk of a species and therefore it is not suitable to simply use the threat status of a species when determining the conservation priorities of a species (Mace & Lande 1991). Cumulative systems are based on the quantitative assignment of priority scores and their summarization (Jiménez-Alfaro et al. 2010). A cumulative system that has been widely used is that of the point scoring method (Jiménez-Alfaro et al. 2010). Some prioritisation schemes which have been based on a point scoring method are described by Millsap (1990), Shaw (1995), Cofe and Marquet (1998), Carter et al. (2000), Shuford and Gardali (2006) and Rebelo et al. (2011).

Prioritisation approaches in South Africa – relevant to SANParks

There are a number of different approaches which have been used for prioritising species for monitoring within SANParks, as well as within other contexts outside of SANParks (SANParks 2011). Three prioritisation processes used or proposed within SANParks are discussed by SANParks (2011). The most relevant one in relation to the research presented in this thesis is that of Rebelo et al. (2011). A cumulative point scoring approach was applied to Table Mountain National Park and 776 Species of Special Concern (across a wide range of taxa) were listed and prioritised in this exercise (Rebelo et al. 2011). In this approach, 14 variables (criteria), both biotic and management variables were selected. A species was assigned a score of 0, 1, 2, or 3 for each variable. Reasons for when a score of 0 – 3 would be allocated were given explicitly. For each species, a final score was calculated by summing the scores assigned to each of the 14 variables. No weights were assigned to specific variables, and the implicit meaning of this is that all were given equal weight.

Another relevant example of a prioritisation exercise is that of Shaw (1995). He focused on prioritising bird species in the Western Cape Province, South Africa. This again was a cumulative point scoring system. He made use of 11 categories to assess the status of each species – five of these categories focused on biological factors and the remaining six on non-biological factors (Table 1.2).

For each category, a scoring system of 0 – 3 was used, with clear reasons given for why a species would be allocated a score of 0, 1, 2 or 3. So the highest possible score was 33 (3 × 11) and lowest score 0 (0 × 11). No weights were attached to the factors, although a type of 'sensitivity analysis' was carried out to investigate whether the allocation of weights would be appropriate, but the final decision was not to allocate any weights to the factors (which means that equal 'weights' are given to all the factors).

Table1.2. Factors used in prioritisation bird species in the Western Cape Province by Shaw (1995)

	Biological (B) or non-biological (N)
Breeding Rate	B
Distribution	B
Habitat/vegetation	B
Population size	B
Natural Stress	B
International status	N
Taxonomic status	N
Population trends	N
Human induced stress	N
Endemism	N
Additional factors	N

A different prioritisation approach: Multiple Criteria Decision Analysis (MCDA)

The disadvantage of point-scoring methods is that in general they do not capture the processes used in human decision making. Replicating this thought process has been an area of active research by 'decision scientists' for decades. Decision science has become established as a sub-discipline of Operations Research, where it is known as Multiple Criteria Decision Analysis (MCDA).

Multiple Criteria Decision Analysis (MCDA) is a decision support system which aims to help decision maker's structure and solve problems which involve a number of criteria (Belton & Stewart 2002). MCDA methods aim at improving the quality of decisions by making choices more explicit, transparent, rational and efficient (Belton & Stewart 2002). One of the benefits of MCDA is that it allows and facilitates decision makers learning and understanding of the decision problem they are faced with and they understand more about their values, judgements and uncertainties (Belton & Stewart 2002).

MCDA methods have been used in a number of different fields such as environmental management (Lahdelma et al. 2000), energy policy analysis, farm management, food security, forest management, protection of natural areas, water management, and wildlife management (reviewed by Herath & Prato 2006). However, as far as is known, in the field of prioritising species for monitoring and conservation action, this method has not yet been applied.

Birds as biodiversity indicators

Birds have been shown to have a powerful value as indicators of the state of biodiversity (Furness & Greenwood 1993). Reasons for this include that birds are conspicuous, and relatively easy to identify and monitor, they are ecologically versatile and occur across a wide range of habitats and are sensitive to environmental change and their taxonomy is relatively well agreed upon (Koskiemies 1989, Furness & Greenwood 1993, Bibby 2002). There is also a wide interest in bird watching which is relatively inexpensive, both from professionals and amateurs. Because of this interest, large amounts of data on birds are available, which have been gathered by both professional ornithologists and 'citizen scientists' (Koskiemies 1989, Bibby 2002, Greenwood 2007). Because of the above reasons, birds were selected as 'trial' taxa in this prioritisation process.

The South African Bird Atlas Project (SABAP)

The data used in this analysis were from a bird atlas project co-ordinated for southern Africa. Details of this atlas project, as well as a second more refined atlas project, are described here.

SABAP1: The First Southern African Bird Atlas Project

The first Southern African Bird Atlas Project was launched in 1986 and it gathered data on bird distributions from six southern African countries (Harrison 1992, Harrison et al. 2008). This atlas project began being referred to as SABAP1 (First Southern African Bird Atlas Project) when a follow up project was launched in July 2007. This was then referred to as SABAP2, the Second Southern African Bird Atlas Project.

The objective of SABAP1 was to provide a snapshot of bird distribution in southern Africa from the late 1980s to early 1990s (Harrison & Underhill 1997). The region referred to as southern Africa included six countries: Botswana, Lesotho, Namibia, South Africa, Swaziland and Zimbabwe.

Although official data collection for SABAP1 began in January 1987, a large volume of earlier datasets, starting in 1980, were incorporated into the SABAP1 database in order to improve overall coverage (Harrison & Underhill 1997). Data collection ended in most areas in December 1991 but to improve coverage, particularly in remote and inaccessible areas, data collection in some regions continued into 1992 and 1993 (Harrison & Underhill 1997).

Data for SABAP1 were collected by grid cell, using a 15' × 15' or 'quarter-degree' grid, except for Botswana, where a 30' × 30' or 'half-degree' grid had already been adopted (Harrison & Underhill 1997). The total number of grid cells for SABAP1, taking into account the coarser grid in Botswana was 3973 (Harrison & Underhill 1997). However if each half-degree grid cell in Botswana is counted as four quarter degree grid cells, the number of grid cells for SABAP1 was 4537 (Harrison & Underhill 1997).

The unit of data collection for SABAP1 was the checklist. A checklist covered a period of one calendar month or less. The amount of effort that went into a single checklist was not recorded but varied between under one hour and 31 days, although 50% were made over a period of 10 days or less. Most checklists can be considered to represent roughly one day's intensive birding in at least one area of the quarter degree grid cell. There are a number of biases inherent in the reporting processes which were discussed in detail in Harrison & Underhill (1997) who also discussed further caveats to the interpretation of the SABAP1 database.

Most of the data collection for SABAP1 was undertaken by amateur birders or 'citizen scientists' (Harrison et al. 2008). Citizen science can be defined as 'a method of integrating public outreach and scientific data collection locally, regionally, and across large geographical scales' (Cooper et al. 2007). SABAP1 had a big impact on raising public awareness of birds and conservation issues through the use of 'citizen scientists' (Harrison et al. 2008).

At the end of SABAP1, 7.33 million records of 932 bird distributions had been collected on 147605 checklists. No data were collected for 88 grid cells, 2.2% of the total and only one grid cell in South Africa had no data (Harrison & Underhill 1997).

SABAP2: The Second Southern African Bird Atlas Project

The Second Southern African Bird Atlas Project (SABAP2), which was a follow up to SABAP1, began in 2007 and was still on-going in August 2012. The data collected from SABAP2 will build on the results of SABAP1 thereby allowing an improved atlas to be created which can contribute in a greater way to biodiversity conservation (Harebottle et al. 2008). The main difference between SABAP1 and SABAP2 was that the latter has a finer spatial resolution: presence of bird species was recorded within a 5 minute latitude × 5 minute longitude grid cell (approximately 9 km × 8 km), as opposed to a quarter degree grid cell (Harebottle et al. 2008). This finer scale was used for SABAP2 so that more detailed information about species occurrences could be collected in order to allow for a better understanding of bird distributions (Harebottle et al. 2008). There was also a difference in the geographic area covered – SABAP2 only covers South Africa, Lesotho and Swaziland, and not the whole of southern Africa as was the case for SABAP1 (Harebottle et al. 2008).

The protocol for data collection differed from that of SABAP1. An intensive two-hour birding period was required during which the order in which species were seen or heard was recorded (Harebottle et al. 2008). The main aim of SABAP2 was to collect distributional records of birds in order to document changes in bird distributions since SABAP1 and to relate this to landscape changes and climate change (Harebottle et al. 2008).

Data from SABAP1 were used in the calculation of two of the four criteria used in this prioritisation approach. SABAP2 data were not used but an explanation of this dataset is still described in this thesis, because future recommendations are that SABAP2 data will be used once the coverage of this atlas project is sufficient.

Summary of themes, focus and aims of thesis

SANParks is the custodian of a public resource and when undertaking a prioritisation exercise (which is inherently subjective) a carefully considered, transparent process needs to be followed which also allows for input from experts from relevant fields. Multiple Criteria Decision Analysis (MCDA) is a decision support system which is rigorous, participative and transparent and therefore encourages and allows for meaningful debate. It is for these reasons that an MCDA approach was selected for this prioritisation exercise. Because the MCDA approach is an important component of this thesis, it is afforded a separate chapter (Chapter 2), in which a general overview of MCDA for a non-specialist in this field is given, and the general steps which are followed when an MCDA approach is applied are also discussed.

The focus of this thesis is on prioritising Bird Species of Special Concern within SANParks, using the framework of the Species of Special Concern Monitoring Programme (SSC MP). The rationale behind this focus on birds was to undertake a 'trial' exercise in developing an approach for prioritising Bird Species of Special Concern in SANParks, which could then be applied to other taxa and/or modified where necessary. This approach was conducted concurrently with the development of the SSC MP by SANParks scientific services and will provide input into the further refinement of this programme. The aim of this thesis was therefore to develop and test a conservation prioritisation approach, applied specifically to the conservation of Bird Species of Special Concern within the South African National Parks.

CHAPTER 2

Multiple Criteria Decision Analysis

Introduction

This chapter provides an introduction to Multiple Criteria Decision Analysis (MCDA) to a non-specialist within this field. Multiple Criteria Decision Analysis (MCDA), sometimes called Multiple Criteria Decision Making (MCDM), is a discipline aimed at giving support to decision makers who have to make decisions based on a number of criteria (Belton & Stewart 2002). Every decision that we make requires that we consider a number of factors or criteria – sometimes this is done explicitly and sometimes sub-consciously – so to some degree everyone is making use of MCDA daily.

Belton and Stewart (2002, p. 2) define MCDA as, "an umbrella term to describe a collection of formal approaches which seek to take explicit account of multiple criteria in helping individuals or groups explore decisions that matter". One of the main aims and benefits of MCDA is that it allows and facilitates decision makers to learn about the decision problem with which they are faced, and they gain an understanding about their own values, judgements and uncertainties through the decision making process (Belton & Stewart 2002). But it does not take away the need for a decision maker, as Keeney & Raiffa (1972, p. 65) succinctly state, "Formal analysis is meant to serve as an aid to the decision maker, not as a substitute for him."

The MCDA process also aims to make subjective judgements explicit through a transparent process (Belton & Stewart 2002). MCDA is also useful in structuring the decision making process, and the use of a decision model allows for a focus and language for discussion (Belton & Stewart 2002). The emphasis in MCDA is on the process, and not only on the outcome (Zeleny 1982).

Value function methods and value-focused thinking

Within MCDA there are a number of different approaches which can be used. The method used in this thesis is known as the value function method, also called Multi-Attribute Value Theory (Belton & Stewart 2002).

Multi-Attribute Value Theory is an approach in which the concept of value measurement is used in the development of models, which explicitly make use of multiple factors (Belton & Stewart 2000). In value theory, the preferences of a decision maker are represented in the form of a value-function $V(a)$ for an alternative a. A value function is constructed such that:

$a \succ b$ (a is preferred to b) if and only if $V(a) > V(b)$; and a is equally preferred to (or indiscernible from) b if $V(a) = V(b)$.

In the context of the application in this thesis, the alternatives are different species, and the notation $a \succ b$ should be interpreted as species a has priority over species b. The best model is the one which provides insight and guidance to the decision maker which is best achieved by constructing the simplest possible model (Belton & Stewart 2002). This may look like it implies a strong set of assumptions, but it is possible to carry out extensive sensitivity analysis to weaken the effects of assumptions as well as to facilitate learning (Belton & Stewart 2002). The simplest and most widely used form of value function is the additive form, given by:

$$V(a) = \sum_{i=1}^{m} w_i v_i(a) \qquad (1)$$

In equation (1), $V(a)$ is the overall value of alternative a (i.e. species a), where there are m criteria from $i=1$ to m, $v_i(a)$ is the value score reflecting alternative a's performance on criterion i, and w_i is the weight assigned to reflect the 'importance' of criterion i.

Note that $v_i(a)$ is the value associated with alternative a on criterion i. The level that alternative a achieves on criterion i will be captured on some scale z (e.g. weight loss measured in kg). Thus $v_i(a) = v_i(z_i(a))$; in other words there are two steps to the valuation process: the first being measurement of the level of the criterion on some scale z (existing or constructed), and the second being the value associated with this level of the criterion.

Most approaches to decision making take the route of focusing on alternatives. Keeney (1996) referred to this as 'alternative-focused thinking'. However he states: "It is values that are fundamentally important in any decision situation. Alternatives are relevant only because they are means to achieve your values" (Keeney 1996, p. 537).

Keeney (1996) argued that the thinking around a decision problem should first focus on values and only later on the alternatives that may be used to achieve them. He referred to this as 'value-focused thinking'. The implications for this application are that, rather than focus on the species themselves, we should try to uncover the criteria (values) by which we prioritise species.

Robustness of Additive Value Function Methods in MCDA

Additive value function methods are widely used because they are transparent and relatively simply to understand and implement (Stewart 1996). It could be argued that the additive model is an over-simplified model and that perhaps one should consider using other more complex models such as multiplicative models. However, Stewart (1996) demonstrated the robustness of additive value function methods used in MCDA. In this paper he showed that the use of additive value function methods gives results that are consistent and reliable, provided that they fulfil two conditions – at least three or four points are used to create the non-linear function and that criteria are additively independent (Stewart 1996). Both of these were fulfilled in the priority setting exercise undertaken in this thesis. Additive independence, also referred to as mutual independence, means that a score or value can be assigned to one criterion without needing to know the scores or values associated with the other criteria (Belton & Stewart 2002). Additive or mutual independence is not the same concept as statistical independence.

Multiplicative models can also be used in the value function approach. In this model, as the name suggests, the scores are multiplied rather than added to obtain the overall preference scores. Choo & Wedley (2008) compared the advantages and limitations of additive and multiplicative aggregation in MCDM (using ratios scales). They concluded that the additive aggregation model is superior and that it is easier for decision makers to use and understand than the multiplicative aggregation model, and therefore recommend the former for use in multi-criteria decision making problems. The additive aggregation model was therefore used for this approach.

Steps of MCDA

There are a number of steps in the MCDA process which different authors group or detail slightly differently (Belton & Stewart 2002, Department for Communities and Local Government 2009). The following nine steps capture the MCDA process as applied in this thesis. A visual representation of the process of MCDA is also provided which incorporates these described steps (Figure 2.1).

STEP 1: Identify the problem and establish the decision context

STEP 2: Identify the alternatives or options to be valued/appraised

STEP 3: Identify and define the criteria

STEP 4: Construct a hierarchical value tree

STEP 5: Score the criteria in the value tree

STEP 6: Weight the criteria in the value tree

STEP 7: Calculate the overall value of the alternatives and assess the initial model outputs

STEP 8: Perform a sensitivity and robustness analysis

STEP 9: Apply the decision model

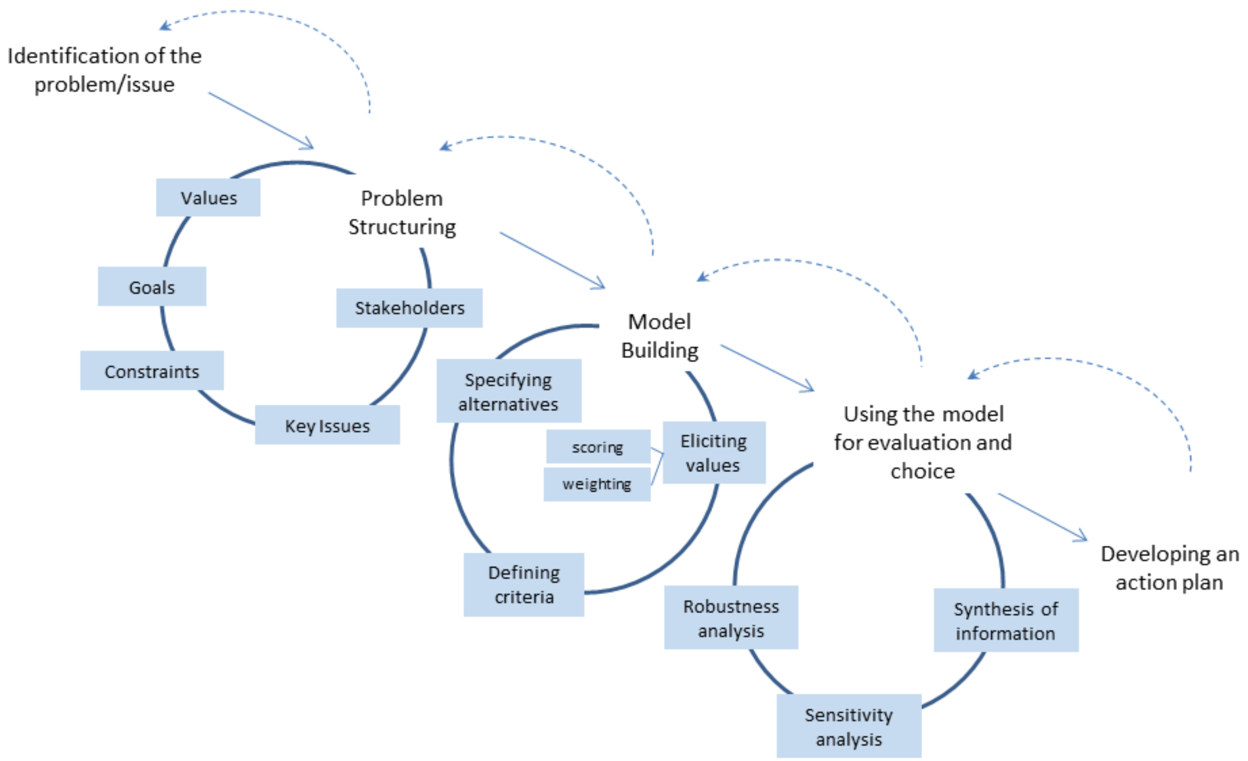


Figure 2.1. The process of Multi-Criteria Decision Analysis (MCDA). The dashed arrows indicate the iterative nature of this process (adapted from Belton (1999) and Belton & Stewart (2002))

STEP 1: Identifying or establishing the decision context

At the start of a MCDA process, one needs to determine the context of the decision problem. If a problem is well structured it is easier to solve than one where the aims or objectives are not clear. Belton & Stewart (2010) provided an overview of the current thinking behind problem structuring of MCDA and how it is used in practice. As part of the problem structuring process the following questions should be considered:

- Who are the relevant stakeholders?
- Are there key uncertainties or constraints and how should these be managed?
- What are the objectives of the decision problem?

STEP 2: Identify the alternatives or options to be valued/appraised

After the decision context has been established, it is then necessary to identify the alternative or options which are to be assessed. The particular type of decision making exercise undertaken in this thesis was one of ranking, and in this case it was only necessary to specify what the items (alternatives) to be ranked are. In other decision problems the alternatives may be consist of different types of action scenarios that can be implemented.

STEP 3: Identify and define the criteria

In this step it is necessary to identify what the criteria are. There are many ways in which the criteria can be elicited (Keeney 1992). When deciding on what criteria to use, especially for value function methods, it is important that the criteria are additively or mutually independent (Belton & Stewart 2002, Department for Communities and Local Government 2009). This means that one can indicate one's level of preference in terms of one particular criterion without knowing at what levels the other criteria are been made.

STEP 4: Construct a hierarchical value tree

Once the criteria and objectives have been established, it is necessary to organise them in such a way that facilitates the scoring of the criteria, and this is usually done in the form of a value tree. A value tree is a hierarchical structure of the overall objective, criteria and sub-criteria. The lowest level is one that must be easily definable for alternatives.

STEP 5: Score the criteria in the value tree

The MCDA scoring process has a two-stage nature. The first stage is to establish a measurement or objective scale for each criterion. However, having a measurement scale for a criterion doesn't imply that you know the value attached to the different levels (or measurements) on the scale.

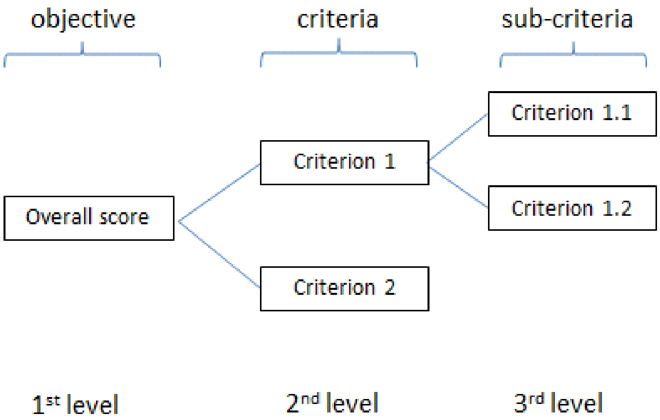


Figure 2.2. Theoretical example of an hierarchical value tree

A value scale (sometimes referred to as a preference scale) therefore needs to be developed, which is the second stage of the process. Value scales are useful in that they standardise comparison across criteria measured on different scales or using different units. For these scales, the values of the end points need to be determined, usually defined at the most and least preferred options of a criterion, and by convention these are given a value score of 100 and 0, respectively (Belton & Stewart 2002).

When defining these minimum and maximum points on a scale, one can make use of either a local scale or a global scale (Belton & Stewart 2002). If a local scale is used, the end points are defined by the set of alternatives under consideration (Belton & Stewart 2002). For a global scale however, the end points are defined by considering the best and worst performances which could ever occur, and therefore a much wider set of possibilities is used as a reference (Belton & Stewart 2002).

Once the end points of the value scale have been defined, values need to be assigned to other points on the scale. i.e. each point on the measurements scale z_i is mapped onto the value scale so that v(z_i) is created for each z_i . There are a number of methods by which the construction of the value scale can be undertaken using either direct or indirect assessment methods. A commonly used indirect assessment method is the Bisection Method (Belton & Stewart 2002).

Bisection Method

One first needs to determine whether the value function is monotonically increasing or decreasing. The value function needs to be increasing if the attributes of the criterion are scaled so that the least preferred are less than the most preferred, and vice versa.

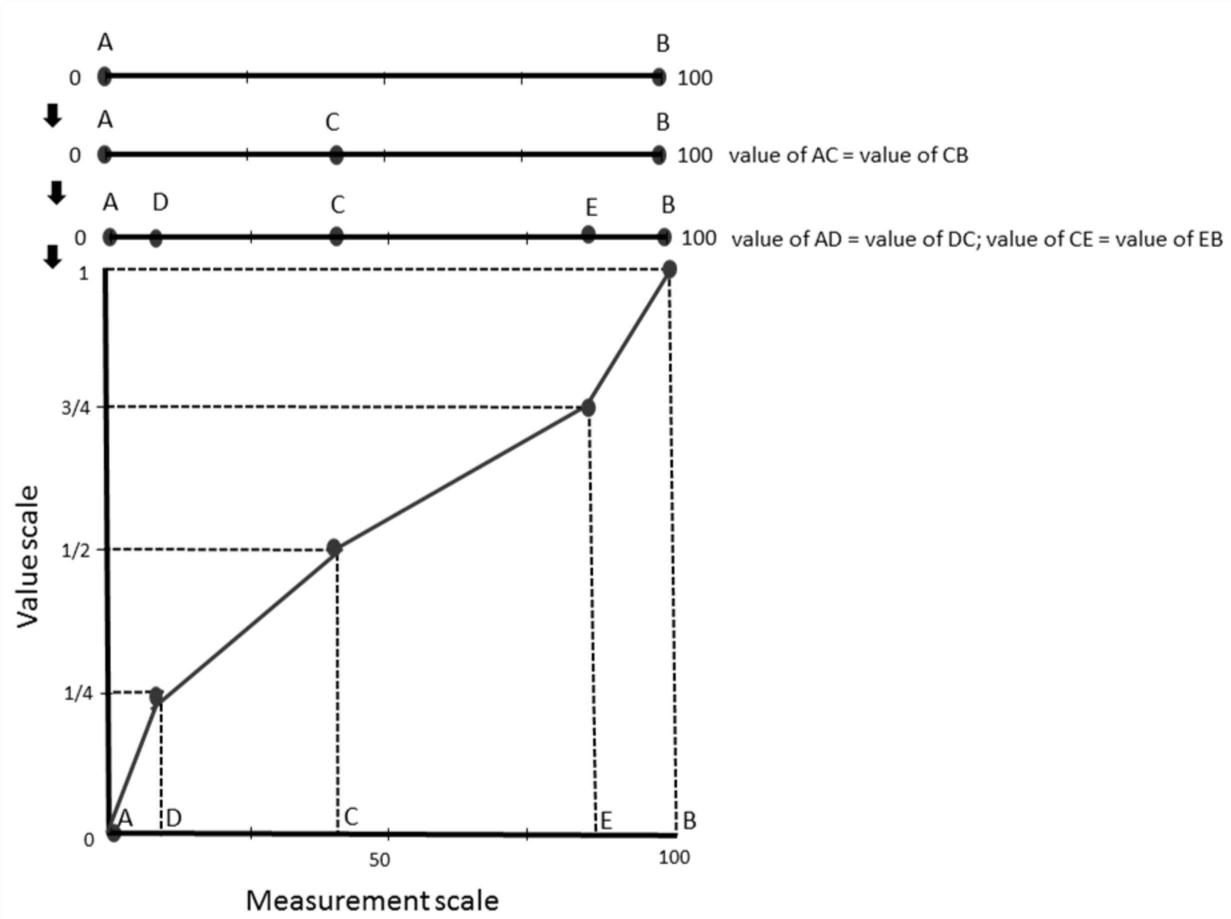
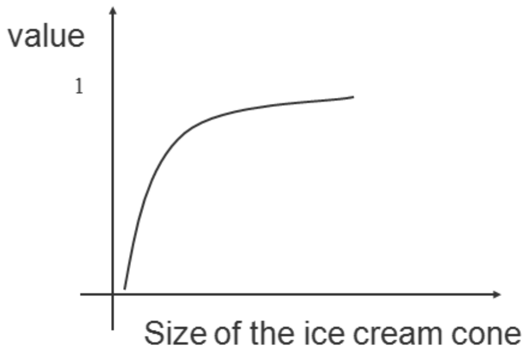


Figure 2.3. Graphical illustration of the Bisection Method (adapted from Hämäläinen (n.d))

This is the case for the illustrated example (Figure 2.3). Firstly the end points of the measurement scale were defined: the lowest or least preferred (point A) and highest or most preferred (point B) points of the alternatives to which scores of 0 and 100 are allocated respectively. Now further points on the measurement scale need to be determined. This can be done by asking the following question, "At what point (C) on the measurement scale will the value/impact of going from point A to point C and from point C to point B, be equal?" Once this point has been determined, the question can be repeated but this time establishing where points D and E are. Once these five points have been determined, it is possible to plot the value function as illustrated (Figure 2.3). Stewart (1996) showed that, provided at least three or four points were used in capturing the shape of a non-linear value function, use of the Additive Value Function method will give reliable and consistent results.



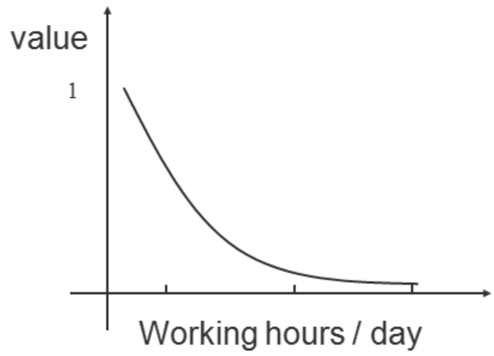


Figure 2.4. Example of an increasing non-linear value function (adapted from Hämäläinen (n.d))

Figure 2.5. Example of a decreasing non-linear value function (adapted from Hämäläinen (n.d))

Examples of non-linear value functions

The following examples were adapted from Hämäläinen (n.d). Someone given an ice-cream with a very small cone would probably be disappointed and not attach a great value to the size of the cone (assuming he or she loves ice-cream). However, as the size of the cone increases, so does the value attached to the cone. At a certain stage, the further increase in the size of the cone (say from extra-large to huge) would not be valued as much (or have the same impact) as an increase from small to medium would. The shape of the function is therefore not linear and an example of an increasing value function (Figure 2.4).

On the other hand, given that a person is employed, the value per hour of working a few hours per day is disproportionately larger than the value per hour of working many hours per day. This is an example of a non-linear value function that is decreasing (Figure 2.5).

STEP 6: Weight the criteria in the value tree

Not all criteria in a value-tree necessarily carry the same weight and it is therefore essential to assess the relative importance of each of the criteria. Weights are therefore indicators of the strength of impact of the criterion on the overall value of an alternative.

Weighting of criteria is also important to make meaningful judgements between preference scales (Department for Communities and Local Government 2009). For example, if criterion A has a weight which is twice that of criterion B this should be interpreted that the decision maker values an increase of 10 value points on criterion A the same as an increase of 20 value points on criterion B.

There are several methods available for assessing the weights of criteria. A commonly used approach is the swing weight method (Belton & Stewart 2002). In this approach, the participants are asked to consider a swing from worst to best status on each of the criteria (at a given level of the model) and to evaluate the contribution (to overall importance) of such a swing (Belton & Stewart 2002). The criterion whose swing is considered to have the most impact is given the highest weight and the other criterion weights are set at values relative to this maximum. All weights sum to 1 (or 100%). For this method to work, there first has to be clarity about the scales which are used for the criteria.

STEP 7: Calculate the overall value of the alternatives and assess the initial model outputs

Once the scoring and weighting have been completed for a value tree (also known as calibrating a value tree) then the overall value for each alternative(given as a score) can be calculated using the additive value function model, as discussed earlier (equation (1)).

$$V(a) = \sum_{i=1}^{m} w_i v_i(a) \tag{1}$$

The second part of Step 7 is to assess critically the initial outputs of the model. The results produced by a value function model are not meant to be seen as 'set in stone'. Rather, the results should encourage critical thinking and be assessed against the intuition of the decision maker (Belton & Stewart 2002). The 'numbers' produced by the model should also help the decision maker to understand the ranges of impacts. During this step one needs to ask and try and answer some questions relating to the relative scores that the model gives. Steps 7 and 8 are closely linked and are both iterative. When more is understood about what the model is producing, one can refine the approaches that one takes in conducting the sensitivity analysis.

STEP 8: Perform a sensitivity analysis

An important part of multi-criteria decision analysis is conducting a sensitivity analysis. A sensitivity analysis can be undertaken to determine the robustness of a model and the effect that different weights can have on the outputs of a model (Belton & Stewart 2002). This analysis also provides a way to investigate decision makers' uncertainty about their values or priorities, or to examine the extent to which disagreements between decision makers impact on the final overall results and can also be used to offer a different perspective on the problem investigated (Belton & Stewart 2002).

STEP 9: Apply the decision model

Once the analysis has been undertaken, it does not 'solve' the decision problem (Belton & Stewart 2002). The results of the decision analysis and the insights gained need to be implemented and translated into an 'action plan'. This is the final step of the decision making process but this step was beyond the scope of this thesis.

CHAPTER 3

A participative approach to prioritising Bird Species of Special Concern using Multiple Criteria Decision Analysis

Introduction

This chapter sets out the approach undertaken for the prioritisation of Bird Species of Special Concern within SANParks using Multiple Criteria Decision Analysis. Included in this chapter is the background to the decision to organise a workshop as part of the prioritisation process, and information about the workshop itself, including the design, execution and outcomes. In this chapter the steps of MCDA (as described in Chapter 2) are discussed as applied to this decision problem.

An important part of the MCDA process is the learning and understanding that happens during the decision analysis process (Stewart 1996) – with the emphasis being on 'process' and not just 'product. At the end of this chapter a section is included which contains a summary of some feedback from the participants, collected at the end of the workshop through an evaluation questionnaire, and provides some insights into the value of the approach used in the workshop.

Detailed explanations of the calculations of three of the four criteria chosen during the workshop are presented in Chapter 4, because of the complexity of the calculations and to allow for a better flow of this chapter. After the workshop was completed a sensitivity analysis (Step 8) was undertaken. This is presented in a separate chapter (Chapter 5). The last step of the decision making process (Step 9) in which the decision model is applied was beyond the scope of this thesis.

Rationale for workshop

In March 2010, I attended a one-day workshop hosted by BirdLife South Africa, in Cape Town. The aim of the workshop was to develop a model to rank and score the Important Bird Areas (IBAs) of South Africa so as to be able to prioritise them. A value function approach was used in this workshop and the programme V·I·S·A (Visual Interactive Sensitivity Analysis) was used to facilitate the decision making process.

The exposure of this approach for a particular prioritisation planted the seed for the idea to use a similar approach and apply it to the decision problem of this thesis. After discussions between Melodie McGeoch (SANParks), Leanne Scott (Department of Statistical Sciences, UCT) who facilitated the BirdLife South Africa workshop, Les Underhill (Director of the Animal Demography Unit, UCT) and myself, a decision was made to organise a workshop in January 2011 to help with addressing the decision problem of prioritising Bird Species of Special Concern in SANParks for conservation and management action. The rationale behind this decision was that it was thought that it would be useful to allow a discussion to take place around this decision problem with the input from various stakeholders. From this point, the term 'Workshop' refers to this event organised as part of the research for this thesis.

Besides SANParks, organisations invited to the Workshop included SANBI, BirdLife South Africa, CapeNature, Durban Natural Science Museum and the National Museum Bloemfontein the Percy FitzPatrick Institute of African Ornithology and the Animal Demography Unit (ADU). A list of Workshop participants is contained in Appendix 1. Participants were not limited to SANParks individuals because SANParks is an organisation which has a national responsibility for species conservation and monitoring and therefore input from experts outside of SANParks is both necessary and desirable. The SANParks participants included both those in management positions, and staff and researchers from Scientific Services. This was done in order to allow various disciplines within SANParks to provide input and promote dialogue and debate around these issues. Undertaking a prioritisation process in this way also allowed for a record of the reasoning that took place and provide a basis for future decisions.

Design and execution of the Workshop

The total number of participants was restricted to less than 20 in order to allow all participants to be involved with and contribute to discussions. Prior to the Workshop, a background document was prepared and given to all participants (Appendix 1). This contained the objectives and output of the Workshop as well as a provisional list of suggested criteria for the Workshop, information about Multi-Criteria Decision Analysis (MCDA), the value-function method and value-focused thinking, with a worked example of this method, and some papers for background reading. The Appendix A of this Background Document contained criteria that had been used in other prioritisation processes, and Appendix B contained data of bird species for four provisionally selected criteria.

The Workshop took place over one-and-a-half days in January 2011 and was hosted by the South African National Parks' (SANParks) Cape Research Centre (CRC) Scientific Services, Tokai, Cape Town. The Workshop was facilitated by Dr Leanne Scott, Department of Statistical Sciences, University of Cape Town. Because the Workshop continued to a second day it allowed for time on the first day to give background information about the SANParks context and more information about the MCDA approach (Appendix 1 – Programme). On the first day the criteria were discussed and finalised, a value tree was constructed and the criteria were scored. The fact that there was a break overnight allowed participants to consolidate their own thinking around the new approaches as well as their own subjective views on the model inputs. A Report of the Workshop, which documented the proceedings and discussions at the Workshop, was produced and circulated to participants (Appendix 2).

The additive value function method (Chapter 2) was used for this decision problem because of its simplicity, robustness and transparency (Stewart 1996, Choo & Wendly 2008). Each of the nine steps of the MCDA process, described in Chapter 2, is discussed in turn below in relation to this specific decision problem.

Applied MCDA steps of Bird Species of Special Concern Prioritisation

STEP 1: Identifying or establishing the decision context

The problem structuring part of this decision context had already largely been undertaken. because it was a further step in a process which had been laid out by SANParks in their Species of Special Concern Monitoring Programme (SSC MP) which falls under the over-arching Biodiversity Monitoring System (BMS) developed by McGeoch et al. (2011). Several meetings were held prior to the workshop with Professor Melodie McGeoch from SANParks Cape Research Centre, so that the background to this decision problem could be fully understood. Another part of the problem identification was to become familiar with historical documents and literature relating to SANParks, its history of biodiversity monitoring and future developments. (Reyers & McGeoch 2007, SANParks 201 Freitag-Ronaldson et al. 20100, McGeoch et al. 2011, SANParks 2011).

The decision context in this case was that SANParks is the custodian of natural parks and has the imperative to engage with experts and the general public to conserve these national assets. In this regard they need to prioritise birds within SANParks for conservation and monitoring action. The intention is that this approach could subsequently be used for other taxa across the national parks.

Part of the problem structuring process is also to determine what the aim and objectives for the decision problem are. The aim of this decision problem was to develop a defensible, transparent, understandable method to prioritise Bird Species of Special Concern for monitoring and conservation action within protected areas, using SANParks as a case study. Thus the output of this process potentially has a broader application.

STEP 2: Identify the alternatives or options to be valued/appraised

In this decision problem, the alternatives were all the bird species which occurred in a National Park. There were however some species which were not considered suitable for this prioritisation exercise and were removed. This included for example, introduced invasive species. This was a transparent process and these cases are discussed in detail in STEP 7.

STEP 3: Identify and define the criteria

The process of identifying relevant criteria was initiated before the Workshop; a number of provisional criteria were included in a background document (Appendix 1: Part A). This was emailed to Workshop participants before the start of the Workshop. The discussion and final selection of criteria took place during the Workshop. During the early stage of the workshop there was some discussion about which criteria should or should not be included. Both biological and non-biological criteria were discussed at this stage. Some non-biological criteria, such as the iconic status of a species, the legislative requirements of a species, the management requirements of a species, were discussed. After some discussion a consensus decision was reached that the focus would be on biological criteria only. It was identified that there would then need to be a second part to the decision analysis problem where non-biological criteria would also be considered. The reason for this decision was to try and simplify the decision making process and focus only on biological criteria as a first step. The results from this step would then be used to contribute to the next part of the decision process where criteria related to management would be considered.

Four biological criteria selected:

Criterion 1: Threat Status

Threat status is a measure of the extinction risk of a species, based on the latest IUCN Red Data list (Barnes 2000). A species placed in a high threat status category has a higher need for conservation action than one in a lower threat category because of the likelihood of extinction.

Criterion 2: Range Size

This measures of the geographic area covered by a species. A species with a small or restricted range has a greater need for conservation action than a species with a very large range size due to the extinction risk of range restricted species (Purvis et al. 2000).

Criterion 3: Core Range (in relation to SANParks)

The Core Range is a measure of the area where a species is most abundant (in popular terms 'where it likes to be'). The Core Range excludes the periphery of the range, and any occurrences as a vagrant. A species with a high percentage of its Core Range within a national park would imply a greater responsibility of SANParks to the monitoring and conservation of this species.

Criterion 4: Taxonomic Uniqueness

This is a measure of the relative taxonomic distinctiveness of a species. A species with a high measure of taxonomic distinctiveness has a greater need for conservation than one whose taxonomic value is low if the taxonomic uniqueness of taxa world-wide is to be maintained. Thus, other things being equal, a white-eye is less taxonomically unique than an ostrich.

In order to enable this chapter to flow more smoothly, a detailed description of how Criteria 2–4 were derived is provided by Chapter 4. The outlines of these criteria are, however, contained in this chapter.

There was discussion around the provisional criterion of 'Peripheral Species' (Appendix 3). These peripheral species refer to the 31 species listed in the appendix of the Eskom Red Data Book of South Africa, Lesotho and Swaziland (Barnes 2000). Initially it was decided to amend this criterion to only include peripheral species which had a globally assigned threat status. However, after subsequent discussion, it was found that only one species, Sooty Falcon (*Falco concolor*), fell in this category, and therefore this criterion was excluded. After further discussion and looking at the outputs of the sensitivity analysis, it

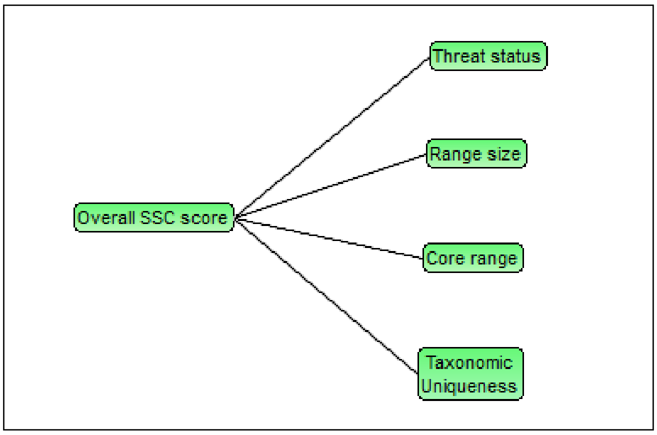


Figure 3.1. The value tree constructed for this prioritisation problem

was decided that all species listed as Peripheral (Appendix 3) would be excluded from this prioritisation exercise as they are too 'marginal' for SANParks to have any significant effect on their conservation status.

STEP 4: Construct a value tree

Once the criteria had been selected, the next step of the construction of the value tree took place. The value tree which was constructed during the Workshop was a simple one because no sub-criteria were selected (Figure 3.1)

STEP 5: Score the criteria in the value tree

There are essentially two stages in the MCDA scoring process (as discussed in Chapter 2). For each criterion a measurement scale was adopted or developed and then a value scale measurement was derived from this measurement scale. This process is described below.

Criterion 1: Threat Status

For Criterion 1, Threat Status, a categorical scale was used based on the IUCN Red Data Book threat status categories. The basis for the Threat Status was taken from Barnes (2000) which applied the global 1994 IUCN Red List criteria in use at the time, but modified for application at the regional level (see Barnes 2000 for details). These regional criteria were used in this application, but wherever the global status has subsequently been changed to a higher threat status than in Barnes (2000), the regional threat status was changed to match the global status. For example, the African Penguin was classified (regionally) as Vulnerable by Barnes (2000), but the global threat status was changed to Endangered in 2010 (BirdLife International 2010). On the basis of the fact that the regional threat status can never be lower than the global threat status, the classification used here for the African Penguin is Endangered.

Table 3.1. Scores assigned to the Threat Status categories

Threat category		Score
Extinct	EX	100
Extinct in the Wild	EW	100
Critically Endangered	CR	100
Endangered	EN	90
Vulnerable	VU	70
Near-threatened	NT	50
Data Deficient	DD	20
Least Concern	LC	0

The IUCN threat categories are an ordering of eight categories from Least Concern to Extinct. For this application a value needs to be attached to each category. These values needed to be determined by the Workshop, because the increments (gaps), in terms of the value function, between the categories are not necessarily equal. The process of assigning scores to each of the eight Red Data threat status categories was determined by discussion in the Workshop led by the facilitator. A vertical line was drawn on a flipchart and the scores 0 and 100 allocated to the bottom and top of this scale respectively. Cardboard rectangles with the threat status categories written on them were then placed at a point on this vertical line, reached by consensus from the workshop participants (Table 3.1). Three of the categories, Extinct (EX), Extinct in the Wild (EW) and Data Deficient (DD), were not used in this analysis, because there were no birds with these classifications in the data set, but they were still assigned a score during this step in the workshop.

Criterion 2: Range Size

The Range Size for a species was defined as the number of QDGCs occupied in seven countries of southern Africa (excluding northern Mozambique). QDGCs where the species had low reporting rates were excluded. Full details of the Range Size calculations are given in Chapter 4.

This criterion is a refinement, on a continuous scale, of the concept of Endemism. This is frequently captured, on an ordered categorical scale, using terms such as “endemic (to South Africa)”, “near endemic”, “southern African endemic”, and “not endemic”. The Range Size criterion provides a more nuanced approach. A species with a small Range Size occupies only a relatively small number of QDGCs and has a restricted range. It is

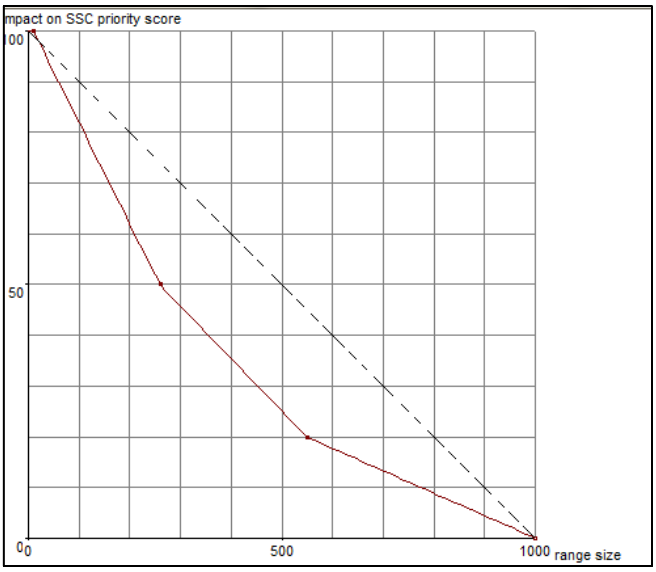


Figure 3.2. Value function for Range Size for South African species indicated by solid line (dashed line indicates a simple linear value function) (Display is taken from V·I·S·A; the dashed line has been added)

therefore more at risk of extinction. It therefore ought to have a higher value attached to it than a species which occupies a large number of QDGCs. This appropriate value function was a monotonically decreasing function. The maximum point was defined at 0 QDGCs (given a score of 100) and the minimum endpoint was set at 1000 QDGCs (and given a score of 0, and any species occupying a range greater than 1000 QDGCs were also allocated a score of 0) (Figure 3.2).

There was some discussion in the Workshop around where to set the upper endpoint of Range Size, beyond which further increases in range size should have no impact on the priority setting exercise. 1000 QDGCs represents an area of c. 70 000 km^2. The Workshop took the view that any species occupying such a large area could not be construed as having a restricted range, and the appropriate score for the value function for this Range Size and larger is 0.

Further intermediate points on the value scale were identified during the Workshop using the bisection method. The value function which emerged (Figure 3.2) was concave. A theoretical species which occupied an area 250 QDGCs would receive a value score of 50, half the maximum score. All species occupying more than 1000 QDCCs were assigned a value of 0 on the Range Size criterion.

Criterion 3: Core Range in South Africa

The units for the measurement scale of this criterion were the percentage of the Core Range of a species which occurred in a defined area. Full details of the definition are contained in Chapter 4.

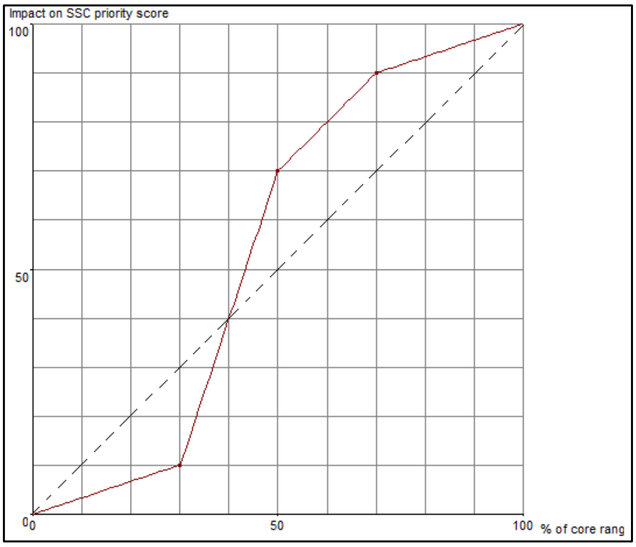


Figure 3.3. Core Range value function indicated by solid line (dashed line indicates a simple linear value function) (Display taken from V·I·S·A)

In brief the Core Range of a species in a national park (or other area) is defined as a percentage. The denominator contains the number of QDGCs, within South Africa, Lesotho and Swaziland, at which the species occurs at reporting rates above the median (i.e. the core of the range of the species) and the numerator is the count of those QDGCs which fall within the national park. The motivation for this criterion is that if a large percentage of the core of the range within South Africa falls within the national park, then that species assumes higher priority within that national park (or other area).

In this case the value function is monotonically increasing, because a low value was attached to a species which only has a small percentage of its Core Range in a defined national park or area, but this value increases as the percentage of its Core Range within the park increases. The end points of the scale of Core Range values, the minimum and maximum, were set at 0% and 100%. A method, based on the bisection method, was used to determine further points on the value function, through the facilitator eliciting discussion on these values at the Workshop (Figure 3.3). The value function developed by consensus showed that high values (above 90%) were placed on species which had a core range of 70% and above within the national park. On the other hand, the values of species with 30% of less of its core range within a national park were mapped to values of 10 % and less (Figure 3.3).

Criterion 4: Taxonomic Uniqueness

The motivation for this criterion was that species which are taxonomically distinct from other species ought to enjoy higher value than those which have many closely related species (Faith 1996, Rodrigues & Gaston 2002, Redding & Mooers 2006, Forest et al. 2007).

During the workshop a simple 'coarse' method was devised to determine the taxonomic uniqueness of each species, based on the concepts of order, family, genus and species. Subsequent to the workshop, a more complex 'nuanced' method was developed. In this second method the value of the criterion was based on the concept of considering a flow through a simplified taxonomic tree of the bird species, taking into account only order, family and genus. At each branch of the tree, incoming flow to that branch was split equally into the outgoing branches. Further details about the calculations involved in both these methods are given in Chapter 4.

STEP 6: Weight the criteria in the value tree

The swing weight method was used in the Workshop to assign weights to the four selected criteria. The context in which this was presented was as follows: participants were asked to consider a species (x) which scored at the bottom of the scale in all four criteria, and a species (y) which scored at the bottom of the scale for three criteria and at the top of the scale in one criterion. The question was then posed, "Which criterion would be the one that you would consider would make the greatest difference in 'need to be conserved' between species x and y".

A V·I·S·A display with four bar charts (Figure 3.5) representing each criterion was used to elicit the weights from the Workshop participants. As the weight for one criterion was shifted, the other three remaining weights shifted relative to this so that the weights always summed to 1 or 100%.

Figure 3.5. Example of a V·I·S·A display of weights for Model 1

There was considerable discussion at the Workshop about the allocation of weights, especially about which criterion should receive the largest weight. Two main preferences emerged to which different sets of weights were attached, and were termed Model 1 and Model 2. In Model 1 equal weight was given to the criteria of Threat Status and Core Range (35%), this was followed by the Range size (20%) and the lowest weight was given to Taxonomic Uniqueness (10%). In Model 2, the highest weight was given to Threat status (40%), this was then followed by Core Range (30%), Range size (20%) and Taxonomic Uniqueness (10%).

After the Workshop was complete, a third model was suggested where the highest weight was given to the Core Range (40%), followed by the Threat Status (30%), and then equal scores of 15% were given to Range Size and Taxonomic Uniqueness. There are many examples in the literature in conservation prioritisation setting exercises in which equal weights are allocated to the criteria (Shaw 1995, Rodriguez et al. 2004, Rebelo et al. 2011). In order to determine the effect of differing weights, a fourth model was developed were equal weights of 25% were given to all four criteria. This can be thought of as a 'control model' which can be used to highlight the outcomes of using different weights for the criteria. A summary of the four models is shown in Table 3.2.

STEP 7: Calculate the overall value of the alternatives and assess the initial model outputs

STEPS 7 and 8 are closely linked and need to be undertaken in an iterative process. The outputs of STEP 8 (Sensitivity Analysis) are presented in Chapter 5. Model 1 (Table 3.2) was selected as best capturing the priority ordering of species (discussed in detail in Chapter 5).

Table 3.2. The weights assigned to the four criteria for the Models used in the sensitivity analysis

	Criteria Scores			
	Threat Status	**Range Size**	**Core Range**	**Taxonomic Uniqueness**
Model 1	***35***	20	***35***	10
Model 2	***40***	20	30	10
Model 3	30	15	***40***	15
Model 4	25	25	25	25

Refinement of Alternatives

In first assessment of the initial outputs it was apparent that there were some groups species included in the outputs, which were not appropriate to include. One of these groups was vagrant migrant species. Three vagrant species which had been recorded in national parks were also removed from the prioritisation list. They had been recorded only in one or two QDGCs in South Africa (Table 3.3). They had extensive distributions father north in Africa and were therefore not priorities for conservation in South Africa in general and within SANParks in particular.

Five introduced species (Table 3.4) whose presence and absence were recorded for SABAP1, were removed from the list of species assessed in this priority setting exercise as they are not a conservation priority for SANParks. These species however, may be relevant to consider in another Biodiversity Monitoring Programme, namely that of 'Alien and Invasive Species' (Chapter 1, Figure 1.1).

When the initial outputs of Model 1 for the ranking and scores of species for SANParks as an 'Estate' were examined, it became obvious that it did not make sense to include the majority of non-breeding seabirds in this prioritisation exercise. Seabirds, especially pelagic seabirds, tend to be recorded erratically in bird atlas projects such as SABAP1. As a consequence seabirds had misleading values for the criteria Range Size and Core Range, and the final scores, which are not comparable to terrestrial species (Table 3.5).

As discussed earlier in this chapter, species listed as "peripheral" by Barnes (2000) were also not included in this prioritisation exercise and are listed in Appendix 3.

Table 3.3. Vagrant terrestrial migrants excluded from this prioritisation exercise

Common Name	Scientific name	No. QDGCs in South Africa
Wheatear, Northern	*Oenanthe oenanthe*	1
Turtle-Dove, European	*Streptopelia turtur*	1
Plover, Crab	*Dromas ardeola*	2

Table 3.4. Introduced species excluded from this prioritisation exercise

Common Name	Scientific Name
Duck, Mallard	*Anas platyrhynchos*
Starling, Common	*Sturnus vulgaris*
Myna, Common	*Acridotheres tristis*
Sparrow, House	*Passer domesticus*
Chaffinch, Common	*Fringilla coelebs*

Table 3.5. Seabirds excluded from this prioritisation exercise

Common Name	Scientific Name
Albatross, Tristan	*Diomedea dabbenena*
Albatross, Wandering	*Diomedea exulans*
Albatross, Shy	*Thalassarche cauta*
Albatross, Chatham	*Thalassarche eremita*
Albatross, Salvin's	*Thalassarche salvini*
Albatross, Black-browed	*Thalassarche melanophrys*
Albatross, Atlantic Yellow-nosed	*Thalassarche chlororhynchos*
Albatross, Indian Yellow-nosed	*Thalassarche carteri*
Giant-Petrel, Southern	*Macronectes giganteus*
Giant-Petrel, Northern	*Macronectes halli*
Petrel, Pintado	*Daption capense*
Petrel, Great-winged	*Pterodroma macroptera*
Petrel, Soft-plumaged	*Pterodroma mollis*
Petrel, Blue	*Halobaena caerulea*
Prion, Antarctic	*Pachyptila desolata*
Prion, Broad-billed	*Pachyptila vittata*
Prion, Salvin's	*Pachyptila , salvini*
Prion, Slender-billed	*Pachyptila belcheri*
Petrel, Spectacled	*Procellaria conspicillata*
Petrel, White-chinned	*Procellaria aequinoctialis*
Shearwater, Cory's	*Calonectris diomedea*
Shearwater, Great	*Puffinus gravis*
Shearwater, Sooty	*Puffinus griseus*
Shearwater, Balearic	*Puffinus mauretanicus*
Shearwater, Manx	*Puffinus puffinus*
Jaeger, Parasitic	*Stercorarius parasiticus*
Skua, Subantarctic	*Catharacta Antarctica*
Gull, Sabine's	*Xema sabini*
Tern, Arctic	*Sterna paradisaea*
Tern, Antarctic	*Sterna vittata*
Tern, Roseate	*Sterna dougallii*
Tern, Little	*Sterna albifrons*
Tern, Whiskered	*Chlidonias hybrid*
Tern, White-winged	*Chlidonias leucopterus*

Overall value of the alternatives

<u>Detailed Outputs: Kruger National Park – Model 1</u>

Because of space limitations, only the detailed outputs for the Kruger National Park are presented here. A more general summary of a further five national parks is also presented in the next section. The following outputs are all from those produced from Model 1 – the reason why this Model was selected is described in the discussion of the sensitivity analysis (Chapter 5).

The striking component of Table 3.6 is that on each of the three criteria Threat Status, Range Size and Core Range, the species on the top 20 list for Kruger National Park, have a large variability. The top 20 include species which are in four Threat Status categories (Endangered (EN), Near Threatened (NT), Vulnerable (VU) and Least Concern (LC)). Range Size varies from 107 QDGCs to 2245 QDGCs and Core Range between 5.3% and 100%. Taxonomic Uniqueness had a smaller range, from 5.7 to 33.3 (out of the possible range of 0–100).

Although 16 of the top 20 species were in threat categories, four species of Least Concern were included. The Brown-headed Parrot was ranked 11 in spite of having a score of 0 in the Threat Status criterion. This is because 97.5 % of its South Africa Core Range falls within the Kruger National Park, and thus SANParks has almost exclusive responsibility for its survival within South Africa.

The Yellow-billed Oxpecker and Hooded Vulture are ranked in the top priorities because they score highly in the Threat Status and Core Range criteria and have an above average value in the Range Size and Taxonomic Uniqueness criteria.

In contrast, the Saddle-billed Stork is ranked third, in spite of being the only species in the Kruger National Park with an Endangered Threat Status and therefore, at a first scan, the top priority species. This slight lowering of rank was because it has only 54% of its South African Core Range of 894 QDGCs lies within the Kruger National Park. Thus this national park is not solely responsible for its conservation as is the case with Yellow-billed Oxpecker and (to a lesser extent) the Hooded Vulture, the two species ranked above it.

The full list of species ranking and scores for the Kruger National Park (KNP) is contained in Appendix 4.

Table 3.6. Outputs of the prioritization exercise for the Kruger National Park, showing the top 20 species ranked by Grand Score. W indicates the weight assigned to a criterion

		Threat Status				Range Size				Core Range				Taxonomic Uniqueness			Grand Score
	Common Name	Status	Raw	W	Final Score	Raw	Scale	W	Final Score	Raw	Scale	W	Final Score	Raw	W	Final Score	
1	Oxpecker, Yellow-billed	VU	70	0.35	24.5	349	40.1	0.20	8.0	100.0	100.0	0.35	35.0	12.6	0.10	1.3	68.8
2	Vulture, Hooded	VU	70	0.35	24.5	506	24.4	0.20	4.9	90.9	97.0	0.35	33.9	12.5	0.10	1.3	64.6
3	Stork, Saddle-billed	EN	90	0.35	31.5	894	4.7	0.20	0.9	53.8	73.8	0.35	25.8	27.9	0.10	2.8	61.0
4	Lapwing, White-crowned	NT	50	0.35	17.5	302	44.8	0.20	9.0	58.8	78.8	0.35	27.6	8.2	0.10	0.8	54.9
5	Bateleur	VU	70	0.35	24.5	2245	0.0	0.20	0.0	50.6	70.6	0.35	24.7	12.5	0.10	1.3	50.5
6	Openbill, African	NT	50	0.35	17.5	791	9.3	0.20	1.9	56.7	76.7	0.35	26.8	27.9	0.10	2.8	49.0
7	Vulture, White-headed	VU	70	0.35	24.5	1212	0.0	0.20	0.0	46.7	60.2	0.35	21.1	12.5	0.10	1.3	46.8
8	Night-Heron, White-backed	VU	70	0.35	24.5	174	67.2	0.20	13.4	32.5	17.5	0.35	6.1	11.7	0.10	1.2	45.2
9	Hawk, Bat	NT	50	0.35	17.5	234	55.2	0.20	11.0	40.0	40.0	0.35	14.0	12.5	0.10	1.3	43.8
10	Crake, Corn	VU	70	0.35	24.5	107	80.6	0.20	16.1	5.3	1.8	0.35	0.6	11.5	0.10	1.2	42.4
11	Parrot, Brown-headed	LC	0	0.35	0.0	474	27.6	0.20	5.5	97.5	99.2	0.35	34.7	9.0	0.10	0.9	41.1
12	Fishing-Owl, Pel's	VU	70	0.35	24.5	215	59.0	0.20	11.8	18.8	6.3	0.35	2.2	13.8	0.10	1.4	39.9
13	Finfoot, African	VU	70	0.35	24.5	267	48.3	0.20	9.7	19.6	6.5	0.35	2.3	24.0	0.10	2.4	38.8
14	Ground-Hornbill, Southern	VU	70	0.35	24.5	1388	0.0	0.20	0.0	32.8	18.4	0.35	6.5	33.3	0.10	3.3	34.3
15	Canary, Lemon-breasted	NT	50	0.35	17.5	141	73.8	0.20	14.8	12.5	4.2	0.35	1.5	5.7	0.10	0.6	34.3
16	Stork, Marabou	NT	50	0.35	17.5	1253	0.0	0.20	0.0	40.2	40.5	0.35	14.2	24.0	0.10	2.4	34.1
17	Owlet, African Barred	LC	0	0.35	0.0	873	5.6	0.20	1.1	66.7	86.7	0.35	30.3	9.6	0.10	1.0	32.4
18	Oxpecker, Red-billed	NT	50	0.35	17.5	937	2.8	0.20	0.6	38.8	36.4	0.35	12.7	12.6	0.10	1.3	32.1
19	Dove, African Mourning	LC	0	0.35	0.0	679	14.3	0.20	2.9	59.7	79.7	0.35	27.9	11.0	0.10	1.1	31.8
20	Eagle, Lesser Spotted	LC	0	0.35	0.0	535	21.5	0.20	4.3	54.2	74.2	0.35	26.0	8.5	0.10	0.9	31.1

Overview of initial outputs of priority scores for all species for other selected national parks and SANParks 'Estate'

Outputs for the overall priority scores for five selected national parks of varying sizes as well as SANParks as an 'Estate' are presented in Table 3.9. These results are presented in order to gain a sense of the distribution of the scores using 'groupings' or categories which have been arbitrarily decided. It is important to bear in mind that it is the difference between the values that have meaning, and that the absolute scores are not important.

Kruger National Park, which is the largest national park in area, also had the largest number of species of the parks included in this prioritisation assessment, 357. The Bontebok National Park, which is the smallest national park in area, had the smallest number of species assessed, 35. These numbers do not represent the total number of species recorded in the national park; in this assessment, a cut-off threshold of 0.5% for the Core Range criterion was used so that only those species which had substantial fractions of their range within the park were considered as candidates for Species of Special Concern for that park (Chapter 4).

While the highest maximum score for a species, 68.7 (Yellow-billed Oxpecker) was in the Kruger National Park, the lowest of the other maximum scores from the selected parks, was not for the Bontebok National Park (the smallest national park), but for the Karoo National Park, 26.9 (Barlow's Lark). The Karoo National Park also had the largest number of species with a score of less than 1 (48). This was due to the fact that largest percentage Core Range occupied by a species in this park was only 4.1% (Cinnamon-breasted Warbler). 81 of the 110 species (74%) had Range Sizes greater than 1000 QDGCs and therefore were assigned a score of 0 for this criterion (http://www.adu.org.za/pdf/Mostert_E_2012_MSc_Appendix_7-Karoo_NP.pdf). For smaller parks such as Bontebok National Park, the Threat Status criterion dominated the contribution to the Grand Scores (http://www.adu.org.za/pdf/Mostert_E_2012_MSc_Appendix_9-Bontebok_NP.pdf). This was expected because the Bontebok National Park has a small area, relative to the other parks and South Africa, and so the Core Range values of all species were inevitably small. For the other selected national parks as well as SANParks as an 'Estate', the full lists of prioritised species are available as an appendix online (http://www.adu.org.za/pdf/Mostert_E_2012_MSc_Appendix_5-SANParks_Estate.pdf).

Table 3.9. Summary statistics showing the number of species in each range of scores for Model 1, for selected national parks. For example in the SANParks Estate, four species had scores exceeding 60. Areas (ha) for each park are also given

Species Score	SANParks Estate	Kruger NP	Kgalagadi Transfrontier NP	Karoo NP	Table Mountain NP	Bontebok NP
>60	4	3	0	0	0	0
50–60	8	2	0	0	1	0
40–50	8	6	0	0	2	0
30–40	27	11	0	0	4	2
20–30	46	26	9	7	6	2
10–20	66	20	3	5	13	7
5–10	61	33	3	9	10	9
1–5	360	236	49	41	11	10
<1	9	20	23	48	3	5
Total no. of species	**589**	**357**	**87**	**110**	**50**	**35**
Maximum Score	68.8	68.8	27.7	26.9	50.2	34.4
Minimum Score	0.8	0.6	0.7	0.6	0.8	0.7
Park Size (ha)	4 090 861	1 962 362	959 103	83133	24 310	2 786

Feedback from participants about Workshop and Model

Towards the end of the Workshop, time was allocated for a discussion and feedback about the Workshop process in general. Workshop participants were also given a questionnaire, one part of which contained a set of statements for which the participants were asked to allocate a score of 1 – 5, 1 being the lowest score, and 5 being the highest. Selections of outcomes from the questionnaire are discussed here. Two statements to be assessed about the Background Document and aims were as follows: “The Background Document provided sufficient information for me to be prepared for the workshop”; “The aims and objectives of this workshop were made clear”. The average score given to these statements, from the 14 participants, were 4.2 and 4.0 respectively. Two other statements about the Workshop approach were as follows: “I feel the approach used in the workshop was useful”; “I feel the approach used in the workshop can be applied to other taxa”. From the 14 participants, average scores were 4.3 and 4.0.

One of the open ended questions from the questionnaire completed by the Workshop participants was, “What was the most constructive part of the workshop?” Some of the constructive aspects of the Workshop which were highlighted were: the Workshop participants were co-operative - no one tried to ‘push their own agenda’; the expertise of ornithologists was well represented by the Workshop participants; it was good to listen to expert opinions; the in-depth discussion about the mathematical and statistical aspects of this method was good; it was very good to have a selected number of trial species on which to test the model because this solicited a lot of interaction and comment from the participants which was valuable; the discussions at the Workshop were very constructive and helpful; it is good to know that the method being used is sound and that it will produce a product that will be used in practice; it was good that difficult areas were worked through until a consensus was reached and that these areas were not just swept under a mat ‘to be looked at at a later stage’.

In terms of evaluating the product of this MCDA process; a smaller group of ornithologists continued to engage on aspects of the model development after the Workshop. While a full evaluation of the product has not been attempted, it appears that those who were involved in the development of this model are satisfied that it is producing sensible outputs that reflect their values. A full scale evaluation of the model itself will require a longer term process and will unfold only once it is used in practice.

CHAPTER 4

Criteria for selecting Species of Special Concern: Core Range, Range Size and Taxonomic Uniqueness

Introduction

This chapter contains a detailed explanation of the calculation of three of the four criteria chosen in this prioritisation process. For the first two criteria of Core Range and Range Size, SABAP1 data were used. For the third criterion, Taxonomic Uniqueness, data were based on the species list from the International Ornithologists' Committee (IOC).

In this chapter, the 'Workshop' refers to a one and a half day event held in January 2011 at SANParks Cape Research Centre (CRC) in Tokai, Cape Town. The aim of the Workshop was to develop a method, including a set of criteria, by which Bird Species of Special Concern could be prioritised in SANParks. Further details of the Workshop are provided in the previous chapter.

Criteria explanations

Core Range criterion calculation

The calculation for the Core Range criterion of a species was based on the concept of reporting rates. This in turn was dependent on the protocol used for the first bird atlas project in southern Africa, SABAP1 (Harrison et al. 1997). During SABAP1, checklists of bird species were collected in quarter degree grid cells (QDGCs), each with an area of c. 675 km^2, with dimensions 27 km north-south × c. 25 km east-west, and were captured electronically. The reporting rate is defined as the proportion of times a species was recorded as present in a QDGC out of the total number of checklists completed for that QDGC. This is expressed as a percentage. Caveats to the interpretation of reporting rates are discussed by Harrison & Underhill (1997). SABAP2 data were not used in this core range criterion calculation because the SABAP2 coverage was not yet adequate to define the distributions of species. At the time of the workshop in January 2011, coverage was 48% of the grid cells used by SABAP2; almost exactly half of these grid cells had only had a single checklist submitted, and only 14.5% of the grid cells in the SABAP2 region had four or more checklists, which is regarded as the minimum sample size from which to begin to estimate reliable reporting rates (LG Underhill *in litt*.).

An algorithm, based on the generalized linear model, was developed by Little (2003) to perform local smoothing of reporting rates; her smoothed reporting rates largely removed the consequences of small sample sizes on the observed reporting rates in a particular cell by making use of data from its neighbouring cells. There was insufficient SABAP2 data to perform this smoothing operation. There is strong evidence (e.g. Griffioen 2001) that, for a particular species, reporting rates are monotonically related to abundance. Griffioen (2001) had large volumes of standardized bird count data from Australia available to him, and he demonstrated both the strength of the relationship between abundance and reporting rate and its theoretical functional form. The smoothed maps developed by Little (2003) used the data from Harrison et al. (1997) and Parker (1999, 2005), and covered Namibia, Botswana, Zimbabwe, southern and central Mozambique (including Tete Province), South Africa, Lesotho and Swaziland. Apart from Tete Province, this is the area south of the Zambezi and Kunene Rivers, which is generally referred to as "southern Africa" (e.g. Hockey et al. 2005). These smoothed maps are available for all species on the SABAP2 website, http://sabap2.adu.org.za.

The most important caveat to the interpretation of reporting rates is that, in relationship to abundance, they are not comparable between species. Within a single species however, those parts of the range with the largest reporting rates for that species are likely to be the areas where it is most abundant. This leads to the definition of the concept of the core of the range of a species. The "core range" of a species was defined as the QDGCs where the atlas reporting rates exceed a defined threshold. Because the absolute reporting rates in themselves were not comparable between species, it makes sense to set these thresholds on a 'within species' basis (Little 2003). For this workshop five thresholds were available. These were based on the calculations by Little (2003). To facilitate the mapping algorithm on the website, the database included these five percentiles of the reporting rates for each species for the smoothed distributions.

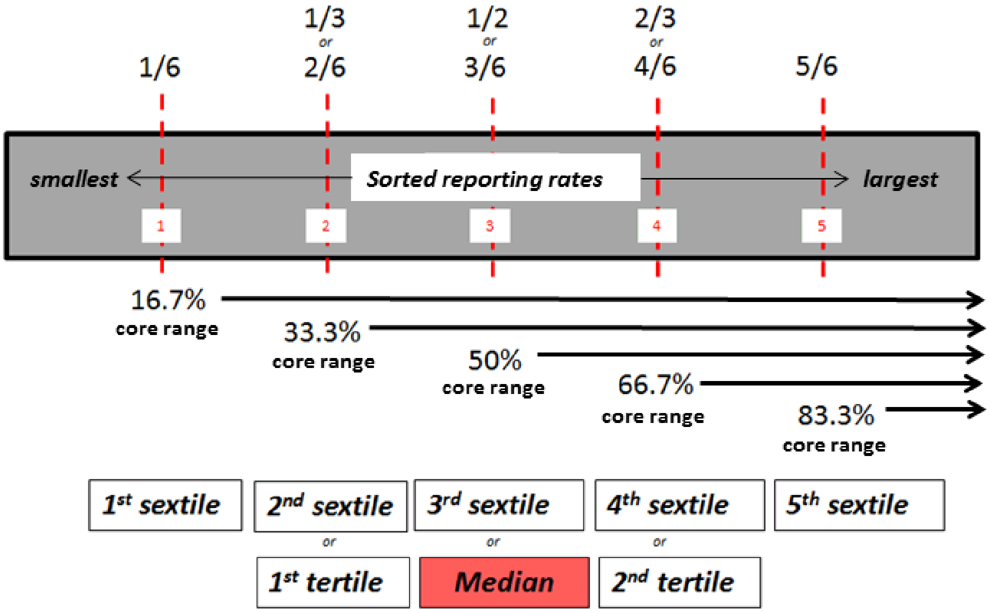


Figure 4.1. Graphic illustration of how five thresholds (percentile divisions) were derived from 'smoothed' SABAP1 data. Conceptually, the shaded box contains the reporting rates for a species, sorted from smallest to largest. The reporting rates in each sextile is equal (or as equal as possible with integer arithmetic)

The reporting rates for cells where the species was present were divided into six categories (hence five thresholds or percentiles), so that there were the same number of QDGCs in each category. These were dubbed sextiles (by analogy with quartiles) and cut off 1/6 (first sextile), 2/6 =1/3 (first tertile), 3/6=1/2 (median), 4/6=2/3 (second tertile) and 5/6 (fifth sextile) of the reporting rates respectively. They define the 1/6th = 16.7% core range, 33.3% core range, 50% core range, 66.7% core range and 83.3% core ranges respectively (Figure 4.1). In words, the 50% core range, for example, consists of half the QDGCs in which the species was recorded, those in which the reporting rate was above the median. In the distribution of the Cape Sugarbird *Promerops cafer* the dark green colour, as well as the two shades of blue, represents the 'core range' of this species (Figure 4.2). The legend for this figure shows the six cut-points at which the reporting rate for this species was divided.

Because these five percentiles were readily available, the results presented at the Workshop included those defining the "core of the distribution" in these five ways. However it is the median (50%) core range which is the most useful percentile (Little 2003) and this threshold has been used in subsequent calculations and sensitivity analyses. The use of other percentiles than these five to define the core range is also possible, but involves extensive calculations within the database.

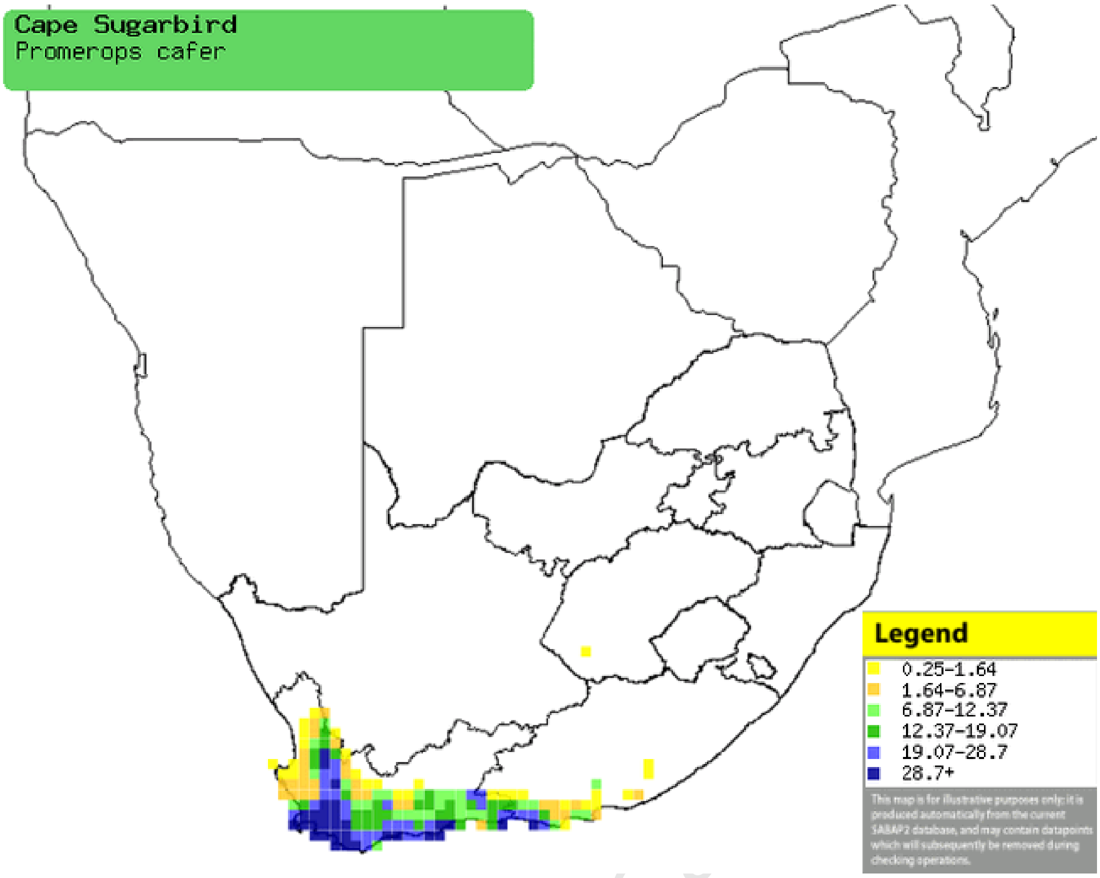


Figure 4.2. Distribution of Cape Sugarbird *Promerops cafer* using SABAP1 data smoothed by the algorithm of Little (2003). The cutpoints in the Legend are determined in such a way that equal numbers of quarter degree grid cells have each shading. The 50% core range is therefore shown by the darker shade of green and the two shades of blue

Thus the "50% core range" of a species is defined as the subset of cells with reporting rates above the median. Another informal interpretation of "core range" is that it represents the part of the range where the species really does "want to be." The "50% core range" or "median core range" seems to provide a useful description of the most important part of the range of a species, and is likely to represent the primary area in which conservation action can most effectively be focused. From this point on, the term "Core Range" is used to specifically mean the "50% core range" of a species.

This definition of the core of the range requires that the area covered is so large that it includes marginal and unsuitable habitat for all species. This is true of the range maps developed by Little (2003), which cover southern Africa south of the Zambezi and Kunene Rivers. Probably the most widespread species in this region is the Cape Turtle Dove *Streptopelia senegalensis*, (Colahan & Harrison 1997, Figure 4.3).

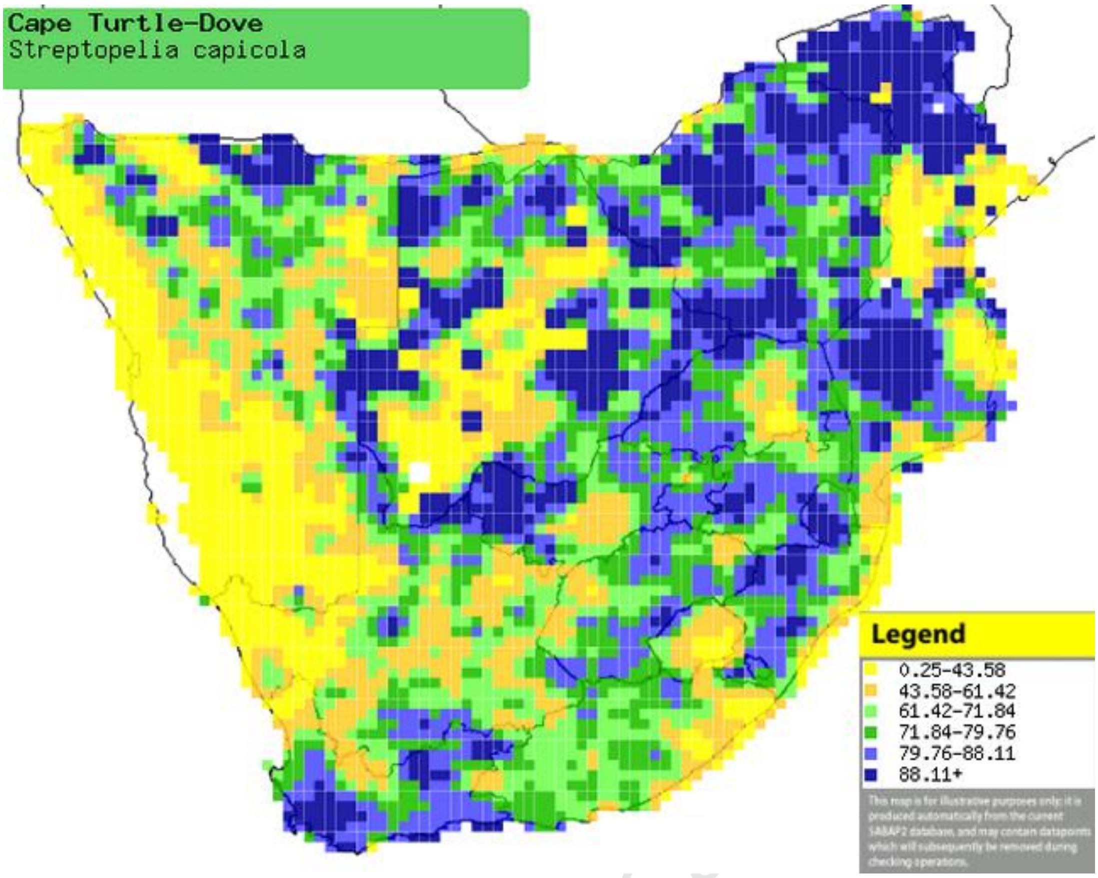


Figure 4.3. SABAP1 distribution of Cape Turtle-Dove *Streptopelia capicola* smoothed by the algorithm of Little (2003). The cutpoints in the Legend are determined in such a way that equal numbers of quarter degree grid cells have each shading. The 50% core range is therefore shown by the darker shade of green and the two shades of blue

One of the ecological requirements of this species is that it requires a supply of water to drink. Even for this species there are areas, for example much of the arid west, where there is no open water, and which are clearly not part of the core of the range of the species (Figure 4.3). In contrast, the calculation of core range in this way does not make sense if the area under consideration is so small that there are species which are common throughout the area. For example, if reporting rates for a species are high, say above 80%, for all grid cells in the area, then the entire area should be core range, but this approach will only define the area with reporting rates above the median as being core range. In the bird atlas for southern Mozambique (Parker 1999) for example, because of the relatively small area that was atlased, some species were common throughout the entire area. A consequence of this was that, if the distribution maps had been produced in the same way as for the Southern African Bird Atlas Project (Harrison et al. 1997), they would have been visually misleading, and would have implied that a species was ‘rare’ in some grid cells, even though in reality the reporting rate was large.

Ideally, these calculations on reporting rates to determine the core of the range should be done using the entire range of the species. Data limitations restricted the analyses of the core of the range to within southern Africa only. For the purposes of this project, with its focus on national parks within South Africa, it was fortunate that there was good quality reporting rate data for a wide buffer of area to the north of the country – the large countries of Namibia, Botswana, Zimbabwe and much of Mozambique.

Counts of grid cells in the Core Range can be made for specific geographical areas. Two geographic areas are important for this application – the geographic area which constitutes South Africa (Lesotho and Swaziland) and the geographic area constituting the national parks within South Africa. The number of grid cells in the (southern African) Core Range that fall within South Africa (plus Lesotho and Swaziland) were counted as well as the number of grid cells in the Core Range of a species for each national park. The "South African value" of a national park to a species was defined as the ratio of these two numbers, expressed as a percentage. This percentage thus measures the importance of a national park to a species, within a South African context – in other words, it measures the extent to which the South African Core Range of the species falls within the national park. The larger this percentage, the greater the responsibility of that national park in particular and SANParks in general, towards the conservation of this species in South Africa.

Many variations of the calculation of this statistic are possible. It is possible for example, to compute the number of Core Range cells which fall within the entire national park 'Estate' (i.e. the amalgamation of all the SANParks) and therefore estimate the overall SANParks responsibility towards the conservation of a species within its Core Range.

Example of a Core Range calculation for Bateleur in the Kruger National Park

Table 4.1 presents a variety of Core Range statistics for a selection of 10 species of birds in the Kruger National Park. The row with values for the Bateleur *Terathopius ecaudatus* is highlighted as is the column headed "Above median". This latter column is the column on which the table has been sorted; therefore it is based on the concept of using the "50% Core Range" as the way to determine the Core Range of a species, the area where "it really wants to be."

Table 4.1: Kruger National Park Core Range data for a selected number of species, highlighting the Bateleur *Terathopius ecaudatus*. An explanation of a 'sextile' is provided in Figure 4.1 and the key provides an explanation of the abbreviations used in the column headings

	Above 1st sextile					Above 2nd sextile					Above median					Above 4th sextile					Above 5th sextile				
	1					2					3					4					5				
Common Name	QDGCs PA	QDGCs RSA	% PA/RSA	QDGCs sA	% RSA/sA	QDGCs PA	QDGCs RSA	% PA/RSA	QDGCs sA	% RSA/sA	QDGCs PA	QDGCs RSA	% PA/RSA	QDGCs sA	% RSA/sA	QDGCs PA	QDGCs RSA	% PA/RSA	QDGCs sA	% RSA/sA	QDGCs PA	QDGCs RSA	% PA/RSA	QDGCs sA	% RSA/sA
Oxpecker, Yellow-billed	12	16	75	349	4.6	7	7	100	276	2.5	3	3	100	208	1.4	0	0	0	138	0.0	0	0	0	70	0.0
Openbill, African	45	92	48.91	791	11.6	38	74	51.35	627	11.8	34	60	56.67	472	12.7	28	40	70	315	12.7	12	14	85.71	160	8.8
Eremomela, Green-capped	24	66	36.36	675	9.8	17	42	40.48	538	7.8	9	16	56.25	404	4.0	0	0	0	270	0.0	0	0	0	137	0.0
Eagle, Lesser Spotted	46	101	45.54	535	18.9	42	89	47.19	421	21.1	39	72	54.17	316	22.8	33	50	66	213	23.5	20	24	83.33	107	22.4
Stork, Saddle-billed	50	123	40.65	894	13.8	43	104	41.35	713	14.6	43	80	53.75	536	14.9	39	58	67.24	359	16.2	28	34	82.35	181	18.8
Lark, Flappet	51	174	29.31	1143	15.2	46	125	36.8	915	13.7	33	64	51.56	687	9.3	14	25	56	460	5.4	0	0	0	232	0.0
Eagle, Steppe	44	122	36.07	765	16.0	42	100	42	601	16.6	38	74	51.35	454	16.3	27	43	62.79	305	14.1	4	13	30.77	154	8.4
Bateleur	50	211	23.7	2245	9.4	46	114	40.35	1797	6.3	43	85	50.59	1349	6.3	38	56	67.86	904	6.2	27	30	90	457	6.6
Lark, Dusky	43	112	38.39	885	12.7	41	98	41.84	701	14.0	37	75	49.33	526	14.3	21	48	43.75	353	13.6	11	26	42.31	178	14.6
Vulture, White-headed	47	138	34.06	1212	11.4	46	113	40.71	963	11.7	43	92	46.74	727	12.7	36	49	73.47	487	10.1	25	29	86.21	246	11.8

Key	
Abbreviation	**Explanation**
QDGCs PA	No. of Quarter Degree Grid Cells in specified Protected Area in South Africa
QDGCs RSA	No. of Quarter Degree Grid Cells in South Africa, Lesotho and Swaziland
% PA/RSA	Ratio of QDGCs in specified Protected Area and QDGCs in South Africa, Lesotho and Swaziland, expressed as a percentage
QDGCs sA	No. of Quarter Degree Grid Cells in southern Africa
% RSA/sA	Ratio of QDGCs in South Africa (plus Lesotho and Swaziland) and QDGCs in southern Africa, expressed as a percentage

The five numbers associated with “Bateleur” and “median” are 43, 85, 50.59, 1349 and 6.3. These are interpreted as follows. In 43 QDGCs in the Kruger National Park, the Bateleur has reporting rates above the median reporting rate for the Bateleur (i.e. which fall within the Core Range of this species). Within South Africa, Lesotho and Swaziland there are 85 quarter degree grid cells have reporting rates above the median reporting rate. Thus 50.59% (=43/85) of the South African Core Range of the Bateleur falls within the Kruger National Park. In a South African context, the Kruger National Park therefore has a high level of responsibility for this species, because it contains 51% of the national Core Range for this species. However, within southern Africa as a whole, there are 1349 QDGCs with reporting rates above the median, and the percentage of these which fall within South Africa is 6.3% (=85/1349). For all Core Range criterion calculations, it was decided to include a cut-off threshold of 0.5% for the central column (Table 4.1) on which the species were sorted. This was done to exclude species which have an insignificant fraction of their Core Range within a national park.

A selection of 10 species from the “SANParks Estate” is shown (Table 4.2). If one again focuses on the Bateleur, 59 of the 85 quarter degree grid cells in the Core Range for the Bateleur are in the national park estate, 69.4% of the total. This can be interpreted as suggesting that SANParks carries 69% of the responsibility for the conservation of the Bateleur in South Africa, Lesotho and Swaziland. For all the Core Range calculations, a cut-off threshold of 0.5% for the Core Range criterion was used so that only those species which had substantial fractions of their range within the park were considered as candidates for Species of Special Concern for that park.

Range Size criterion calculation

A provisional criterion suggested prior to the Workshop (Appendix 1) was that of “Endemics, Near-endemics and range-restricted species”. During subsequent discussions at the Workshop, the term “endemic” (to South Africa) was identified as being too vague, because it meant that widespread endemic species, such as the Cape Weaver *Ploceus capensis*, were considered as equivalent to range restricted endemics such as the Cape Sugarbird. It was decided therefore to replace the criterion with one that was based only on range size, as determined by the data from the bird atlas project.

“Range Size” can refer to the total number of grid cells where the species occurred. The primary disadvantage of this is that it includes cells in which the species occurred only rarely. In order to avoid this problem, grid cells were only counted for species in which the reporting rate was above the first sextile.

Table 4.2: 'SANParks Estate' Core Range data for selected species, highlighting the Bateleur *Terathopius ecaudatus*. An explanation of a 'sextile' is provided in Figure 4.1 and the key provides an explanation of the abbreviations used in the column headings

Common Name	Above 1st sextile 1					Above 2nd sextile 2					Above median 3					Above 4th sextile 4					Above 5th sextile 5				
	QDGCs PA	QDGCs RSA	% PA/RSA	QDGCs sA	% RSA/sA	QDGCs PA	QDGCs RSA	% PA/RSA	QDGCs sA	% RSA/sA	QDGCs PA	QDGCs RSA	% PA/RSA	QDGCs sA	% RSA/sA	QDGCs PA	QDGCs RSA	% PA/RSA	QDGCs sA	% RSA/sA	QDGCs PA	QDGCs RSA	% PA/RSA	QDGCs sA	% RSA/sA
Oxpecker, Yellow-billed	13	16	81.25	349	4.58	7	7	100	276	2.54	3	3	100	208	1.44	0	0	0	138	0	0	0	0	70	0
Parrot, Brown-headed	50	97	51.55	474	20.46	47	61	77.05	378	16.14	39	40	97.5	284	14.08	31	31	100	190	16.32	11	11	100	96	11.46
Vulture, Hooded	48	64	75	506	12.65	43	52	82.69	403	12.9	40	44	90.91	303	14.52	31	31	100	203	15.27	19	19	100	102	18.63
Owlet, African Barred	32	46	69.57	873	5.27	29	39	74.36	698	5.59	17	21	80.95	524	4.01	6	7	85.71	351	1.99	2	2	100	177	1.13
Lapwing, White-crowned	39	59	66.1	302	19.54	32	48	66.67	237	20.25	24	34	70.59	180	18.89	13	17	76.47	119	14.29	2	2	100	61	3.28
Bateleur	75	211	35.55	2245	9.4	66	114	57.89	1797	6.34	59	85	69.41	1349	6.3	46	56	82.14	904	6.19	30	30	100	457	6.56
Dove, African Mourning	48	86	55.81	679	12.67	45	74	60.81	542	13.65	39	57	68.42	408	13.97	23	28	82.14	273	10.26	12	13	92.31	138	9.42
Stork, Saddle-billed	55	123	44.72	894	13.76	48	104	46.15	713	14.59	48	80	60	536	14.93	44	58	75.86	359	16.16	33	34	97.06	181	18.78
Vulture, White-headed	68	138	49.28	1212	11.39	63	113	55.75	963	11.73	54	92	58.7	727	12.65	38	49	77.55	487	10.06	25	29	86.21	246	11.79
Openbill, African	49	92	53.26	791	11.63	41	74	55.41	627	11.8	35	60	58.33	472	12.71	28	40	70	315	12.7	12	14	85.71	160	8.75

Key	
Abbreviation	**Explanation**
QDGCs PA	No. of Quarter Degree Grid Cells in specified Protected Area in South Africa
QDGCs RSA	No. of Quarter Degree Grid Cells in South Africa, Lesotho and Swaziland
% PA/RSA	Ratio of QDGCs in specified Protected Area and QDGCs in South Africa, Lesotho and Swaziland, expressed as a percentage
QDGCs sA	No. of Quarter Degree Grid Cells in southern Africa
% RSA/sA	Ratio of QDGCs in South Africa (plus Lesotho and Swaziland) and QDGCs in southern Africa, expressed as a percentage

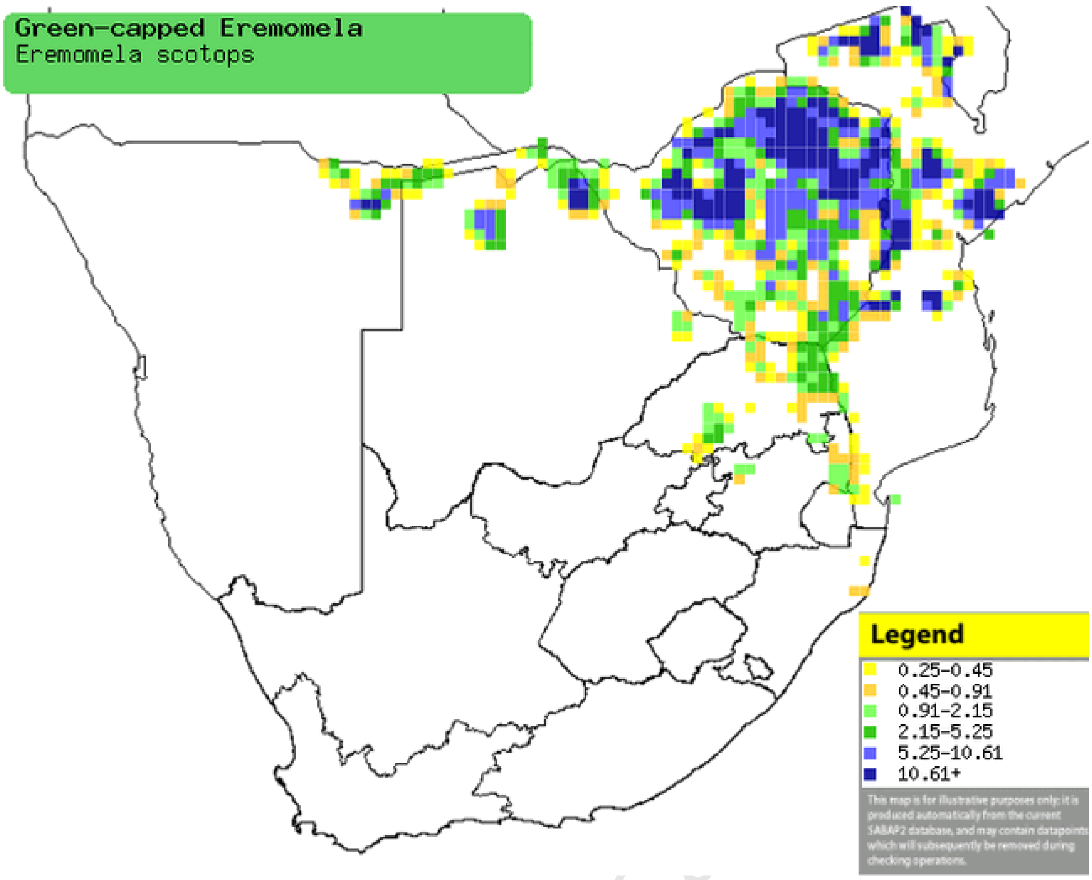


Figure 4.4. SABAP1 data of Green-capped Eremomela *Eremomela scotops* reporting rate, distribution, smoothed by the algorithm of Little (2003). The cutpoints in the Legend are determined in such a way that equal numbers of quarter degree grid cells have each shading

For the Range Size criterion, the same thresholds of reporting rates were used as discussed for the Core Range criterion and described in the previous section (Figure 4.1). The total number of quarter degree grid cells in South Africa is 2008 and in southern Africa it is 4537. For this Range Size criterion, the area covered in which grid cells were counted was *southern* Africa. This was done so that species with only a small portion of their range in South Africa, and a large portion in southern Africa, would not score more highly than genuinely range restricted species.

Example of a Range Size criterion calculation for Green-capped Eremonela and Bateleur in the Kruger National Park

The Green-capped Eremonela *Eremomela scotops* is an example of an 'apparent' range restricted South African species. It only occupies 66 QDGCs, above the first percentile, in the whole of South Africa but in southern Africa it has a coverage of 675 QDGC above the first sextile (Table 4.3). This species may appear to be 'range-restricted' if one only considers the boundaries of South Africa, but looking at the broader scale of southern

Africa, it is apparent that this is not a range restricted species (Figure 4.4). If one again looks at the example of the Bateleur in the Kruger National Park, the number of QDGCs occupied by this species, with a reporting rate above the first sextile, in southern Africa is 2245 (Table 4.3). Of these QDGCs, 211 are in South Africa. In total, 9.4% (211/2245) of the Bateleur's Range Size (above the first sextile) is in South Africa (Figure 4.5).

The explanation which was been provided here is purely to explain how the criterion of Range Size was calculated. The description of how a scale was developed for this criterion, and what values were attached to it (how the value function was developed is contained in Chapter 3).

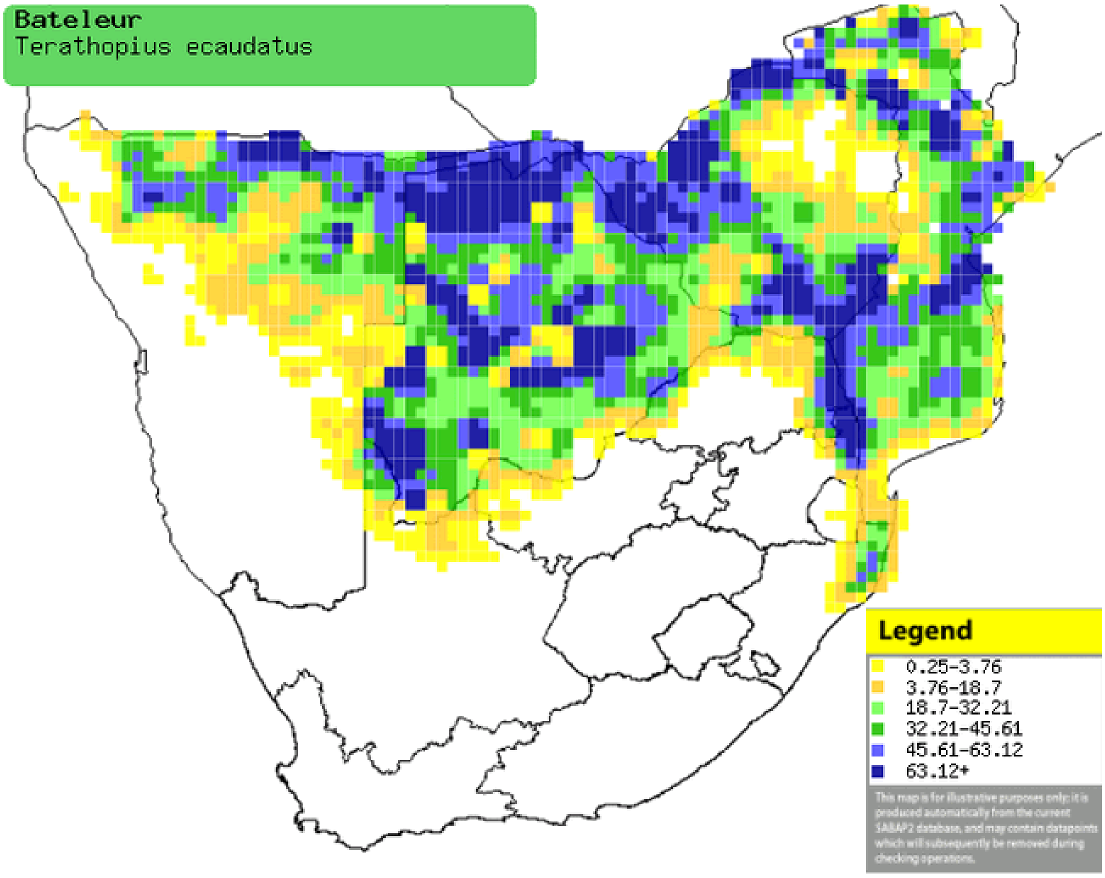


Figure 4.5. Distribution of Bateleur *Terathopius ecaudatus* in southern Africa from SABAP1 data, smoothed by the algorithm of Little (2003). The cutpoints in the Legend are determined in such a way that equal numbers of quarter degree grid cells have each shading

Table 4.3. Kruger National Park Rage Size data for a selection of species highlighting the Green-capped Ermonenla Green-capped Eremomela *Eremomela scotops* and Bateleur *Terathopius ecaudatus*. An explanation of a 'sextile' is provided in Figure 4.1 and the key provides an explanation of the abbreviations used in the column headings. The data are sorted on the highlighted column

	Above 1st sextile					Above 2nd sextile					Above median					Above 4th sextile					Above 5th sextile				
Common Name	1					2					3					4					5				
	QDGCs PA	QDGCs RSA	% PA/RSA	QDGCs sA	% RSA/sA	QDGCs PA	QDGCs RSA	% PA/RSA	QDGCs sA	% RSA/sA	QDGCs PA	QDGCs RSA	% PA/RSA	QDGCs sA	% RSA/sA	QDGCs PA	QDGCs RSA	% PA/RSA	QDGCs sA	% RSA/sA	QDGCs PA	QDGCs RSA	% PA/RSA	QDGCs sA	% RSA/sA
Oxpecker, Yellow-billed	12	16	75	349	4.6	7	7	100	276	2.5	3	3	100	208	1.4	0	0	0	138	0.0	0	0	0	70	0.0
Openbill, African	45	92	48.91	791	11.6	38	74	51.35	627	11.8	34	60	56.67	472	12.7	28	40	70	315	12.7	12	14	85.71	160	8.8
Eremomela, Green-capped	24	66	36.36	675	9.8	17	42	40.48	538	7.8	9	16	56.25	404	4.0	0	0	0	270	0.0	0	0	0	137	0.0
Eagle, Lesser Spotted	46	101	45.54	535	18.9	42	89	47.19	421	21.1	39	72	54.17	316	22.8	33	50	66	213	23.5	20	24	83.33	107	22.4
Stork, Saddle-billed	50	123	40.65	894	13.8	43	104	41.35	713	14.6	43	80	53.75	536	14.9	39	58	67.24	359	16.2	28	34	82.35	181	18.8
Lark, Flappet	51	174	29.31	1143	15.2	46	125	36.8	915	13.7	33	64	51.56	687	9.3	14	25	56	460	5.4	0	0	0	232	0.0
Eagle, Steppe	44	122	36.07	765	16.0	42	100	42	601	16.6	38	74	51.35	454	16.3	27	43	62.79	305	14.1	4	13	30.77	154	8.4
Bateleur	50	211	23.7	2245	9.4	46	114	40.35	1797	6.3	43	85	50.59	1349	6.3	38	56	67.86	904	6.2	27	30	90	457	6.6
Lark, Dusky	43	112	38.39	885	12.7	41	98	41.84	701	14.0	37	75	49.33	526	14.3	21	48	43.75	353	13.6	11	26	42.31	178	14.6
Vulture, White-headed	47	138	34.06	1212	11.4	46	113	40.71	963	11.7	43	92	46.74	727	12.7	36	49	73.47	487	10.1	25	29	86.21	246	11.8

Key	
Abbreviation	**Explanation**
QDGCs PA	No. of Quarter Degree Grid Cells in specified Protected Area in South Africa
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QDGCs sA	No. of Quarter Degree Grid Cells in southern Africa
% RSA/sA	Ratio of QDGCs in South Africa (plus Lesotho and Swaziland) and QDGCs in southern Africa, expressed as a percentage

Taxonomic Uniqueness criterion calculation

The basis of the taxonomic 'value' of a species was incorporated in order to try to maintain a maximum genetic diversity. At the Workshop, a 'coarse' Taxonomic Uniqueness scoring system was developed (referred to as Method 1) and used in the prioritization process (Table 4.4). This system had originally been used by Shaw (1995) in a prioritization exercise for the bird species of the Western Cape. It was based on the idea that a species which is the only member of its group is clearly more "valuable," from the perspective of setting conservation priorities, than a species in a group with lots of other members. Species were classified as belong to one of four groups: monotypic order, monotypic family, monotypic genus and non-monotypic and consensus scores (between 0 –100) were elicited for each of these categories during the Workshop.

After the workshop, a more nuanced approach to Taxonomic Uniqueness was developed (referred to as Method 2) to capture the taxonomic value of a species, still using an approach based on concepts of Order, Family, Genus and Species. There is a vast literature on scoring systems based on taxonomy and phylogeny (eg Faith 1996, Krajewski 1994, Rodrigues & Gaston 2002, Redding & Mooers 2006, Forest et al. 2007). Ultimately, one will be able to determine the taxonomic value of a species from a complete phylogenetic tree, but at the time of the Workshop this was not yet fully complete and available for birds (H. Smit pers. comm.)

Given that the importance (weight) allocated to Taxonomic Uniqueness at the Workshop was the smallest of the four criteria selected, and given that there is not yet consensus on how the complete phylogenetic tree should be translated into a "uniqueness measure" (Redding & Mooers 2006), it is a disputable point whether the gains obtained by using such a system would be better than using the relatively simple and easy to grasp system proposed here. This method is similar to the "equal splits" approach devised in a more complex setting by Redding & Mooers (2006).

Table 4.4. The scores used at the Workshop for each Taxonomic Uniqueness category

Category	Score
Monotypic Order	100
Monotypic Family	75
Monotypic Genus	25
Not monotypic	0

The original data for this classification of the bird species of the world into Order, Family, Genus and Species was based on the web-based International Ornithologists' Union (IOC) master list which was downloaded on 4 April 2011 from http://www.worldbirdnames.org/names.html.

To begin with, each Order was assigned an equal value, and without loss of generality, this value was taken as one. At each level of taxonomic split (Order, Family, Genus), the value entering the split was divided evenly among the units leaving it (Families, Genera, Species). It was proposed that the Taxonomic Value be determined globally, because the overall prioritization system already assigned a value to concepts such as endemism and range restriction which were calculated at a national level. Three examples of this approach to determining Taxonomic Value (TV) are considered (Figure 4.6).

At one extreme was the order Struthiformes, which contained a single family, the Struthionidae, and a single genus, *Struthio*, which contains two species, one of which is the Common Ostrich *Struthio camelus*. This species therefore has Taxonomic Value TV=0.5 (=1/1×1/1×1/2). An intermediate species is the Cape Sugarbird *Promerops cafer*. The Promeropidae is one of 125 families in the order Passeriformes. There are four genera in this family, of which one is *Promerops*, which contains two species. The taxonomic value of the Cape Sugarbird is thus TV=0.001 (=1/125×1/4×1/2). An example of a species with a small taxonomic value is the Cape White-eye *Zosterops pallidus*. The Zosteropidae is one of the 125 families in the Passeriformes. The family contains 17 genera, and there are 80 species within the genus *Zosterops*. The Taxonomic Value is TV=0.000005882 (=1/125×1/17×1/80).

Since there are 40 orders of birds, this calculation, which would have included a multiplication factor of 1/40 to the overall score, is not considered because all species would have this as part of their calculation. Alternatively one could say that the Taxonomic Value obtained in this way 40 times larger than it ought to be. If one was calculating the Taxonomic Values across several taxa, e.g. Mammals, Reptiles and Birds, one might choose to give each taxon a value of one, and then the fact that there birds are classified in 40 Orders would be an important consideration, in relation to the number of Orders in the other taxa.

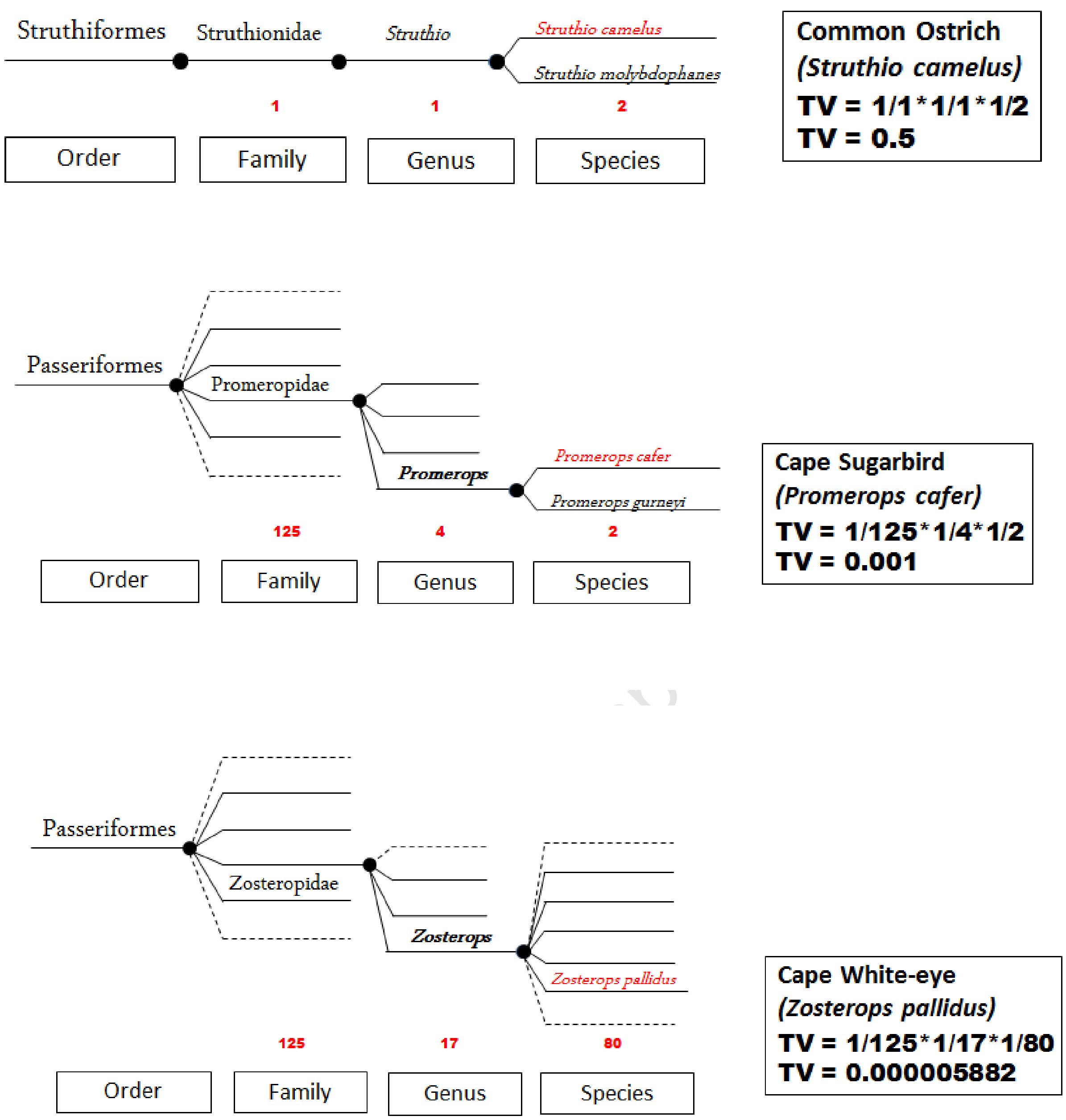

Figure 4.6. Three Taxonomic Value (TV) calculations for birds at extreme values. See text for description of the approach

However, the ratios of these "raw" taxonomic values do not reflect the consensus of the relative Taxonomic Value of an ostrich to a white-eye: 0.5/0.000005882 =85000. i.e. the Taxonomic Value of an ostrich is 85 000 times greater than that of a white-eye. It was proposed that as an initial approach, the logarithmic scale be used to determine values for use in the value function approach. This commonly used transformation has the effect of shrinking in 'outliers' and making contrasts less extreme. On this scale, the value of an ostrich is 17.4 times that of a white-eye (=log(0.5)/log(0.000005882) which is a more realistic ratio.

Table 4.5. The relative Taxonomic Uniqueness scores of the three selected species

Species	Taxonomic Uniqueness Score
Common Ostrich	100
Cape Sugarbird	10
Cape White-eye	5.8

Thus the proposal is that the quantity to enter the value function approach as a measure of the Taxonomic Uniqueness (TU) of a species is computed on a logarithmic scale, relative to the largest Taxonomic Value (TV) calculated, that for Common Ostrich:

TU(species) = log(TV(species))/log(TV(ostrich))

On this scale, the Taxonomic Uniqueness of Common Ostrich is 1, that of the sugarbirds is 0.1003, and that of the white-eyes is 0.0576. To be consistent with other value functions in the model, these values were multiplied by 100 to get scores ranging from 0 to 100, the range that is used by V·I·S·A (Visual Interactive Sensitivity Analysis) for each criterion (Table 4.5). These numbers represent a consensus among the 'workshop leadership' of a first step towards an appropriate set of relative Taxonomic Uniqueness scores.

Future improvements for criteria calculations

SABAP1 data were used for the calculations for the Core Range and Range Size criteria because a sufficient amount of SABAP 2 data were not available. Once there is sufficient coverage for the SABAP2 project, the use of these data will allow the criteria to be based on more recent data. SABAP2 is also up to date with changes in species names and species splits. This is one criticism of the SABAP1 data used in this analysis – it is based on the taxonomy of the time at which the project started; separation of ranges of species which have been split involves arbitrary decisions. SABAP1 has an advantage however in that it covers the whole of southern Africa, not just South Africa. This extensive coverage was used in determining thresholds for the sextiles, used in the Core Range and Range Size criteria calculations, as well as determining the extent of the range of a species in southern Africa. SABAP2 coverage is only for South Africa, Lesotho and Swaziland. SABAP2 coverage is at a finer scale than SABAP1; pentads (5' x 5') are used as opposed to QDGCs, with nine pentads per QDGC. This will allow for a closer 'fit' for the area defined as a National Park, and will mean that most of the species which are recorded on the cards, would have been seen while atlasing in the national park, and not outside of its borders, which was the case for SABAP1 data, especially for smaller parks.

In order for the Core Range criterion to be a meaningful calculation, it is important that monitoring of species be done both inside and outside of SANParks.

There are different methods by which the taxonomic uniqueness of a species can be calculated. When more data become available with regards to the complete phylogeny of birds, it may be possible to calculate a taxonomic score based on the length of branches and number of nodes in the phylogenetic tree. Subsequent to the workshop, a first attempt at a phylogenetic tree for birds has been published (Jetz et al. 2012). This development will make it possible to refine the approach used here.

CHAPTER 5

Sensitivity Analysis

Introduction

An important part of multiple criteria decision analysis is conducting a sensitivity analysis. A sensitivity analysis can be undertaken to determine the robustness of a model and the effect that different sets of weights assigned to the criteria have on the outcome of a model (Belton & Stewart 2002). A sensitivity analysis also provides a way to investigate decision makers' uncertainty about their values or priorities, or to examine the extent to which disagreements between decision makers impact on the final overall results (Belton & Stewart 2002) and to assist in investigating the effects of missing data (Traintaphyllou & Sanchez 1997). When public funds and resources are being used, sensitivity analysis is important in demonstrating that a rigorous process has been followed and that experts have been consulted who together have applied their minds to the decision problem.

Belton and Stewart (2002) mentioned three perspectives from which sensitivity analysis can be viewed: a technical perspective, a group perspective and an individual perspective. The most relevant in this case is the technical perspective. From this perspective, a sensitivity analysis can be used to objectively examine the changes which the input parameters have on the output. The input parameters are the scores, weights, and value-functions which the decision makers determine. The output of a model is the synthesis of this information. So a technical sensitivity analysis can be used to determine which of the input parameters have a critical influence on the final outcome. In other words, the analysis shows where small changes in criteria weights or scores can affect the overall performance of the model.

It is also possible to undertake a very strict mathematical approach to the sensitivity analysis. For example, Traintaphyllou & Sanchez (1997) presented a sensitivity analysis for three widely used decision methods - the weighted sum model (WSM), weighted product model (WPM) and the analytic hierarchy process (AHP). The WSM is also known as the Additive Value Function Model and is the one used in this research (Chapter 2). In their paper, Traintaphyllou & Sanchez (1997) formalised some important issues about sensitivity analysis and derived critical theoretical results. The paper also made the important point that "The decision maker can make better decisions if he or she can determine how critical each criterion is; in other words, how 'sensitive' the actual ranking of the alternatives is to changes on the current weights of the decision criteria" (Traintaphyllou & Sanchez 1997, p. 154). If this is known, more time can be spent determining the weights of the criteria which are more important than on those which are less so (Traintaphyllou & Sanchez, 1997).

The initial sensitivity analysis establishes broadly how sensitive the model is. The sensitivity analysis undertaken here gives an idea of the baseline robustness of the models used, and an important question to consider is "Are the models giving sensible outputs?" In the sensitivity analysis presented here, one does not expect to see large changes or differences in the ranking and total scores of species because the range of weights that were considered was quite conservative. What is important to consider is whether these small shifts in species ranking and scores are important from an expert ornithologist's point of view. In other words, are these changes, which may be small, still significant? When assessing these differences however, one needs to bear in mind that they are based on the outputs of a small set of representative species. It is also through the feedback from experts that the outputs of the sensitivity analysis can be interpreted and understood. One chosen ornithologist from the workshop participants provided feedback and this was taken to represent 'expert' opinion from the workshop. Feedback from this ornithologist is presented in quotation marks in the output sections of this chapter.

As the selected Model is used, mistakes may be picked up and improvements made, so there will be an on-going 'participative' sensitivity analysis that will happen over time. A more 'nuanced', thorough sensitivity analysis will happen when the model is put out to test 'in practice'.

BOX 1: Structure of Sensitivity Analysis Chapter

- Introduction
- Approach to sensitivity analysis using VISA
- Application of sensitivity analysis to prioritization of Species of Special Concern
    - Stage One of Sensitivity Analysis: comparison of four Models
    - Stage Two of Sensitivity Analysis
        - APPROACH 1: Effect of alternative Taxonomic Uniqueness calculations
          APPROACH 2: Robustness of four criteria within chosen model investigated
        - APPROACH 3: Effect of shape of value-functions investigated
        - investigated
- Sensitivity analysis outputs
    - Outputs of Stage One of Sensitivity analysis
    - Outputs of Stage Two of Sensitivity analysis
        - APPROACH 1: Outputs
        - APPROACH 2: Outputs
        - APPROACH 3: Outputs
- Sensitivity analysis summary

The sensitivity analysis which is undertaken here investigates the impact of changes in the weights of the decision criteria, as well as changes in the value-functions and scores associated with a single decision criterion. It also explores the outcomes of two approaches for calculating the Taxonomic Uniqueness of a species. The aim of the sensitivity analysis presented in this chapter is to allow the decision makers to determine which is the most appropriate model (in terms of the different weights), to gain an idea of the robustness of the models and which criteria are the most sensitive to change. The chapter is relatively complex and therefore Box 1 is a provided as a guide to the sections and subsections within this chapter.

Approach to sensitivity analysis using VISA

The software package V•I•S•A (Visual Interactive Sensitivity Analysis) was used to conduct this sensitivity analysis. V•I•S•A is a system designed to support the decision making process using multiple criteria (Belton & Hodgkin 1999). V•I•S•A was developed by Valerie Belton of the University of Strathclyde in 1986 and has been used widely by many decision making groups in a range of environments (Belton & Hodgkin 1999). V•I•S•A has an extensive ability for interactive sensitivity analysis, which enables decision makers to investigate the sensitivity and or uncertainty of their choices, with regards to criteria, scores and weights. V•I•S•A makes use of simple, easy to understand visual displays from which feedback information can be provided (Belton & Hodgkin 1999). Effective and efficient feedback is important to allow for a more in depth discussion of a problem and to allow for a greater understanding of different values among decision makers associated with selected criteria (Belton & Hodgkin 1999).

In V·I·S·A there is on option to display a 'Sensitivity Graph'. This graph enables one to investigate (and see visually) how sensitive the overall preference scores are to changes in a particular criterion weight. A worked example of using a Sensitivity Graph is provided below.

Worked example of the use of a Sensitivity Graph in V·I·S·A

A person wants to buy a car and has constructed a value tree, with scores and weights (Figure 5.1). An example of a Sensitivity Graph is shown for the Total Cost vs. the Overall Preference score (Figure 5.2). It is possible to see the effect on the Overall Preference score (Figure 5.2; vertical axis) of varying the weight (Figure 5.2; horizontal axis) of the Total Cost criterion, from 0 – 1. The current weight is indicated by the dashed vertical line (0.64) and the coloured lines correspond to the alternatives (in this case the choice of cars). As the weight for the total cost increases from zero to one, all other weights are reduced, but are kept in the same proportions to each other.

At the current weight of 0.64, the most preferred alternative is the City Golf D. If one decreases the current weight to 0.5 it causes the preference in cars to change, with three cars - Porsche A, BMW B and City Golf D – all having similar scores. As the weight is decreased further below 0.5, the BMW B very quickly becomes the preferred alternative. However, no matter how much one increases the weight of the Total Cost (above 0.64), the City Golf D will always remain the preferred alternative and in fact the preference score of the City Golf D will increase as the weight of the Total Cost increases.

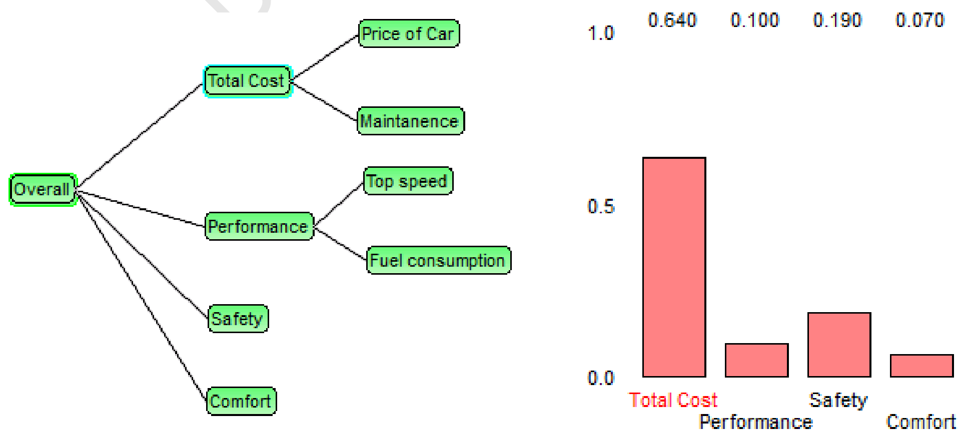

Figure 5.1. Value tree and weights assigned to four criteria for the theoretical decision problem of buying a new car

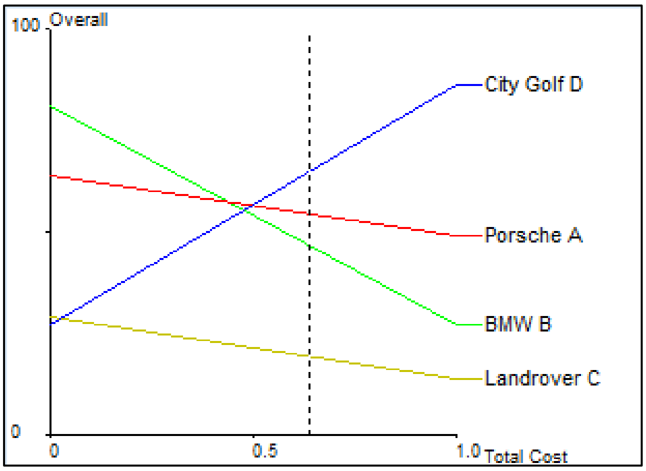

Figure 5.2. Sensitivity Graph in V·I·S·A of the criteria Total Cost of a car versus the Overall Preference score. The dashed line indicates the selected weight of 0.64 for Total Cost

Sensitivity Graphs used in this analysis

In the V·I·S·A Sensitivity Graph display, it is practical to only include a limited number of alternatives (in this case species). If too many alternatives are used, the display window becomes 'cluttered' and difficult to interpret. Because of this, only a small set of species for a particular national park were selected as representative of all species assessed for that park base on selected guidelines.

When interpreting the V·I·S·A Sensitivity Graphs, if the line representing a species had a steep gradient, either positive or negative, it means the rate of change in its position, as the weight shifts for a criterion, is large. In contrast, a species with a fairly horizontal line remains fairly constant in its position, in spite of an increase or decrease in criterion weight. The reason for a species having a steep gradient is most likely related to a high score in one of the criteria in the prioritisation process.

Application of sensitivity analysis to prioritization of Species of Special Concern

Two flow diagrams show two stages of the sensitivity analysis process undertaken (Figure 5.3 & Figure 5.4). A set of a reference of key terms is also provided (Table 5.1).

Stage One of Sensitivity Analysis: comparison of four Models

The sensitivity analysis presented in this chapter was used to first establish which of the four models best captured the relative ranking of the selected species for a national park – from the opinion of an ornithologist. To start with, one national park was selected for the sensitivity analysis. From this park, a set of representative species were selected based on the following guidelines:

- Top 10 species with the highest scores from the initial analysis;
- Species with a high threat status (which were not among the top 10 species);
- One species each from the middle and lower end of the range of scores;
- Iconic or well-known species;
- Species scoring particularly high in one of the four criteria.

Comparison of 'Thermometer Charts '

Not more than 20 species were selected in total to allow for ease of interpretation in the V·I·S·A sensitivity graph display. Data for each of the four criteria for each species were then entered into V·I·S·A. The outputs of the four models were then compared using the 'thermometer display chart in V·I·S·A. Thermometer Charts allow one to easily see the rank ordering and scores attached to each alternative and the 'distance' between the alternatives (which in this analysis are the bird species) – e.g. Figure 5.8. One model was then selected which most accurately captured the ordering of the 20 selected species for monitoring and conservation action, as assessed by an ornithologist.

Stage Two of Sensitivity Analysis

In the next stage of this sensitivity analysis, three Approaches were used which investigated different aspects of the selected model.

Approach 1 investigated the effect of different sets of scores for the Taxonomic Uniqueness calculation using two Methods.

Approach 2 looked at the robustness of the four criteria to changes in weights, using four different weight change Scenarios.

Approach 3 assessed the effect of the shape of the value-functions and scores attached to the criteria, making use of three Cases: A, B and C.

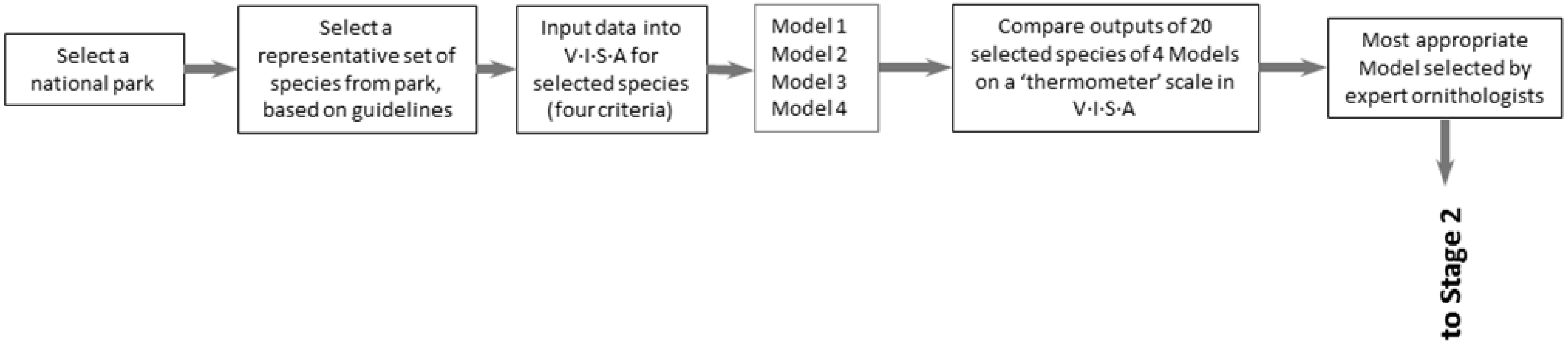

Figure 5.3. First stage of sensitivity analysis process undertaken. The key terms used in the flow diagram are defined in Table 5.1

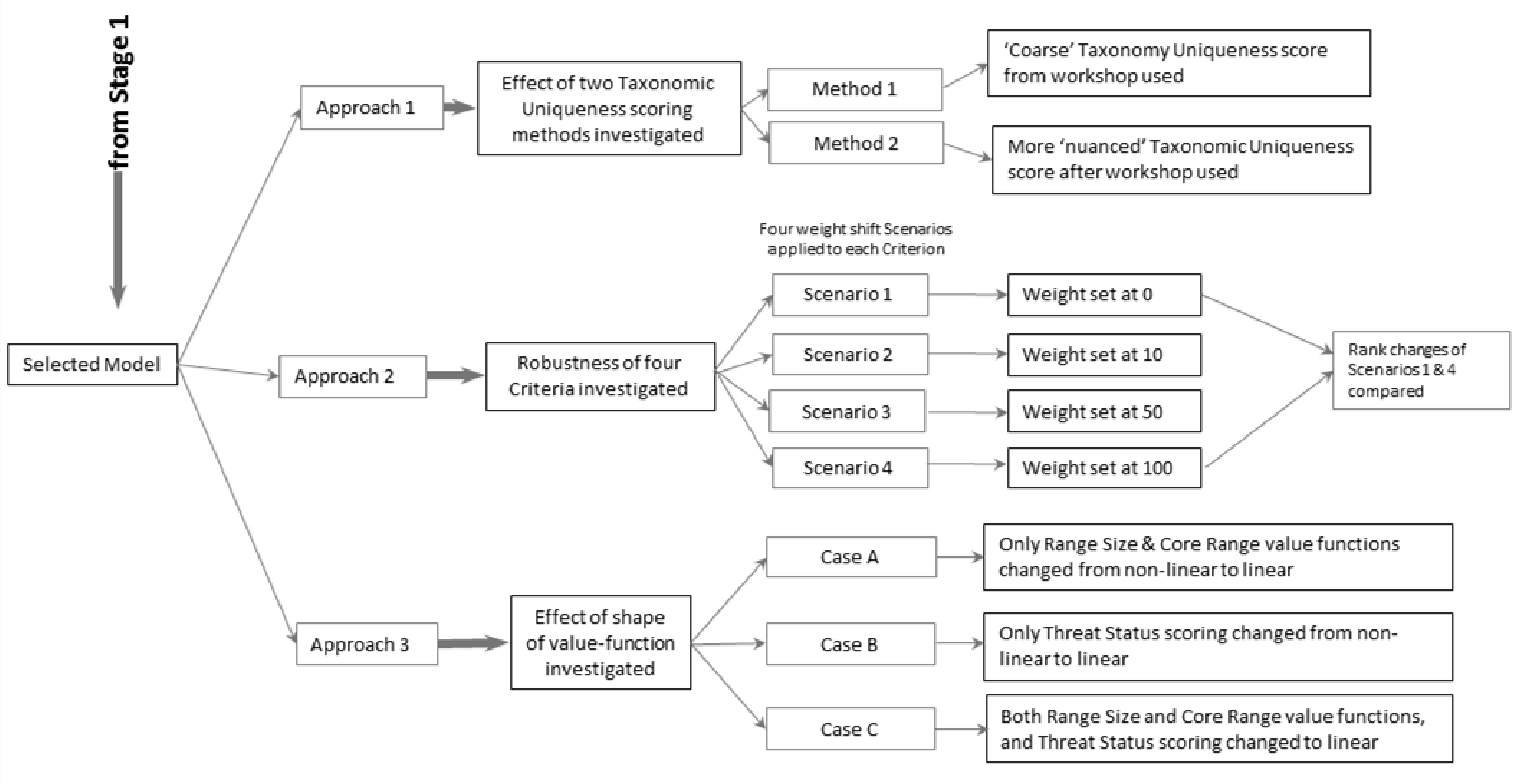

Figure 5.4. Second stage of sensitivity analysis process undertaken. The key terms used in the flow diagram are defined in Table 5.1

Table 5.1. Reference of key terms used in the sensitivity analysis

Model: Refers to the four Models used which have different sets of weights
Approach: Refers to the three ways in which the specific sensitivity analysis of the selected Model was undertaken in Stage Two of the sensitivity analysis
Criteria: Refers to the four conditions by which a species was assessed – Threat Status, Range Size, Core Range and Taxonomic Uniqueness
Method: Refers to the two ways in which the Taxonomic Uniqueness score was calculated (under Approach 1)
Scenario: Refers to the four different weights shifts which were considered when investigating the robustness of each criterion (under Approach 2)
Case: Refers to the three ways in which the effect of the shape of the value function was investigated (under Approach 3)

APPROACH 1: Effect of two Taxonomic Uniqueness calculations investigated

This part of the sensitivity analysis focused on the criterion of Taxonomic Uniqueness. In this approach two methods were compared which both gave a Taxonomic Uniqueness Score for a species, but were calculated in different ways (Chapter 4). These Methods were compared in order to establish whether using a 'coarse' Taxonomic Uniqueness score (Method 1) was adequate, or whether the more 'nuanced' calculation of Taxonomic Uniqueness was necessary or more suitable (Method 2). A summary of the two Methods is as follows:

Method 1: During the Workshop, a 'coarse' method to calculate Taxonomic Uniqueness using the categories of Genus, Family and Order, was developed (Chapter 4, Table 4.4).

Method 2: Subsequent to the workshop, a more 'nuanced' method of calculating the Taxonomic Uniqueness was developed also using the categories of Genus, Family and Order, but incorporating the relative number of units in each category, as well as the one in the hierarchical level above (Chapter 4).

APPROACH 2: Robustness of four criteria within chosen model investigated

Four Scenarios were selected to investigate the robustness of each criterion to shifts in weights (Table 5.2). The 20 species selected for the sensitivity analysis were displayed in a V·I·S·A sensitivity graph, and these top eight species were displayed in a table for each of the four Scenarios. The significant shifts in positions of these eight species, between the four Scenarios, were highlighted. These initial outputs provide insights into understanding the impact of changes of the weight of a Criterion, but do not readily assist in deciding which Criterion is the most sensitive to change. Because of this difficulty, a method was devised that presents a quantitative measure of how sensitive a Criterion is to change in weights, using two extreme weight shifts – Scenario 1 and 4.

Comparison of rank shift changes between Scenario 1 and Scenario 4

Using Scenarios 1 and 4, the unique contribution of a criterion to the final score of a species (alternative), or the amount of 'change' that occurred in a criterion, with a maximal shift in weights, was measured. This measure was calculated as follows: for each criterion the absolute difference in rank was calculated for each species in turn, between Scenario 1 (weight 0 – criterion had no contribution to the total score) and Scenario 4 (weight 100 – criterion was the only factor to consider). This difference was then summed for the 20 selected species to give a Total Score. The higher this Total Score, the greater change there was in the entire species ranking and the greater the 'unique' contribution of this criterion to the grand score of a species.

Table 5.2. Different weights selected to determine the robustness of four criteria

Scenario 1:	A weight of 0 (in other words if this criterion were not to exist)
Scenario 2:	A weight shifted to 10
Scenario 3:	A weight shifted to the midpoint of 50
Scenario 4:	A weight of 100 (in other words if this were the only criterion to consider)

APPROACH 3: Effect of shape of value-functions investigated

This aspect of the sensitivity analysis looked at the effect of the linear versus non-linear value-functions, the latter being developed by consensus in the workshop. Three Cases were considered:

Case A: The value-functions for the Range Size (Figure 5.5) and Core Range (Figure 5.6) criteria were changed from the non-linear ones developed in the workshop to simple linear functions. No other changes to the value functions or scores of the other two criteria were made. This allowed one to focus on the effect that the value-functions for the Core Range and Range Size criteria had on the final ranking of species.

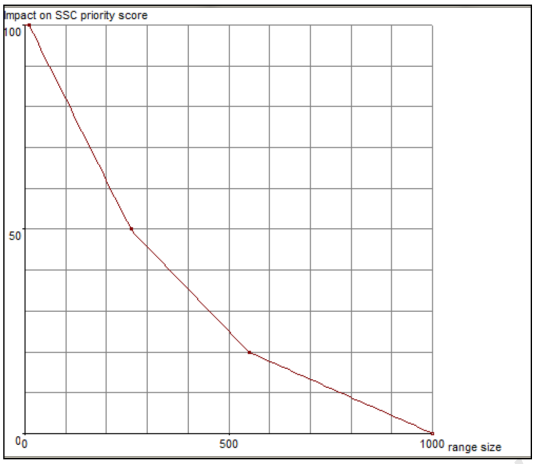

Figure 5.5.1. Non-linear value function of Range Size criterion developed during workshop

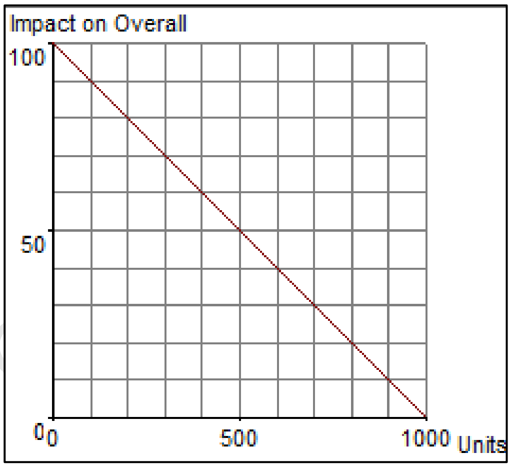

Figure 5.5.2. Value function of Range Size criterion changed to a linear function

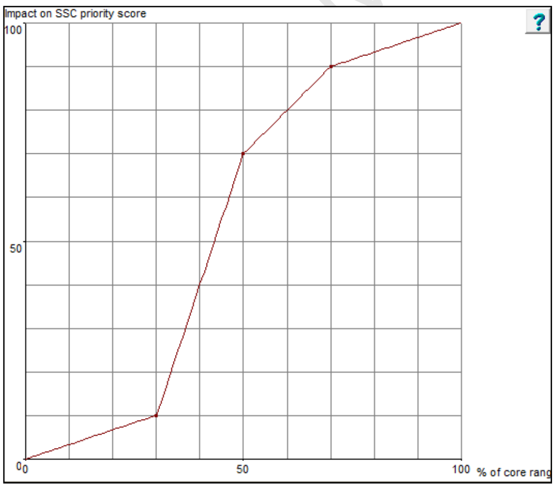

Figure 5.6.1. Non-linear value function of Core Range criterion developed

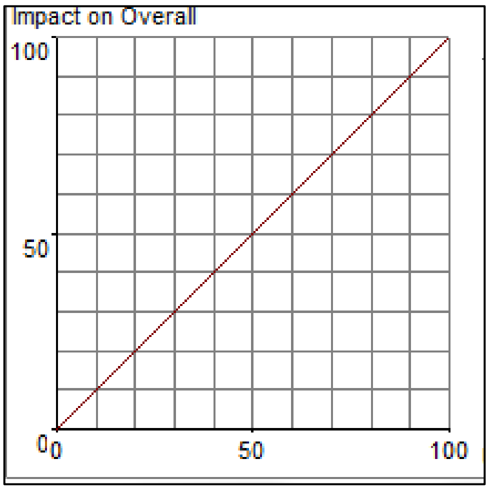

Figure 5.6.2. Value function of Core Range criterion changed to linear function

Case B: The non-linear increments in scores allocated to the Threat Status criterion were changed to a linear scoring scale in which the increments between the threat categories were equal (Table 5.3). For the other criteria (Core Range and Range Size) the value-functions were kept as non-linear to allow one to focus only on the effect that the change in the Threat Status scoring had on the final rankings.

Case C: In this case, both the value-functions for the Core Range and Range Size criteria, as well as the scoring for the Threat Status criterion, were changed to linear value-functions and linear scoring systems respectively. This allowed one to see the combined effect of the value-functions developed and the Threat Status scoring system.

In each of these three Cases, comparisons were made between the specific case described and the 'original' model – which had non-linear value-functions and a non-linear scoring scale (Model 1), for the criteria.

Sensitivity analysis outputs

Many figures and tables can be presented for outputs of this sensitivity analysis. In order to simplify this chapter, the outputs for only one selected national park were presented. The Kruger National Park (KNP) was chosen because it is a large park (1 962 362 ha) and this was therefore better fitted by QDGCs than the smaller parks. It also had a good coverage of SABAP1 data (Figure 5.7). The layout of the outputs section of this sensitivity analysis was done in such a way as to facilitate the flow of figures and graphs, and the relevant text relating to them and consequently some gaps on pages occur.

Table 5.3.1. Non-linear scoring scale of Threat Status categories (from Table 3.1)

Threat Category		Score
Extinct	EX	100
Critically Endangered	CR	100
Endangered	EN	90
Vulnerable	VU	70
Near Threatened	NT	50
Least Concern	LC	0

Table 5.3.2. Linear scoring scale of Threat Status categories

Threat Category		Score
Extinct	EX	100
Critically Endangered	CR	80
Endangered	EN	60
Vulnerable	VU	40
Near Threatened	NT	20
Least Concern	LC	0

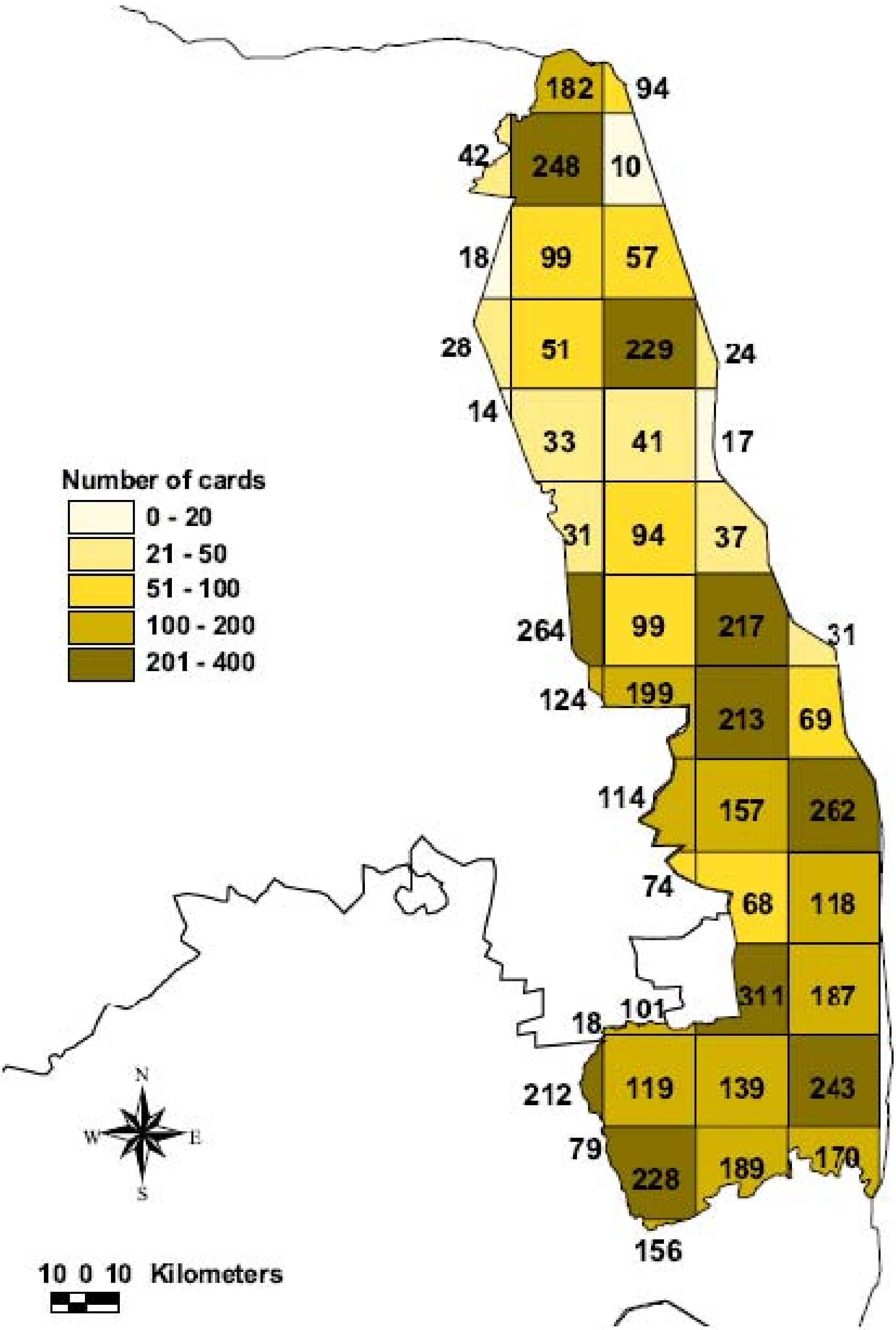

Figure 5.7. SABAP1 coverage of the Kruger National Park. The number in each quarter degree grid cell is the number of checklists in the SABAP1 database for that cell

Table 5.4. Twenty selected species from the Kruger National Park used in the sensitivity analysis. The reasons for the species inclusion is also presented

	Common name	Scientific name	Reason for selection
1	Oxpecker, Yellow-billed	*Buphagus africanus*	In top 10 scoring species
2	Vulture, Hooded	*Neophron percnopterus*	In top 10 scoring species
3	Stork, Saddle-billed	*Ephippiorhynchus senegalensis*	In top 10 scoring species
4	Bateleur	*Terathopius ecaudatus*	In top 10 scoring species
5	Openbill, African	*Anastomus lamelligerus*	In top 10 scoring species
6	Night-Heron, White-backed	*Gorsachius leuconotus*	In top 10 scoring species
7	Hawk, Bat	*Macheiramphus alcinus*	In top 10 scoring species
8	Parrot, Brown-headed	*Poicephalus cryptoxanthus*	High score for Core Range
9	Fishing-Owl, Pel's	*Scotopelia peli*	High score for Threat Status
10	Ground-Hornbill, Southern	*Bucorvus cafer*	High score for Threat Status
11	Stork, Marabou	*Leptoptilos crumeniferus*	Iconic species
12	Harrier, Pallid	*Circus pygargus*	
13	Bustard, Kori	*Ardeotis kori*	Iconic species
14	Bush-Shrike, Black-fronted	*Telophorus nigrifrons*	Peripheral species – included as an exception in this example
15	Secretarybird	*Sagittarius serpentarius*	Iconic species
16	Ostrich, Common	*Struthio camelus*	High score for Taxonomic Uniqueness
17	Mousebird, Red-faced	*Urocolius indicus*	High score for Taxonomic Uniqueness
18	Hamerkop	*Scopus umbretta*	High score for Taxonomic Uniqueness
19	Bee-eater, White-fronted	*Merops bullockoides*	Mid-range of scores
20	White-eye, Cape	*Zosterops pallidus*	Low-range of scores

Table 5.5. Input data for 20 selected species of the Kruger National Park used in the sensitivity analysis (as displayed by V·I·S·A)

	Threat status	Range size	Core range	tax
Oxpecker, Ye	VU	349	100	13
Vulture, Hood	VU	506	91	12
Stork, Saddle-	EN	894	54	28
Bateleur, Bate	VU	1000	51	12
Openbill, Afric	NT	791	57	28
Night-Heron, V	VU	174	32	12
Hawk, Bat	NT	234	40	12
Parrot, Brown	LC	474	98	9
Fishing-Owl, F	VU	215	19	14
Ground-Hornt	VU	1000	33	33
Stork, Marabo	NT	1000	40	24
Harrier, Pallid	NT	315	21	8
Bustard, Kori	VU	1000	8	18
Bush-Shrike, I	LC	37	33	8
Secretarybird	NT	1000	4	33
Ostrich, Comn	LC	1000	5	100
Mousebird, Re	LC	1000	5	50
Hamerkop, Ha	LC	1000	4	43
Bee-eater, Wh	LC	1000	16	12
White-eye, Ca	LC	1000	1	6

Outputs of Stage One of Sensitivity analysis

Twenty species were selected for the KNP sensitivity analysis (Table 5.4) based on the guidelines provided in an earlier section of this chapter. These twenty species together with data for each of the four Criteria were entered into V·I·S·A (Table 5.5).

From the representative species which were selected (Table 5.5) one had an Endangered status (Saddle-Billed Stork), seven were classified as Vulnerable, five as Near-Threatened and the others as Least Concern. The smallest Range Size was for the Black-fronted Bush Shrike (37 QDGCs) and 10 species had Range Sizes of greater than 1000 QDGCs. The Core Range data varied from 1 QDGC for the Cape White-eye, to 100 for the Yellow-billed Oxpecker. For the Taxonomic Uniqueness score the Cape White-eye again had the lowest score (6) and the highest score was for the Common Ostrich (100). One peripheral species, the Black-fronted Bush-shrike, was also included in the representative set of species to illustrate the theoretical score that this species would be given (but in practice all peripheral species were excluded from the analysis).

For the input data of the Range Size criterion in V·I·S·A, for any species with a range size greater than 1000 QDGCs, the actual value which was entered into V·I·S·A was changed to 1000. This was because for the value function that was developed (Chapter 3), a score of 0 was assigned to a species which had a Range Size of 1000 or greater. For the Core Range and Taxonomic Uniqueness criteria, the data entered were rounded off to integers, because it is not possible to input decimal places in V·I·S·A, and because this was also an unnecessary level of precision for this analysis.

Comparison of 'Thermometer Charts': outputs

The four 'Thermometer Charts' of the Models were compared (Figure 5.8), to assess which model (i.e. set of weights) best represents the ordering of the 20 selected species, as assessed by an ornithologist.

"Even though the Saddle-billed Stork was the only one of the selected 20 species which was classified as Endangered, it was not the Rank 1 priority in the Kruger National Park in any of the four Models. The two species with Ranks 1 and 2 in all Models were the Yellow-billed Oxpecker and Hooded Vulture. This higher ranking can be attributed to the fact that their Core Ranges within the park are 100% and 91% respectively, compared to 54% for the Saddle-billed Stork (Table 5.6)."

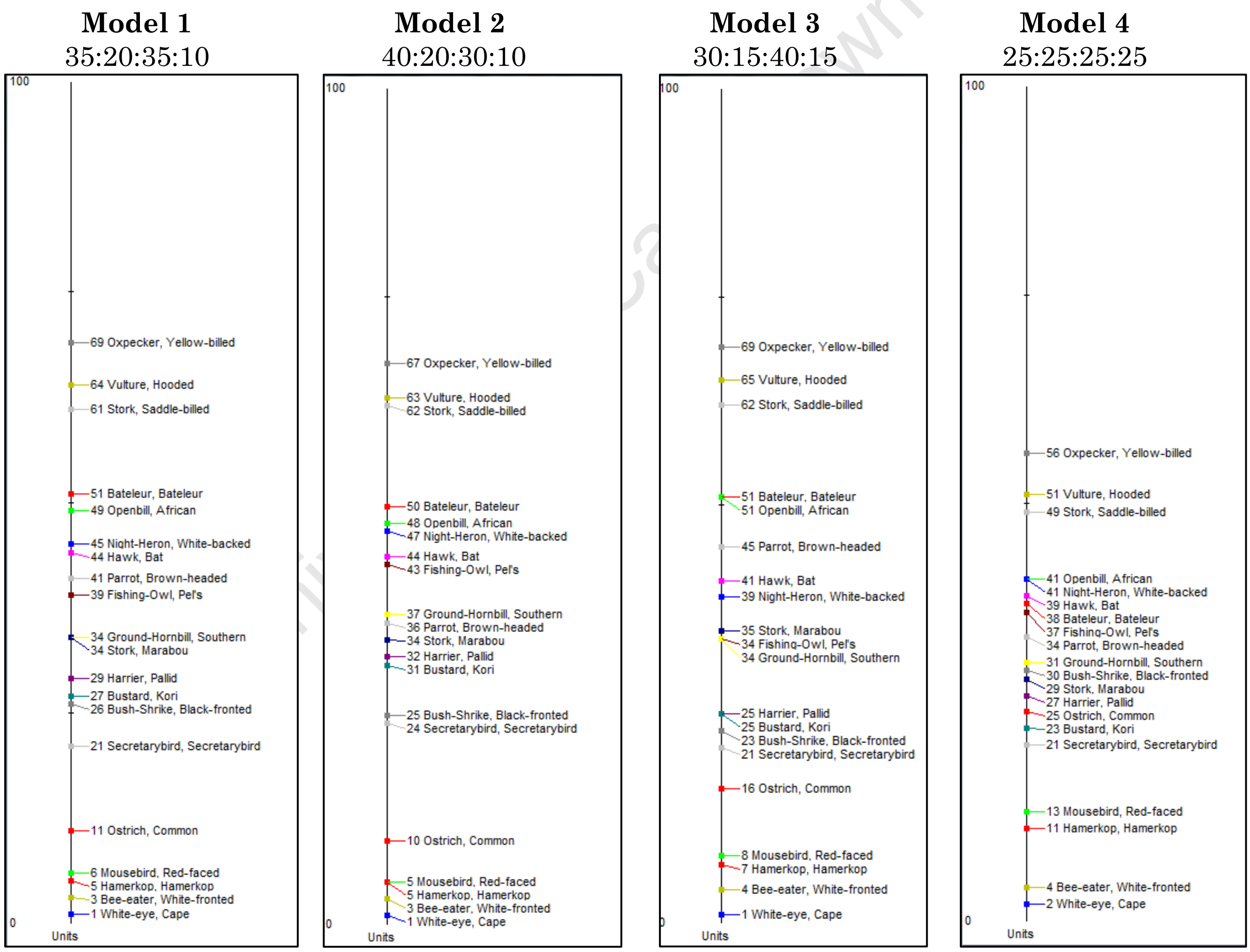

Figure 5.8. Thermometer Charts showing the overall scores of 20 selected birds from Kruger National Park for four Models with different weights for the Criteria. The numbers at the tops of the columns are the weights for each Model, in the order Threat Status, Range Size, Core Range and Taxonomic Uniqueness

"The species with Rank 4 in Models 1, 2 and 3 was the Bateleur, which 'dropped' to Rank 7 in Model 4. In Model 4, African Openbill had Rank 4, higher than the Bateleur. This seems inappropriate, given the relative threat status of these two species (Near-threatened and Vulnerable, respectively).This suggests that the weighting of 25% given to Threat Status in Model 4 is too low. Model 2 assigned 40% weight to Threat Status. A consequence of this was that the Saddle-billed Stork was almost tied in rank to the Hooded Vulture, and if an even larger weight had been assigned to Threat Status it would have overtaken it. This also seems intuitively to be incorrect, because the prioritization then becomes largely driven by Threat Status, no matter what the scores for species on other criteria are."

"The rankings of all 20 species in Models 1, 2 and 3 are similar, suggesting that the Models are relatively robust within the choice of weight ranges. In the light of this, it seems appropriate to accept the first set of consensus weights derived at the workshop: 35% to Threat Status, 20% to Range Size, 35% to Core Range and 10% to Taxonomic Uniqueness, referred to as Model 1."

In Model 4, in which all the criteria were given an equal weight, the ordering of the top 20 selected species was the most different from Models 1–3. According to the ornithologist, this ordering did not capture the 'intuitive' ordering understood by the ornithologist. This ordering was more closely captured in Models 1 – 3. From this it is possible to conclude that the allocation of weights does have a significant impact on the final outcome of this prioritisation process.

Outputs of Stage Two of Sensitivity analysis

Approach 1: Outputs

<u>Alternative Taxonomic Uniqueness score calculations compared</u>

The range of scores (for the selected species) of the more 'nuanced' Taxonomic Uniqueness calculation (Method1), ranged from 5.8 (Cape White-eye) to 100 (Common Ostrich) (Table 5.6). The range for the scoring system developed in the workshop (Method 2) ranged from 0 to 100, and only had four possible scoring options: 0, 25, 75, 100 (Table 5.6).

Because the weight assigned to the Taxonomic Uniqueness criterion was small (10%) relative to the other criteria, it was not feasible to compare the final preference scores of a selected number of species, as was done for Approach 1 and 2. Instead, the scores for the two methods were compared for 350 species from the Kruger National Park, and plotted as a Scatter Plot (Figure 5.9). If these two approaches produced similar results, one would expect to see a strong linear relationship in the scatter plot (Figure 5.9). However this is not the case, and this indicates that these methods are not that closely related.

"The relationship is, at best, weak. Considering only the subset of 20 selected species, those with "coarse" scores of 0 had "nuanced" scores ranging from 5.8 to 13.8, while those with "course" scores of 100 had "nuanced" scores between 18.3 and 50.0, with the ostrich an outlier, scoring 100 in both approaches (Figure 5.9, Table 5.6)."

Table 5.6. Two different Taxonomic Uniqueness scores – using Methods 1 and 2 – for the 20 selected species from the Kruger National Park

	Common name	**Scientific name**	**Method 1 'Coarse' scores**	**Method 2 'Nuanced' scores**
1	Oxpecker, Yellow-billed	*Buphagus africanus*	75	12.6
2	Vulture, Hooded	*Neophron percnopterus*	25	12.5
3	Stork, Saddle-billed	*Ephippiorhynchus senegalensis*	100	27.9
4	Bateleur	*Terathopius ecaudatus*	25	12.5
5	Openbill, African	*Anastomus lamelligerus*	100	27.9
6	Night-Heron, White-backed	*Gorsachius leuconotus*	0	11.7
7	Hawk, Bat	*Macheiramphus alcinus*	25	12.5
8	Parrot, Brown-headed	*Poicephalus cryptoxanthus*	0	8.9
9	Fishing-Owl, Pel's	*Scotopelia peli*	0	13.8
10	Ground-Hornbill, Southern	*Bucorvus cafer*	75	33.3
11	Stork, Marabou	*Leptoptilos crumeniferus*	100	24.0
12	Harrier, Pallid	*Circus pygargus*	0	8.4
13	Bustard, Kori	*Ardeotis kori*	100	18.3
14	Bush-Shrike, Black-fronted	*Telophorus nigrifrons*	0	8.1
15	Secretarybird	*Sagittarius serpentarius*	75	33.3
16	Ostrich, Common	*Struthio camelus*	100	100.0
17	Mousebird, Red-faced	*Urocolius indicus*	100	50.0
18	Hamerkop	*Scopus umbretta*	75	43.1
19	Bee-eater, White-fronted	*Merops bullockoides*	0	11.5
20	White-eye, Cape	*Zosterops pallidus*	0	5.8

The four species with "coarse" scores of 75 had "nuanced" scores ranging between 12.6 and 43.1. The improvement in assessing Taxonomic Uniqueness by adopting the nuanced approach (Method 2) developed in Chapter 4, as opposed to the course approach (Method 1) used at the workshop, is large. The course four-point scale (Method 1) is, at best, a crude first approximation to the concept of Taxonomic Uniqueness. The nuanced scale (Method 2), being an interval scale with essentially infinitely many alternative scores, captures the concept in a more refined way. Even so, the Taxonomic Uniqueness scale presented here will ultimately be rendered obsolete once the concept can be quantified precisely by the development of a well-accepted phylogeny of the birds (Chapter 4).

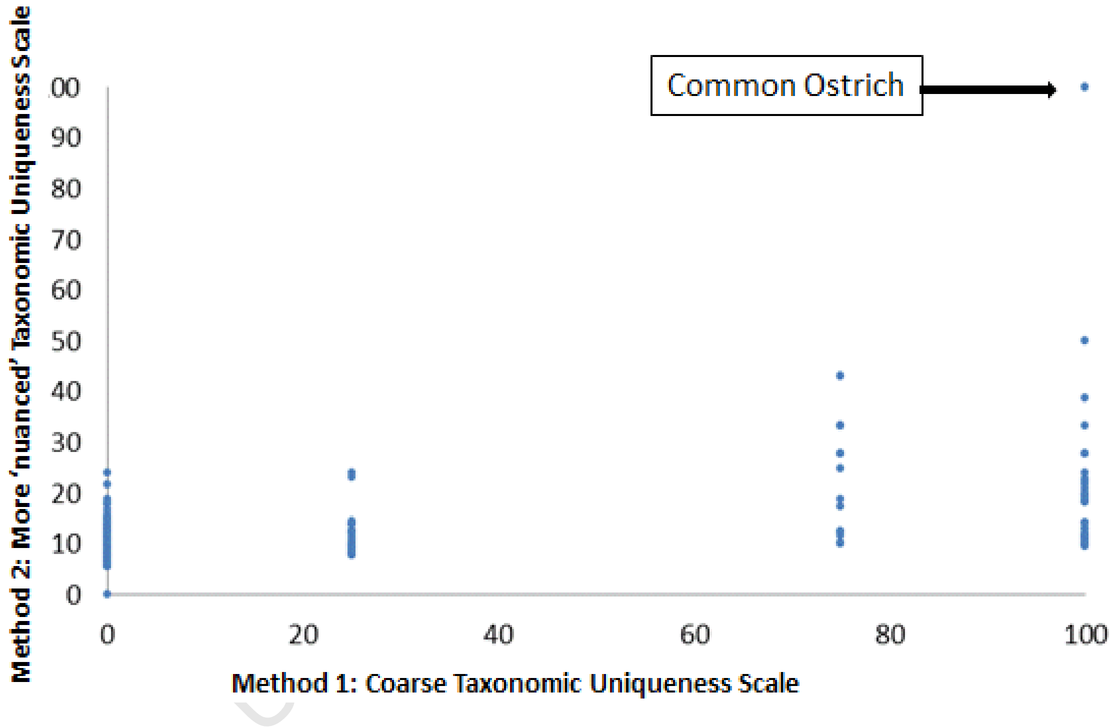

Figure 5.9. Scatter plot of 350 species from Kruger National Park, comparing the Coarse Taxonomic Uniqueness Scale (Method 1) and the more 'nuanced' Taxonomic Uniqueness Scale (Method 2). The Common Ostrich is highlighted as an outlier, and it scores 100 in both Methods

Approach 2: Outputs

<u>Criterion 1: Threat status</u>

In the V·I·S·A sensitivity graph of the Threat Status criterion (Figure 5.9) the intersection of the dashed vertical line (weight 0.35, Model 1) with the solid coloured lines gives the rank ordering of the 20 selected species for the Kruger National Park. The top eight species of this rank order are presented in Table 5.7 (Column 1). The other four columns present the top eight species for each of the four weight shift Scenarios considered. When comparing all four Scenarios (Table 5.7) it is possible to see how the ordering of species changes with shifts in weight. As the weight associated with Threat Status is varied, the weights assigned to the other three criteria are changed but kept in the same proportions to each other.

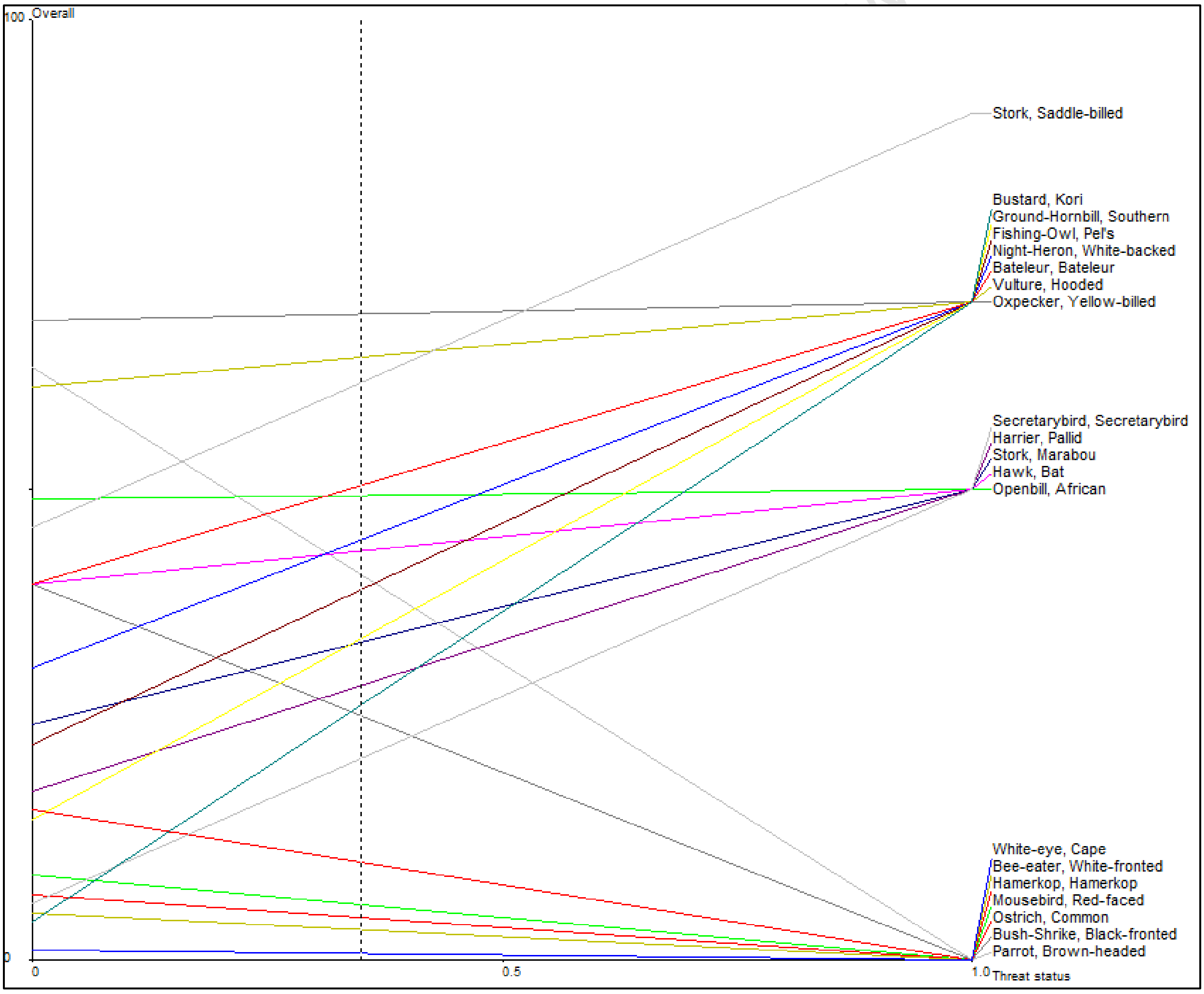

Figure 5.10. Sensitivity Graph for 20 selected species in Kruger National Park, showing Threat Status criterion versus overall score. The dashed vertical line indicates the selected weight (35%) of the Threat Status criterion for Model 1. In V·I·S·A, the weights of 0%, 50% and 100% are rescaled to 0, 0.5 and 1

Table 5.7. Ranking of the eight top species for the Threat Status criterion for four different weight shift Scenarios. The first column sets the weight for Threat Status at 35%, as for Model 1. The Key Table below lists the species in each threat category

		Model 1: Threat status	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4
		Selected weight	If this criterion was not considered	Lower weight	Upper weight	If this were the only criterion
	Score	Weight 35	Weight 0	Weight 10	Weight 50	Weight 100
1	69	Oxpecker, Yellow-billed	Oxpecker, Yellow-billed	Oxpecker, Yellow-billed	Oxpecker, Yellow-billed	Stork, Saddle-billed
2	64	Vulture, Hooded	Vulture, Hooded	Vulture, Hooded	Stork, Saddle-billed	all VU species - 2nd position
3	61	Stork, Saddle-billed	Parrot, Brown-headed	Parrot, Brown-headed	Vulture, Hooded	all NT species - 3rd position
4	51	Bateleur	Openbill, African	Stork, Saddle-billed	Bateleur	all LC species - 4th position
5	49	Openbill, African	Stork, Saddle-billed	Openbill, African	Night-heron, White-backed	
6	45	Night-heron, White-backed	Bateleur	Bateleur	Openbill, African	
7	44	Hawk, Bat	Hawk, Bat	Hawk, Bat	Fishing-Owl, Pel's	
8	41	Parrot, Brown-headed	Bush-shrike, Black-fronted	Bush-shrike, Black-fronted	Hawk, Bat	

Key		
VU - Vulnerable	NT - Near Threatened	LC - Least Concern
Bustard, Kori	Secretarybird	White-eye, Cape
Ground-Hornbill, Southern	Harrier, Pallid	Bee-eater, White-fronted
Fishing-Owl, Pel's	Stork, Marabou	Hamerkop
Night-heron, White-backed	Hawk, Bat	Mousebird, Red-faced
Bateleur	Openbill, African	Ostrich, Common
Vulture, Hooded		Bush-shrike, Black-fronted
Oxpecker, Yellow-billed		Parrot, Brown-headed

The Vulnerable Yellow-billed Oxpecker remains at Rank 1 for all the Scenarios, except Scenario 4, where it is at Rank 2 (together with the six other species that have a Vulnerable status). This criterion is categorical, therefore for Scenario 4 (weight shift to 100), the species 'cluster' into their Threat Status categories according to the scores allocated (Table 5.3).

The African Openbill on the other hand, remains relatively constant for all the weight shift Scenarios, and moves only between Rank 4 (Scenario 1) and Rank 6 (Scenario 3). A species which features highly in Scenarios 1 and 2, but then moves down a number of places, is the Brown-headed Parrot. In Scenario 1 and 2, it has Rank 3, whereas it does not feature in the top 8 for Scenario 3.

Criterion 2: Range Size

In the V·I·S·A sensitivity graph of the Range Size criterion (Figure 5.10) the intersection of the dashed vertical line (weight 0.20) with the solid coloured lines gives the rank ordering of the 20 selected species for the Kruger National Park. The top eight species of this rank order are presented in Table 5.8 (Column 1). The other four columns present the top 8 species for each of the four weight shift Scenarios considered. When comparing all four Scenarios (Table 5.8) it is possible to see how the ordering of species changes with shifts in weights.

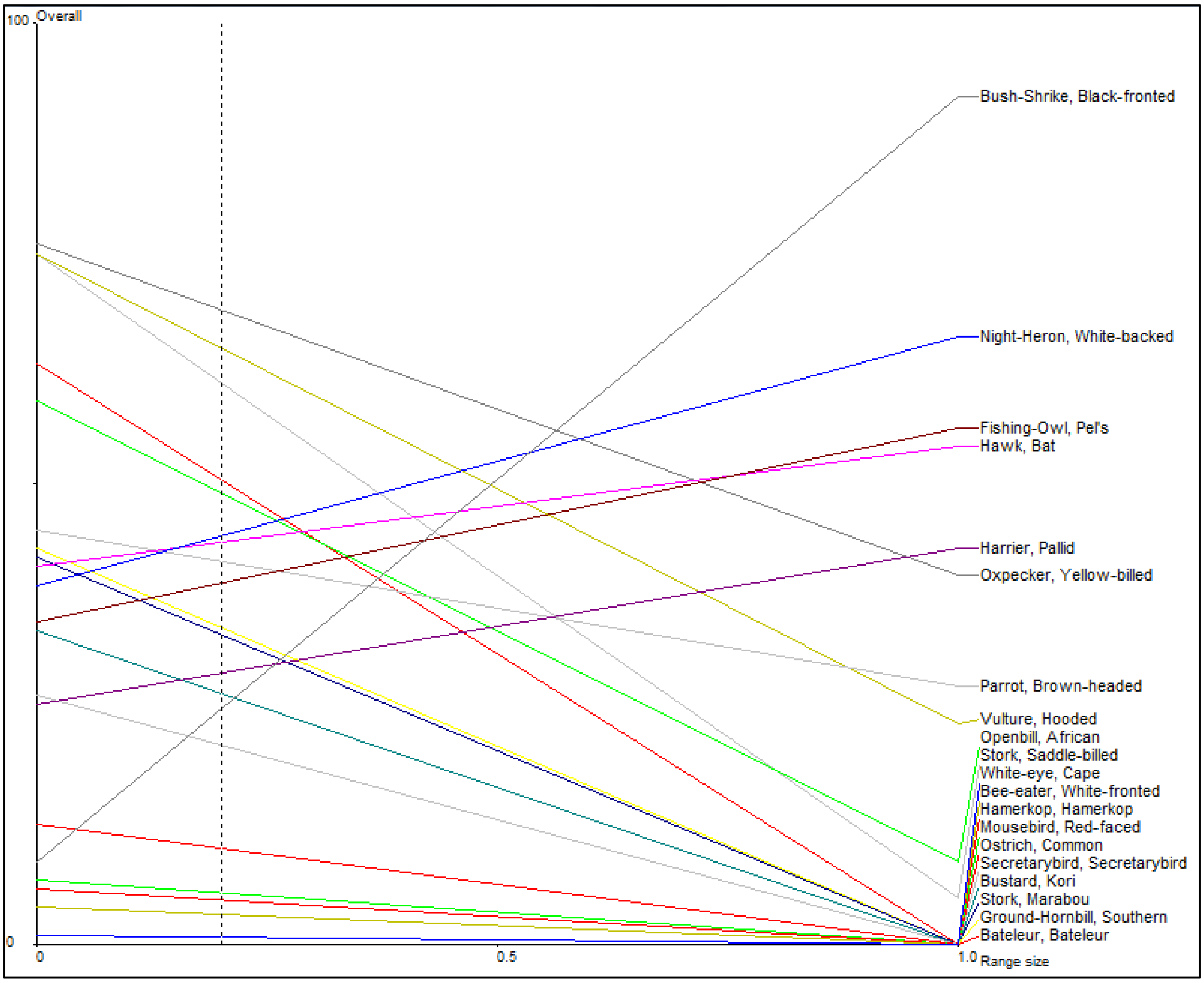

Figure 5.11. Sensitivity Graph for 20 selected species in Kruger National Park, showing Range Size criterion versus overall score. The dashed vertical line indicates the selected weight (20%) of the Range Size Status criterion for Model 1

Table 5.8. Ranking of eight top species for Range Size criterion for different weight shift Scenarios. The first column sets the weight for Range Size at 20% as for Model 1

		Model 1: Range size and endemism	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4
		Selected weight	If this criterion was not considered	Lower weight	Upper weight	If this were the only criterion
	Score	Weight 20	Weight 0	Weight 10	Weight 50	Weight 100
1	69	Oxpecker, Yellow-billed	Oxpecker, Yellow-billed	Oxpecker, Yellow-billed	Oxpecker, Yellow-billed	Bush-shrike, Black-fronted
2	64	Vulture, Hooded	Vulture, Hooded	Vulture, Hooded	Night-heron, White-backed	Night-heron, White-backed
3	61	Stork, Saddle-billed	Stork, Saddle-billed	Stork, Saddle-billed	Bush-shrike, Black-fronted	Fishing-Owl, Pel's
4	51	Bateleur	Bateleur	Bateleur	Vulture, Hooded	Hawk, Bat
5	49	Openbill, African	Openbill, African	Openbill, African	Hawk, Bat	Harrier, Pallid
6	45	Night-heron, White-backed	Parrot, Brown-headed	Parrot, Brown-headed	Fishing-Owl, Pel's	Oxpecker, Yellow-billed
7	44	Hawk, Bat	Hornbill, Ground	Hawk, Bat	Stork, Saddle-billed	Parrot, Brown-headed
8	41	Parrot, Brown-headed	Stork, Marabou	Night-heron, White-backed	Parrot, Brown-headed	Vulture, Hooded

The Yellow-billed Oxpecker again is at Rank 1 for Scenarios 1 – 3, as well as the set weight, but shifts to Rank 6 for Scenario 4. The Black-fronted Bush Shrike features highly for Scenario 3 (Rank 1) and Scenario 4 (Rank 1). The Black-fronted Bush-shrike however does not feature at all in any of the other top 8 species for the other Scenarios. The Black-fronted Bush-shrike has the steepest positive gradient out of all the species for this Sensitivity Graph as it has the smallest Range Size (37 QDGCs) of all the species. The Bateleur has the steepest negative gradient – it has Rank 4 for Scenarios 1 and 2, but is not placed in the top eight positions as the weight shift increases – Scenarios 3 and 4.

Criterion 3: Core Range

In the V·I·S·A sensitivity graph of the Core Range criterion (Figure 5.11) the intersection of the dashed vertical line (weight 0.35, Model 1) with the solid coloured lines gives the rank ordering of the 20 selected species for the Kruger National Park. The top eight species of this rank order are presented in Table 5.9 (Column 1). The other four columns present the top eight species for each of the four weight shift Scenarios considered. When comparing all four Scenarios (Table 5.9) it is possible to see how the ordering of species changes with shifts in weight. As the weight associated with Core Range is varied, the weights assigned to the other three criteria are changed but kept in the same proportion to each other.

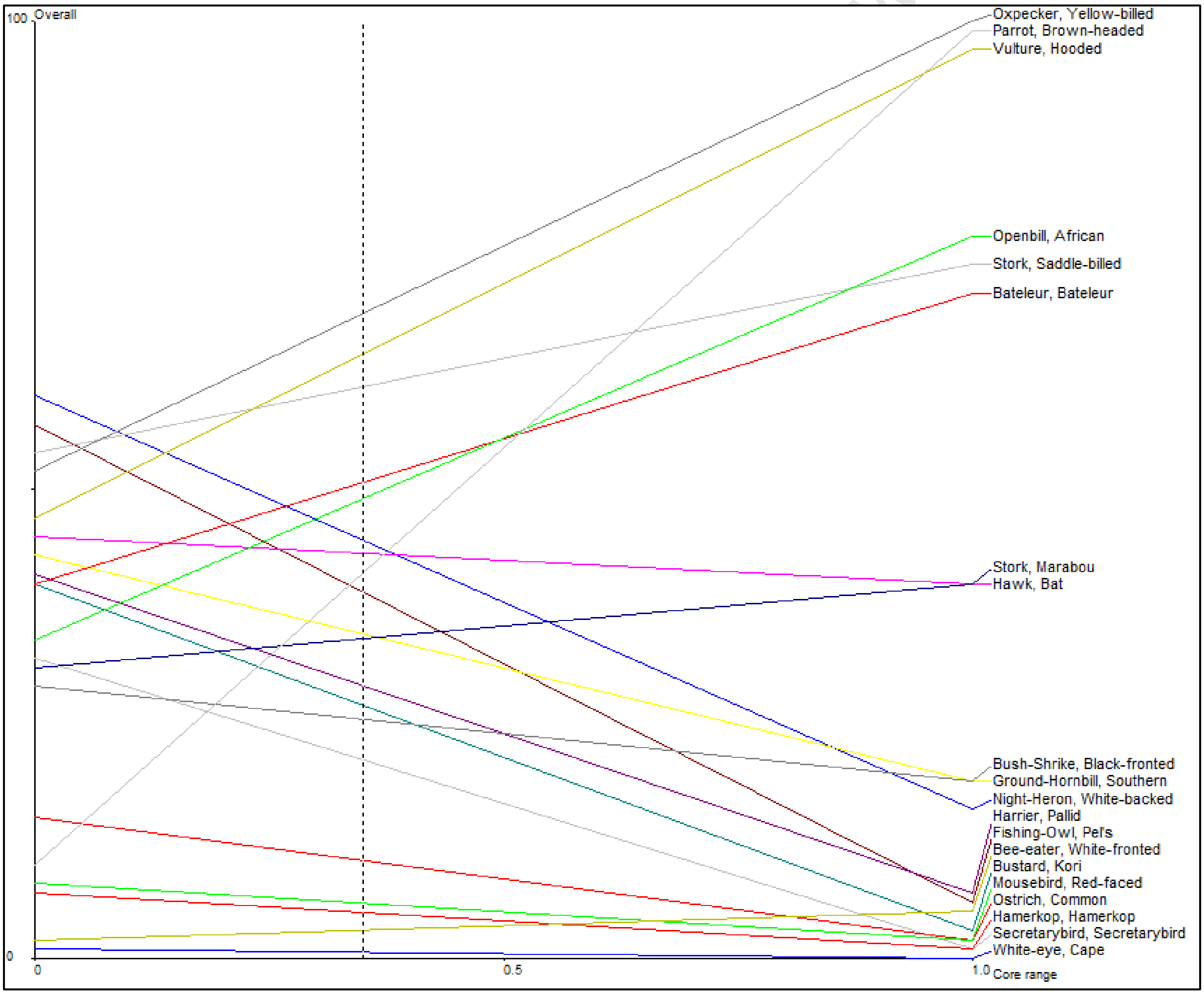

Figure 5.12. Sensitivity Graph for 20 selected species in Kruger National Park, showing Core Range criterion versus overall score. The dashed vertical line indicates the selected weight (35%) of the Core Range criterion for Model 1

Table 5.9. Ranking of eight top species for Core Range criterion for four weight shift Scenarios. The first column sets the weight for Core Range at 35%, as for Model 1

			Core range			
		Model 1: Core range	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4
		Selected weight	If this criterion was not considered	Lower weight	Upper weight	If this were the only criterion
	Score	Weight 35	Weight 0	Weight 10	Weight 50	Weight 100
1	69	Oxpecker, Yellow-billed	Night-heron, White-backed	Oxpecker, Yellow-billed	Oxpecker, Yellow-billed	Oxpecker, Yellow-billed
2	64	Vulture, Hooded	Fishing-Owl, Pel's	Stork, Saddle-billed	Vulture, Hooded	Parrot, Brown-headed
3	61	Stork, Saddle-billed	Stork, Saddle-billed	Vulture, Hooded	Stork, Saddle-billed	Vulture, Hooded
4	51	Bateleur	Oxpecker, Yellow-billed	Fishing-Owl, Pel's	Openbill, African	Openbill, African
5	49	Openbill, African	Vulture, Hooded	Hawk, Bat	Bateleur	Stork, Saddle-billed
6	45	Night-heron, White-backed	Hawk, Bat	Bateleur	Parrot, Brown-headed	Bateleur
7	44	Hawk, Bat	Ground-Hornbill, Southern	Ground-Hornbill, Southern	Hawk, Bat	Stork, Marabou
8	41	Parrot, Brown-headed	Harrier, Palid	Openbill, African	Night-heron, White-backed	Hawk, Bat

The Brown-Headed Parrot shifts from Rank 16 in Scenario 1 (Figure 5.11) to Rank 2 in Scenario 4. This is because of its steep gradient, due to having a Core Range of 98%. In contrast the White-Backed Night-Heron shifts from Rank 1 in Scenario 1, to Rank 8 in Scenario 3, and does not feature at all in Scenario 4. The Bat Hawk has a relatively level gradient and appears in all four weight shift Scenarios.

Criterion 4: Taxonomic uniqueness

In the V·I·S·A sensitivity graph of the Taxonomic Uniqueness criterion (Figure 5.12) the intersection of the dashed vertical line (weight 0.10) with the solid coloured lines gives the rank ordering of the 20 selected species for the Kruger National Park. The top 8 species of this rank order are presented in Table 5.10 (Column 1). The other four columns present the top eight species for each of the four weight shift Scenarios considered. When comparing all four Scenarios (Table 5.10) it is possible to see how the ordering of species changes with shifts in weight

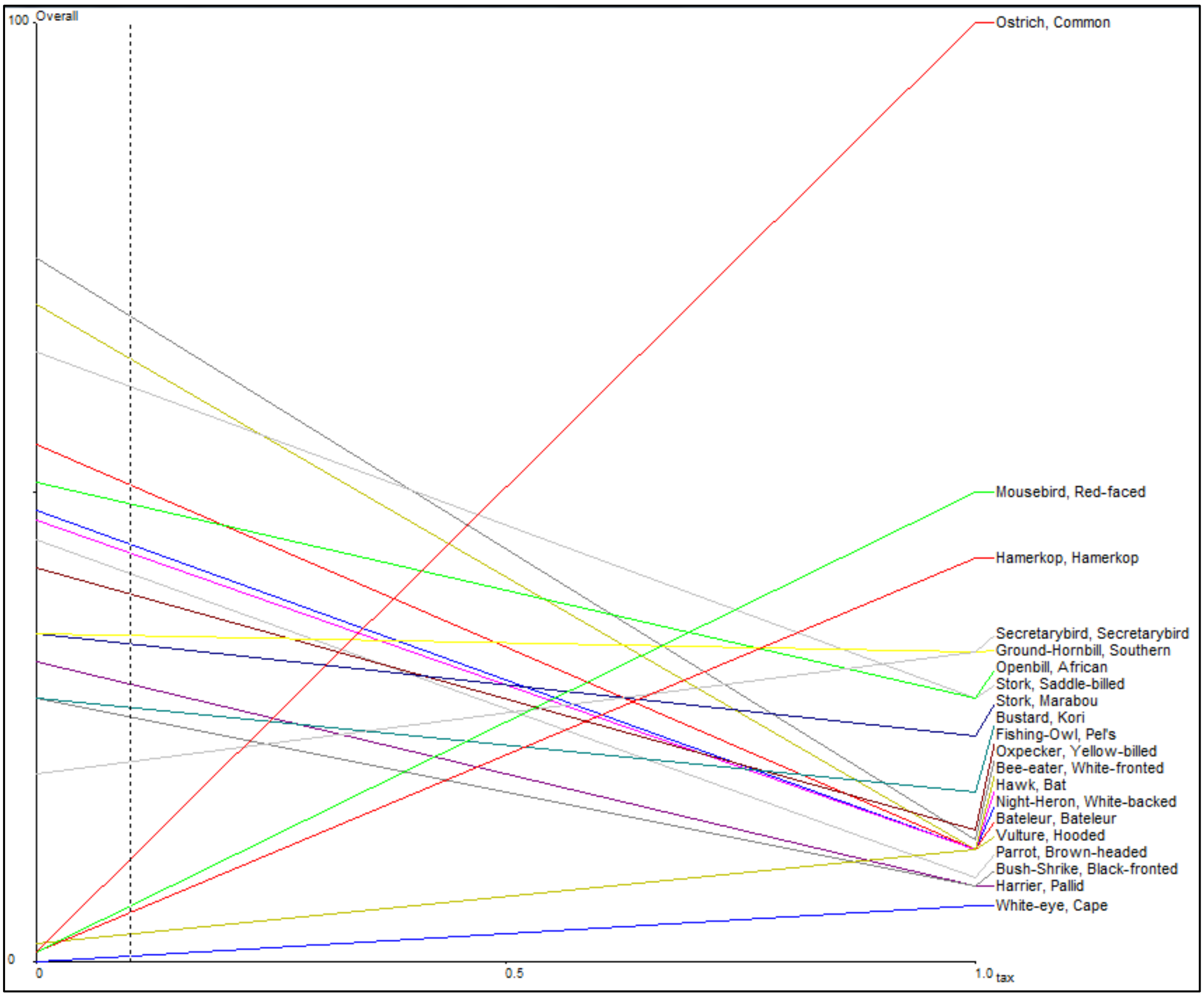

Figure 5.13. Sensitivity Graph for 20 selected species in Kruger National Park, showing Taxonomic Uniqueness criterion versus overall score. The dashed vertical line indicates the selected weight (10%) of the Taxonomic Uniqueness criterion for Model 1

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Table 5.10. Ranking of eight top species for Taxonomic Uniqueness criterion for different weight shift Scenarios. The first column sets the weight of Taxonomic Uniqueness at 10%, as for Model 1

		Model 1: Taxonomic value	SCENARIO 1	SCENARIO 2	SCENARIO 3	SCENARIO 4
		Selected weight	If this criterion was not considered	Lower weight	Upper weight	If this were the only criterion
	Score	Weight 10	Weight 0	Weight 10	Weight 50	Weight 100
1	69	Oxpecker, Yellow-billed	Oxpecker, Yellow-billed	Oxpecker, Yellow-billed	Ostrich, Common	Ostrich, Common
2	64	Vulture, Hooded	Vulture, Hooded	Vulture, Hooded	Stork, Saddle-billed	Mousebird, Red-faced
3	61	Stork, Saddle-billed	Stork, Saddle-billed	Stork, Saddle-billed	Oxpecker, Yellow-billed	Hamerkop
4	51	Bateleur	Bateleur	Bateleur	Vulture, Hooded	Secretarybird
5	49	Openbill, African	Openbill, African	Openbill, African	Openbill, African	Ground-Hornbill, Southern
6	45	Night-heron, White-backed	Night-heron, White-backed	Night-heron, White-backed	Ground-Hornbill, Southern	Openbill, African
7	44	Hawk, Bat	Hawk, Bat	Hawk, Bat	Bateleur	Stork, Saddle-billed
8	43	Parrot, Brown-Headed	Parrot, Brown-Headed	Parrot, Brown-Headed	Night-heron, White-backed	Stork, Marabou

The species with the most noticeable increase in position as the weight shifts from 0 is to 100 is the Common Ostrich. This species scores 100 for the Taxonomic Uniqueness criterion using the more 'nuanced' method to calculate this score (Method 2). It features at Rank 1 for both Scenarios 3 and 4, but does not feature in the top 8 for any of the other Scenarios. The Yellow-billed Oxpecker again remains at Rank 1 in Scenarios 1 and 2. In Scenario 3, the Oxpecker shifts to Rank 3 and in Scenario 4 it does not feature at all in the top 8 species.

Comparison of rank changes between Scenario 1 and Scenario 4: outputs

If, for a criterion, there were no shifts in the position of any species from Scenario 1 to Scenario 4, the Total Score (for this measurement) would be 0. This would mean that the criterion would not be adding any 'unique' contribution to the prioritisation exercise, or that its contribution is entirely captured by the other criteria. For this calculation (of 20 species) the largest absolute change in rank (from position 1 to 20) would be 19, therefore theoretically the largest Total Score for a criterion would be 200.

Taxonomic Uniqueness was the Criterion with the largest Total Score (142), then there was a large gap and the other three criteria were in the range of 90 – 98 (Table 5.11). The outputs can therefore be interpreted that each of the four criteria do add a measure of 'uniqueness' because they have a Total Score much greater than 0, with Taxonomic Uniqueness having the greatest 'uniqueness' contribution. It is also possible to say that the criteria are judgementally independent because they have a score greater than zero.

Table 5.11 Absolute difference in change in ranks from Scenario 1 (weight 0) to Scenario 4 (weight 100) for 20 selected species for all four criteria, for the Kruger National Park

	Common name	Threat Status	Range Size	Core Range	Taxonomic Uniqueness
1	Oxpecker, Yellow-billed	3	5	3	10
2	Vulture, Hooded	3	6	2	10
3	Stork, Saddle-billed	4	7	2	3
4	Bateleur	0	7	3	9
5	Openbill, African	7	4	7	2
6	Night-Heron, White-backed	7	8	10	9
7	Hawk, Bat	2	5	2	7
8	Parrot, Brown-headed	12	1	14	9
9	Fishing-Owl, Pel's	8	8	11	1
10	Ground-Hornbill, Southern	7	6	3	6
11	Stork, Marabou	2	4	6	3
12	Harrier, Pallid	2	8	4	6
13	Bustard, Kori	11	3	5	4
14	Bush-shrike, Black-fronted	6	15	5	5
15	Secretarybird	4	5	7	10
16	Ostrich, Common	4	1	1	16
17	Mousebird, Red-faced	3	0	0	16
18	Hamerkop	3	0	0	16
19	Bee-eater, White-fronted	2	5	5	0
20	White-eye, Cape	0	0	0	0
	Total Score	**90**	**98**	**90**	**142**

This calculation has been computed for a selection of 20 species but it is also feasible to compute this calculation for all the species within a national park.

Approach 3: Outputs

In the Workshop, considerable effort was devoted to constructing the non-linear value functions for the Threat Status, Core Range and Range Size criteria. As part of the sensitivity analysis procedure it is desirable to ask the question "Would it make a substantial difference to the outputs if the value function had been linear?" A first answer to this question is provided in Figure 5.14.

In Model 1A, the Range Size and Core Range criteria were changed from non-linear to linear functions – Case A. A comparison of the scores between Model 1 and Model 1A in Figure 5.14 shows the biggest changes for Pallid Harrier (from 29 to 39), for White-backed Night-Heron (45 to 53) and Bateleur (51 to 44).

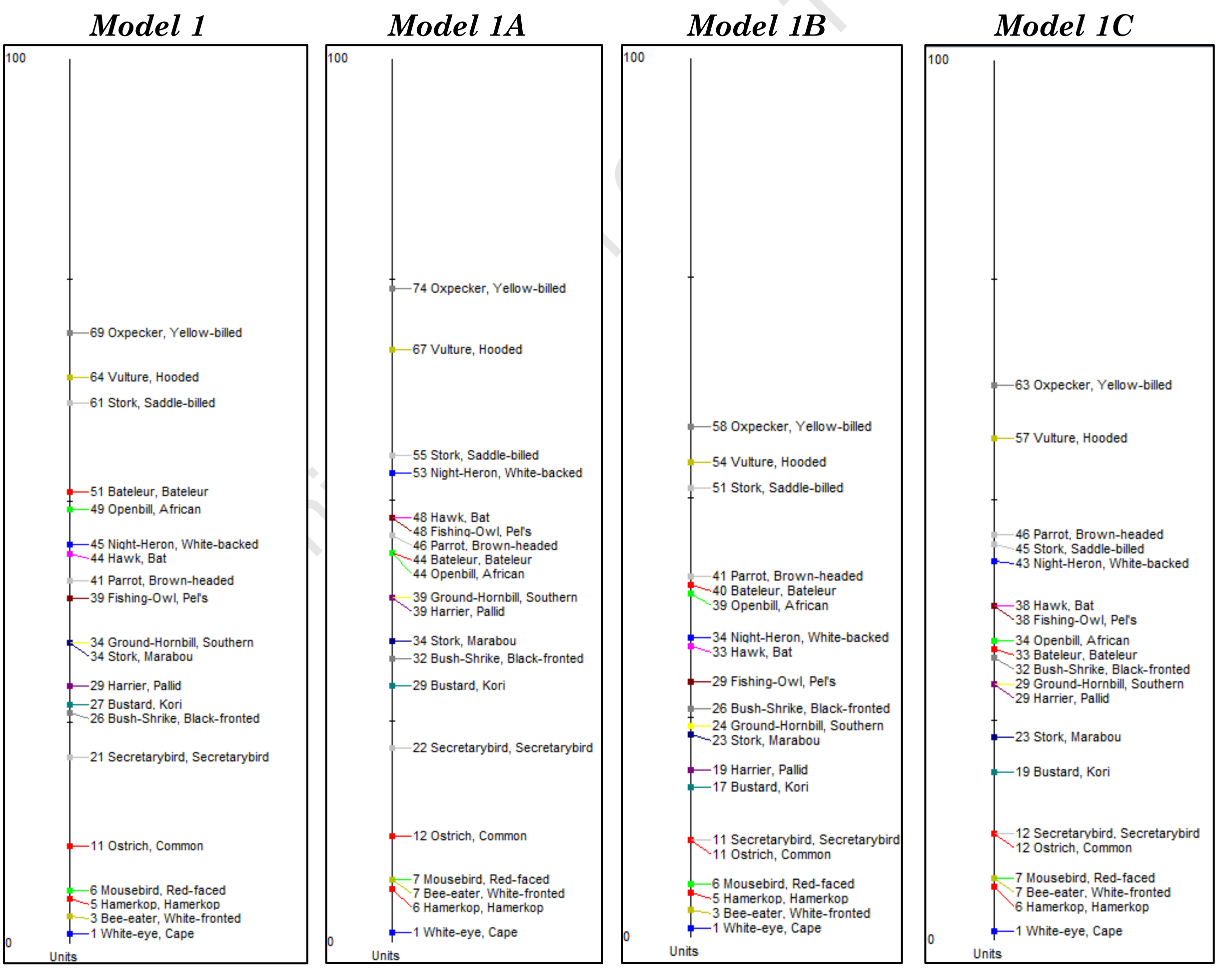

Figure 5.14. Thermometer Charts of four model outputs of 20 selected species of the Kruger National Park based on three variations (Cases) of Model 1, to determine the effect of the shape of the value-functions

Inspection of Table 5.5 shows that Pallid Harrier had values of a 315 for Range Size and 21 for Core Range; comparison of Figures 5.5 and 5.6 shows that these are close to the values where the departure of the value function from linearity was largest. A similar argument applies to the White-backed Night-Heron. However, for the Bateleur the situation is different. The Range Size exceeds 1000, so the linearity makes no difference to the score (0) on this criterion; however, the Core Range is 51 which is a point along the value function where the value is greater than that obtained from the linear value function (Table 5.5, Figures 5.6. and 5.6). The consequence of this is that the final score for this species decreases between Model 1 and Model 1A.

"In Model 1B, the Threat Status scoring is changed to linear (Tables 5.3.1 and 5.3.2). The consequence of this is that the "gap" between Near Threatened and Least Concern (set at 50 and 0 in Table 5.4.1 respectively) is reduced (20 and 0 in the linear scoring of Table 5.4.2). The result of this is to remove much of the differential between species in a threat status and those of Least Concern (Figure 5.14). For example, both Common Ostrich (Least Concern) and Secretarybird (Near Threatened) score 11 in Model 1B, whereas they had scored 12 and 22 respectively in Model 1, a differential which seems appropriate."

"In Model 1C, the three criteria Range Size, Core Range and Threat Status were all linearized (Figure 5.14). Comparison of Model 1 with Model 1C shows substantial changes not only in the scores but also in the rank ordering of this subset of 20 species. For example, Bateleur, Rank 4 in Model 1 is at Rank 9 in Model 1C – subjectively, it is inappropriate for this species to be ranked lower than Pel's Fishing-Owl (Rank 9 in Model 1, Rank 6 in Model 1C); the Bateleur has 51% of its Core Range in the Kruger National Park, whereas Pel's Fishing Owl has only 19%."

"In summary, from the above outputs it is possible to say that the that the non-linear value functions perform better in this prioritization exercise than linear functions would have done."

Sensitivity analysis summary

Stage One

From the first stage of the sensitivity analysis, Models 1–3 had similar outputs in terms of species ranking. From these, Model 1 was selected as best representing the rank ordering of species. This part of the sensitivity analysis also showed that although the models were relatively robust within a conservative set of weights, the allocation of different sets of weights does make a difference and is important, because the model in which equal weights were given to all four criteria (Model 4) did not produce outputs which best captured the ordering of species, from the view of the ornithologist commenting on the outputs of the sensitivity analysis.

Stage Two

In **Approach 1**, Method 2, the more 'nuanced' approach of calculating the taxonomic uniqueness of a species, was found to be more suitable than Method 1, which involved a 'courser calculation'. One of the reasons for this was that Method 2 made use of an interval scale which captured the Taxonomic Uniqueness in a more refined way than the categorical scale of Method 1.

Approach 2 showed that the criterion most sensitive to change was that of Taxonomic Uniqueness. This approach also showed that the four criteria are relatively robust.

In the last part of this stage, **Approach 3** showed that the shape of the value function did make a difference to the outcome of the outputs. It is extremely difficult to do a proper validation of the model, when there is no 'gold standard' to compare it to. Even if the model is compared to an 'individual experts' values, one cannot be absolutely sure that this true representation of the expert's values. It is however possible to say that the non-linear shape of the value functions developed in the Workshop better captured the preference ordering of species, assessed by an ornithologist, and were closer to his intuitive rankings, then the linear value-functions tested in this part of the sensitivity analysis.

CHAPTER 6

Reflections and Conclusion

Introduction

This chapter contains a reflection on the specific prioritisation approach laid out in this thesis. This covers aspects such as what was beneficial about this process, what was difficult, and some future recommendations. Finally this chapter ends with a concluding section which brings together and summarises all the aspects of this thesis.

Reflection on the prioritisation process of this thesis

Positive aspects of this prioritisation process

A very positive aspect of this prioritisation process was what was gained from the Workshop, that brought together stakeholders and various experts, who together discussed and considered the decision problem. For the value function approach used here, this Workshop was very important, because through the debate and discussion that took place, participants were better able to gain an understanding of their own values attached to the selected criteria, as well as the values of other participants. The knowledge brought in by expert ornithologists was also very important, specifically when discussing particular examples, and this allowed for a more meaningful understanding of selecting appropriate criteria, as well as the scoring and weighting of these criteria.

Holding the workshop over one-and-a-half days was also good in that it allowed participants time to consider some of the theoretical aspects discussed, and review, perhaps ‘sub-consciously’ the process which had been undertaken. Having a ‘neutral’ facilitator was also beneficial for this process as the facilitator was able to guide and draw together discussions without having been influenced by their own ‘biases’. The use of a selection of trial species to assess model outputs in the workshop was also useful. By seeing 'real' outputs for a variety of species, participants were able to engage more meaningfully with why specific criteria should be selected, and this also allowed for debate as to why one species scored more highly than other, when the participants may have felt that 'intuitively' the ordering should have been different.

A very important part of this prioritisation process was the sensitivity analysis which was conducted. Although there were certain limitations to the sensitivity analysis, it still allowed for a greater in-depth understanding of how robust the selected criteria were, as well as to help understand the importance or effect that certain methods within the value-function approach had. One of these was showing the importance of the weighting of the criteria. The outputs of the Models showed that the Models were relatively robust within a conservative set of weights, but that if no weighting was applied (in this case all Models been given equal weights), there were significant differences in the outputs of the Models (Chapter 5).

At the beginning of this prioritisation exercise, it was decided to focus only on biological criteria, and to include a separate second step, other factors relating to management and other considerations. This was a good decision because it allowed this part of the conservation prioritisation process to be more simplified and focused.

Difficulties of this prioritisation process

Although it was beneficial to have a number of different stakeholders and experts at the Workshop, this created some difficulties during the sensitivity analysis and feedback stage of this process. Ideally all Workshop participants should have been given the opportunity to look at the outputs of the formal sensitivity analysis conducted after the completion of the workshop. However, because of time restrains, one Workshop participant provided feedback as a 'representative' of the Workshop. This does not imply that feedback from a wider group of participants is not possible, but because of the nature of this MSc thesis, the latter approach was chosen.

Another difficulty of this prioritisation approach was the complexity of using an inter-disciplinary approach. Because the MCDA method used here has not been used in this specific context before, and the participants from the Workshop were not from an operations research background, it was necessary to provide information about MCDA in order to place this prioritisation approach in context. Some people may be hesitant to use an approach whose mathematical or statistical background they are not familiar with or do not understand. However, in this approach this problem was addressed through providing a Background Document (Appendix 1) before the Workshop with details about the selected method. Time was also allocated at the start of the Workshop to explain more about MCDA by Leanne Scott, from the Department of Statistical Sciences at the University of Cape Town, who has vast experience in this field and who also facilitated the Workshop.

Some future recommendations of this prioritisation process

As already mentioned, there is still a second stage of this prioritisation process which needs to take place. This involves the implementation of a monitoring system, based on the outputs of this first stage of the prioritisation process. During this second stage, further factors relating to more 'management type' criteria, would need to be considered. A future recommendation would be to make use of a similar 'workshop-style' process when considering how to implement this second stage of the process.

Conclusion

"Without a sound basis for setting priorities, resources will be wasted." (Avery et al. 1995, p. 238). This thesis has developed a basis for setting priorities for conservation action, for Bird Species of Special Concern within the South African National Parks (SANParks). The context of this prioritisation approach was linked to SANParks Biodiversity Monitoring System, and specifically the Species of Special Concern Monitoring Programme (SSC MP). This thesis focused on a taxon specific conservation prioritisation approach within the South Africa National Parks (SANParks). The focus taxon was that of birds, which have been shown to be good indicators of biodiversity.

An additive value function method, from the field of Multiple Criteria Decision Analysis (MCDA) was used in this prioritisation process. This method had been used in other contexts but, as far as it is known, not specifically for prioritising species for conservation action.

SANParks is the custodian of a public resource and when undertaking a prioritisation exercise (which is inherently subjective) a carefully considered, transparent process needs to be followed which also allows for input from experts from relevant fields. MCDA is a decision support system which is rigorous, participative and transparent and therefore encourages and allows for meaningful debate. This approach also specifically allows for the values of the decision makers to be explored and captured in this process. It is for these reasons that an MCDA approach was selected for this prioritisation exercise.

As part of this prioritisation process a Workshop was organised to which a number of participants were invited, both from within SANParks as well as outside. This workshop was led by a 'neutral' facilitator from the Department of Statistical Sciences at the University of Cape Town with previous experience of leading workshops and working in the field of Multiple Criteria Decision Analysis. During the workshop, criteria to be used in this prioritisation process were discussed and finalised. Specific scales were developed so as to allow a comparative scoring across the criteria to take place. The criteria were then allocated weights. The final score of a species (from which it could be ranked) was then calculated.

During the workshop, a number of representative species were selected as 'trial taxa' whose outputs were presented and which elicited discussion. After the workshop was complete, a sensitivity analysis was conducted to gain an understanding of the most appropriate Model and the robustness of the Criteria.

It is hoped that through this prioritisation process, an understanding was gained about how a different approach to a prioritisation exercise can be undertaken, in which the values of the decision makers can be captured, and insights about the process gained through discussions and feedback. Although this method was developed and applied with SANParks in mind, there is the possibility that it can be used for any protected area as well as for different taxa. There is also potential for this method to be used for the selection of areas to be given a protection status.

Through development of this comprehensive basis for prioritisation species for monitoring and conservation action, it is envisioned that this will ensure that limited resources that SANParks has will be used wisely in order to further conserve the biodiversity which is so fundamental to our ecosystems.

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Appendices

Appendices 1 – 4 are included as hard copies in this thesis and Appendices 5 – 9 are available online at the given site.

Appendix 1	Programme and Background documents prepared for the Workshop
Appendix 2	Workshop report
Appendix 3	List of Peripheral Species
Appendix 4	Complete list of prioritised Species of Special Concern for the Kruger National Park
Appendix 5	Complete list of prioritised Species of Special Concern for SANParks Estate http://www.adu.org.za/pdf/Mostert_E_2012_MSc_Appendix_5-SANParks_Estate.pdf
Appendix 6	Complete list of prioritised Species of Special Concern for the Kgalagadi Transfrontier National Park http://www.adu.org.za/pdf/Mostert_E_2012_MSc_Appendix_6-Kgalagadi_Transfrontier_NP.pdf
Appendix 7	Complete list of prioritised Species of Special Concern for the Karoo National Park http://www.adu.org.za/pdf/Mostert_E_2012_MSc_Appendix_7-Karoo_NP.pdf
Appendix 8	Complete list of prioritised Species of Special Concern for the Table Mountain National Park http://www.adu.org.za/pdf/Mostert_E_2012_MSc_Appendix_8-Table_Mountain_NP.pdf
Appendix 9	Complete list of prioritised Species of Special Concern for the Bontebok National Park http://www.adu.org.za/pdf/Mostert_E_2012_MSc_Appendix_9-Bontebok_NP.pdf

Appendix 1

Programme and Background documents prepared for the Workshop

Programme for the workshop on 25th & 26th January 2011 –

Prioritisation of Bird Species of Special Concern for Monitoring and Conservation Action in Protected Areas

Date: 25th & 26th January 2011

Time: 08h30 – 17h00 (both days)

Venue: SANParks Cape Research Centre, Tokai.

Tuesday, 25 January 2011

08h30 – 08h35 Welcome and Overall objectives

08h35 – 09h00 Introductions

09h00 – 09h20 General background information

- SANParks Biodiversity Monitoring System and SSC Monitoring Programme
- Contribution to MSc Research
- ADU & Bird Atlas Project

09h20 – 10h30 MCDA – Value function method

- Background to MCDA and value-function method
- How scoring and weighting works: recap of car example

10h30 – 10h50 COFFEE/TEA break

10h50 – 11h00 Bird Species of Special Concern – definitions

11h00 – 11h10 SABAP bird lists for parks

11h10 – 11h30 Discussion of provisionally selected criteria and available data

11h30 – 11h50 Explanation of 'core range' tool

11h50 – 12h40 Discussion and finalisation of criteria to be used

12h40 – 13h00 Finalising value tree from chosen criteria

13h00 – 13h45 LUNCH

13h45 – 15h30 Scoring of criteria on value tree

15h30 – 15h50 COFFEE/TEA break

15h50 – 16h50 Continue scoring of criteria on value tree

16h50 – 17h00 Summary of day

DAY ONE ENDS – 17h00

Wednesday, 26 January 2011

08h30 – 09h00 Review and finalise scoring of criteria on value tree

09h00 – 10h30 Weighting of criteria on value tree

10h30 – 10h50 COFFEE/TEA break

10h50 – 13h00 Asses outputs of calibrated value tree using 12 pre-selected trial species

13h00 – 13h45 LUNCH

13h45 – 15h30 Discuss outputs of trial species

15h30 – 15h50 COFFEE/TEA break

15h50 – 16h10 Evaluation/feedback on workshop

16h10 – 16h40 Way forward after the workshop, thanks and closure

16h40 – 17h00 Completion of questionnaire & informal discussions.

CLOSE OF WORKSHOP – 17h00

Background document for the workshop on 25th & 26th January 2011 –

Prioritisation of Bird Species of Special Concern for Monitoring and Conservation Action in Protected Areas

This document provides background information for the workshop to be held in January 2011, relating to the prioritisation of bird species for monitoring and conservation action in protected areas.

Objectives & Outputs:

The following are the objectives and envisioned outputs from the workshop

Objective:

1. To prioritise bird species for monitoring and conservation action in the South African National Parks using a value-function approach
2. To debate and agree on criteria to be used in this process
3. To construct and 'calibrate' a value-tree with criteria relating to the prioritisation of birds for monitoring and conservation action (this process is described in Part B of this document)
4. To receive feedback from stakeholders and decision makers on the value-function method used in this workshop

Envisioned output

1. A prioritised list of bird Species of Special Concern (SSC) for all SANParks
2. A calibrated value function model
3. Co-authored publication of the workshop process and results in a peer reviewed journal
4. Contribution towards MSc research project at UCT – entitled "Bird Monitoring in Protected Areas"

Context

The objectives for this workshop take place within the context of SANParks' Biodiversity Monitoring System and specifically the Species of Special Concern Monitoring Programme (SSC – MP) that forms part thereof (McGeoch et al. in press).

Part A: SSC definition and discussion around criteria selection

This document provides the definition of a SSC and gives information relating to criteria which have been provisionally selected.

In the SSC-MP mentioned above, the following steps are listed:

STEP 1: Identification and listing of SSC for the biodiversity estate (all national parks) and for each park using a set of standard and transparent criteria,

STEP 2: Prioritising the SSC (across all national parks and within each park) for monitoring action,

STEP 3: Monitoring these 'target' SSC using standard approaches and measuring a series of pre-defined variables, and

STEP 4: Making decisions and taking action based on the above, which will be incorporated into the Biodiversity Lower Level Plans for parks.

These first two steps are what this workshop aims at addressing.

The SANParks Species of Special Concern (SSC) Monitoring Programme (encompassing the full spectrum of taxa, not only birds) considers following groups of taxa to fall within the definition of Species of Special Concern (note that a single species may fall into more than a single group):

Principally:

(i) Red List taxa in the following categories: Critically Endangered (CE), Endangered (EN), Vulnerable (VU) and also Near Threatened (NT), locally Extinct (LEX) or Extinct in the Wild (EW) (IUCN, sub-global or national Red List status and additional national categories where necessary; IUCN 2001, Victor & Keith 2004) ;

(ii) Taxa that are thought to be threatened but that are currently Data Deficient (IUCN 2001), or whose conservation status has not yet been formally assessed (also for example species whose taxonomic status is uncertain and may be rare or threatened).

(iii) Threatened or protected species as listed in the NEM:BA TOPS Regulations (as well as those identified by CITES as being subject to high levels of international trade in the few cases where they are not part of TOPS);

(iv) A species which is the subject of a biodiversity management plan published by the Minister in terms of Section 43 of NEM:BA, which may be applicable to a park management plan as stipulated in Section 41 of NEM:PAA.

(v) Endemic taxa, defined as taxa with over 80% of their range, or 80% of their populations or individuals, confined to the park or region (Rebelo *et al.* submitted);

(vi) Reintroduced taxa that were extinct or threatened, or indigenous species that have recently been reintroduced.

(vii) Locally threatened populations (e.g. populations of species at geographic range margins or key migrant populations; nationally or internationally important populations);

Species of Special Concern may (and in some cases should) also include the following:

Taxa that have been monitored in the past because they were threatened, but whose conservation status has improved to the point where they are of lower conservation concern;

(viii) Functionally important or keystone species (Mace *et al.* 2007);

(ix) Selected abundant or common species (Gaston 2010);

(x) Other species with social and cultural value (e.g. iconic species, Mace *et al.* 2007).

(xi) Taxa subject to resource use via legitimate sustainable harvesting and/or illegal extraction (although these will be covered by the *Resource Use Monitoring Programme*);

(xii) Species listed under relevant international conventions (e.g. Appendices I and II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS) (http://www.cms.int)).

NOTE: This definition of a SSC is taken directly from the SSC-MP developed by SANParks (McGeoch *et al.* in press).

Using the above definition, one needs to select a number of criteria, which reflect these definitions, which can be used to construct a model to determine what the Species of

Special Concern are. Some initial reading/discussion has already taken place around what criteria are to be used.

For birds, the following criteria have initially been selected as they seem the most relevant and important (the number in brackets refers to what definition the criterion is linked to):

1. Threat status – Threatened or Protected Species (TOPS) Regulations and IUCN: Red Data List species **(i)** & **(iii)**
2. Endemic, near-endemics and range-restricted species **(v)**
3. Peripheral species **(vii)**
4. SANParks 'core range' species

The above four criteria are not the only ones which can/will be used in this workshop. Additional criteria for the prioritisation of bird species, used in other prioritisation processes are listed in Appendix A. One of the main reasons for sending this document out is to allow you as a participant to comment on the criteria which have been selected and to consider whether other criteria should be included.

Please provide any feedback to esther.mostert@uct.ac.za or by phone **021 650 2423** about four initially selected criteria and other criteria which should be included (bearing in mind that one needs to be able to get information for each species in South Africa). A further discussion around the selection/use of criteria will take place at the workshop.

Below follows an explanation of what the above four listed criteria entail and reasons for their provisional inclusion (available data for bird species for these criteria is include in Appendix B).

1. Threat Status: Threatened or Protected Species (TOPS) Regulations and Red Data Book Species

TOPS & Red Data Book overlaps

Both TOPS and the Red Data Book are concerned with the threat status of birds. Although they have some categories in common (Critically Endangered, Endangered, and Vulnerable) the definitions of TOPS are much broader than that of the Red Data Book. It would not make sense to have both of TOPS and Red Data Book as criteria for classification as they are essentially a way of measuring the same factor. A way of combining these two criteria is still being discussed, and further suggestions as to this process are welcome.

TOPS

Threatened and Protected Species Regulations, which fall under the National Environmental Management: Biodiversity Act, 2004 (Act 10 or 2004) provides a list of species which are classified under this Act (Appendix B). They fall into four categories:

1. Critically Endangered Species
2. Endangered Species
3. Vulnerable Species
4. Protected Species

These are National regulations, set by the then Department of Environmental Affairs and Tourism (now Department of Environmental Affairs) and SANParks has a mandate to conserve these species. The TOPS categories are therefore included as criteria in this workshop.

Red Data Book

The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland provides a comprehensive status of threatened bird species based on the IUCN Red List Criteria. This book was published in 2000 and an update of this book is currently underway (envisioned date of completion is 2012, pers comm. Martin Taylor). The list of species relevant for the 'threat status' criterion are: Critically Endangered (CE), Endangered (EN), Vulnerable (VU), Near Threatened (NT) and Locally Extinct (LEX) or Extinct in the Wild (EX). A definition of these criteria is given in Appendix B.

2. Endemics, near-endemics and range-restricted species

Endemics and near-endemics are species which are defined as having at least 90% of their breeding range or population confined to South Africa, Lesotho and Swaziland (Barnes 2000).

Endemic and near endemic species have a greater risk of extinction. These species have a need to be monitored as the region in which they occur is almost entirely responsible for their global survival and hence this criterion has been selected.

Species of restricted range, are those which have an area of 50 000 ha or less, and which have all or part of their range in South Africa, Lesotho or Swaziland (Barnes 2000). Restricted range species are also at risk due to the limitation of the area in which they occur and therefore this criterion is important. These species are shown in Appendix B.

There is some overlap with restricted range species and endemics (Appendix B), and the method to deal with this in terms of prioritisation will be discussed/debated further in the workshop.

3. Peripheral species

These species (Appendix B) are common in the Afrotropics, but have small populations within South Africa, Lesotho and Swaziland (Barnes 2000).

These species were excluded as Red Data Book Species but they are susceptible to regional extinction based on their marginal status and a large number of these species are reliant on conservation areas in the north or east of South Africa (Barnes 2000). It is because of identified reliance/dependence of species on conservation areas, that this criterion is being used.

4. SANParks 'core range' species

In order for a park to effectively conserve a species, there has to be a "substantial" population of the species depending on the park. It is of no use to make a vagrant (however high its threat status) a priority species in the park because the park can play no meaningful role in improving its conservation status.

The first Southern African Bird Atlas Project (SABAP1) was run by the Animal Demography Unit (ADU) from 1987 to 1991. It involved recording the presence and absence of species within defined areas, throughout southern Africa. Results are presented as reporting rates. Every time a person goes out to atlas, they record the presence of species in a particular area, and a checklist is then submitted of the records. The reporting rate is calculated as a percentage of the number of times a bird was recorded present in an area, out of the total number of checklists submitted. SABAP1 culminated in the publication in 1997 of two volumes on and the distribution and relative abundance of southern African birds.

The Ramsar Convention (The Convention on Wetlands of International Importance) defines a wetland to be of international importance (amongst other criteria) if it holds 1% of the individuals in a population of species or subspecies of waterbirds (Ramsar

Convention, 4th edition, 2006). This is irrespective of whether the species is in a threat category; it is the 1% threshold that is an important figure. For example, Langebaan Lagoon, in the West Coast National Park, has been declared a Ramsar site, because, amongst others, the number of Curlew Sandpipers at the Lagoon falls above the 1% threshold category. However, in terms of threat status, Curlew Sandpipers are in the 'Least Concern' category.

The second Southern African Bird Atlas Project (SABAP2) is an update and a refinement of SABAP1. It has been running since 2007 and is a project already registered with SANParks. SABAP2 still involves recording the presence or absence of species within a grid cell but the differences in protocol from SABAP1 means much more improved coverage in grid cells and also allows an overall better quality of data.

Using atlas data, it is possible to extend the 'threshold' concept from waterbirds to terrestrial birds and apply this concept within SANParks. The atlas data can be used to look at the 'core' of the South African distribution for a species and then to determine what fraction of the 'core' distribution occurs within a National Park. This would then be used to identify what species have a substantial fraction of their core range in the park, and for which the park is therefore largely responsible for their conservation. For example, a substantial fraction of the core range in South Africa of the Bateleur occurs within the National Parks. Thus, although this species is relatively abundant with the parks, its conservation with South Africa largely devolves on SANParks. A data extraction tool is being developed at the ADU, whereby this data to be extracted. The technicalities of this tool will be explained further in the workshop.

This "threshold" criterion is selected for consideration at the workshop because it gives an indication of which species SANParks is mainly responsible for so that conservation effort can then be focused on these species. This criterion will enable SANParks to determine which species are largely its responsibility and that conservation effort can be then focused on these species.

This section has provided information on the criteria which will be used in this workshop. These criteria will be used in the value function method, in order to obtain a rank-ordering of bird species. A description, and worked example, of this value function method is provided in the following section (Part B).

Part B: Multi-Criteria Decision Analysis (MCDA) – Value-Function Method & Value-Focused thinking

This document provides some background about the method what will be used in the workshop for the prioritisations process. As there is limited time in this workshop, one cannot afford to spend large amounts of time explaining the method to be used. The intentional of this document is to allow you as a stakeholder become familiar with the method which will be used, to allow more time in the workshop to be spent on conducting the actually process.

MCDA

Multi-Criteria Decision Analysis (MCDA), sometimes called Multi-criteria Decision Making (MCDM), is a discipline aimed at giving support to decision makers who have to make decisions based on multiple criteria. MCDA falls within the broader discipline known as Operations Research, which itself lies at the interface between Statistics and Mathematics, with linkages into the social sciences.

Belton and Stewart (2002: 2) define multi-criteria decision analysis (MCDA) as, "*an umbrella term to describe a collection of formal approaches which seek to take explicit account of multiple criteria in helping individuals or groups explore decisions that matter*".

MCDA methods aim at improving the quality of decisions by making choices more explicit, transparent, rational and efficient. An important use of MCDA is that there is a transparent process for the justification of the decision. The paper by Scott (2005), include as background reading in this document, provides a good further description of the background of MCDA.

The aim of MCDA is to "facilitate decision makers' learning about and understanding of the problem faced, about their own, other parties' and organisational priorities, values and objectives and through exploring these in the context of the problem to guide them in identifying a preferred course of action" (Belton & Stewart, 2002, 3).

The following quotes support and make this idea more clear:

"Simply stated, the major role of formal analysis is to promote good decision making. Formal analysis is meant to serve as an aid to the decision maker, not as a substitute for him." (Keeney & Raiffa, 1972, 65)

"The decision unfolds through a process of learning, understanding, information processing, assessing and defining the problem and its circumstances. The emphasis must be on the process, not on the act of the outcome of making a decision..." (Zeleny, 1982).

Value-focused thinking

Most approaches to decision making take the route of focusing on alternatives. Keeney (1996) refers to this as 'alternative-focused thinking'. However he states that "It is values that are fundamentally important in any decision situation. Alternatives are relevant only because they are means to achieve your values" (Keeney 1996: 537).

Keeney (1996) argues that the thinking around a decision problem should first focus on values and only later on the alternatives that may be used to achieve them. He refers to this as '**value-focused thinking'**. This latter approach is what will be used for this workshop. Note that Keeney's paper is included as background reading material for the workshop.

In multi-criteria decision analysis one tries to model the value judgements and preferences of the decision maker. "In a very real sense, the preferences and value judgements do not exist (or at least are very incompletely formed) at the start of the decision analysis, and are formed at least partially as a result of the decision aiding process" (Belton & Stuart 2004: 80). The model is thus a mechanism hereby decision makers are able to learn about their own preferences (Belton & Stuart 2004).

Robustness of Additive Value-Function Methods in MCDA

Additive value function methods are widely used and they are transparent and relatively simply to understand and implement (Stewart 1996).

Stewart (1996: 308) describes the robustness of additive value function methods used in MCDA. In this paper he shows that using additive value-function methods gives results that are consistent and reliable, provided that

a) "Non-linearities in the marginal value functions are adequately captured (by using interpolation between three or four points at least),
b) Due care is taken in ensuring that the modelled criteria are close to additively independent"

Value-function models

The best model is the one which provides insight and guidance to the decision maker. Such insight is best achieved by constructing the simplest possible model. This may look like it implies a strong set of assumptions, but it is possible to carry out extensive sensitivity analysis to weaken the effects of assumptions and to facilitate learning.

The value function approach, also known as multi-attribute value theory (MAVT), is the method that will be used in this workshop. The simplest and most widely used form of value function (which will also be used in the workshop) is the additive model.

The additive value function model is as follows:

$$V(a) = \sum_{i=1}^{m} w_i v_i(a)$$

$V(a)$ is the overall value of alternative a

v_i(a) is the value score reflecting alternative a's performance on criterion i

w_i is the weight assigned to reflect the importance of criterion i

m is the total number of criteria

In words: the value of an alternative is calculated by adding together all the score of the criteria or sub-criteria associated with each branch, multiplied by the weight of that branch

The main steps in constructing a value-function are as follows:

Step 1: Construct a ***value tree*** using selected criteria

Step 2: ***Score*** the criteria in the value tree

Step 3: ***Weight*** the criteria in the value tree

Step 4: Calculate the ***overall value*** of the alternatives

Step 5: Assess the model ***outputs***

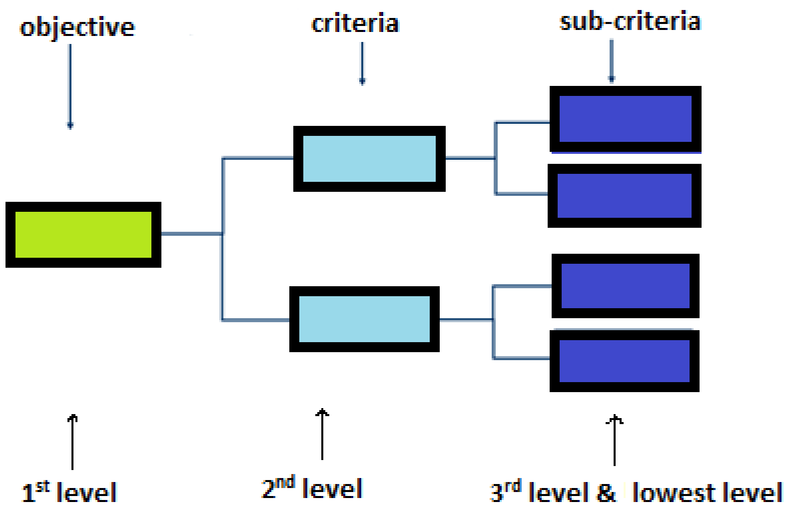
Step 6: Perform a ***sensitivity analysis*** on the model

Step 7: Make a ***final recommendation*** based on the model outputs

Step 1: Construct a ***value tree*** using selected criteria

A value tree is a hierarchical structure of the overall objective, criteria and sub-criteria (or even sub-sub-criteria). The lowest level is one that must be easily definable for alternatives. So each objective is defined by the criteria, and sub-criteria. The decision alternatives are connected to the sub-criteria.

A simple generic example of a value tree is shown below:



The lowest level of the value tree (in the above example it is the sub-criteria) is what is important, because it is here where the measure is used to assess the performance of the alternatives.
This step of constructing the value tree is very important as it forms the basis for the other steps in the value function method.

Software package: V I S A (Visual Interactive Sensitivity Analysis) for WINDOWS

The package **VISA for WINDOWS** was used was used to construct the example below and will be used in the workshop. VISA was designed to support the decision making process using multiple criteria. Decisions are modelled using a hierarchical weighted value function. VISA has an extensive facility for visual interactive sensitivity analysis (hence the name), which enables decision makers to explore the implications of changing or differing priorities and values.

NOTE: The example used throughout this document is a constructed one, based on hypothetical values, which aims to illustrate a practical application of the theory.

Car Example: Constructing a value tree for buying a car

The **decision problem**: Joe Soap wants to buy a new car

The **overall objective**: Buying a suitable car for Joe Soap

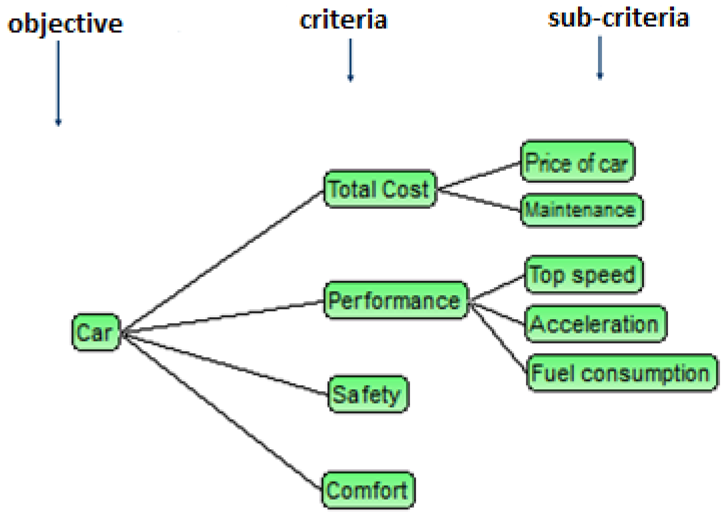
The **decision alternatives:** Porsche, BMW, Landrover, City Golf

Note: this example is for a local scale (an explanation of a local and global scale is provided later)

The **criteria (which Joe selected)**: Total cost, Performance, Safety & Comfort

The **subcriteria** for Total Cost are Price of car & maintenance, and for Performance the subcriteria are Top speed, Acceleration and Fuel consumption. Joe has decided that he does not need to split the criteria of Safety and Comfort into further subcriteria (although this would be possible).

Below is the value tree that has been constructed for this decision problem:



Step 2: *Score* the criteria in the value tree

Before proceeding with the explanation of scoring, one needs to look more closely at the idea of a value function.

Value Function

- A value function $v(x)$ assigns a number i.e. *value* to each sub-criteria level x.
- The value describes the subjective desirability of the corresponding sub-criteria level.

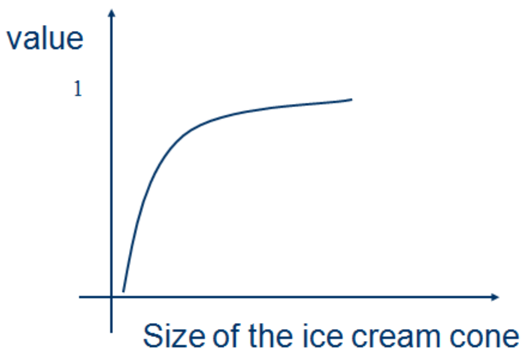
For example:

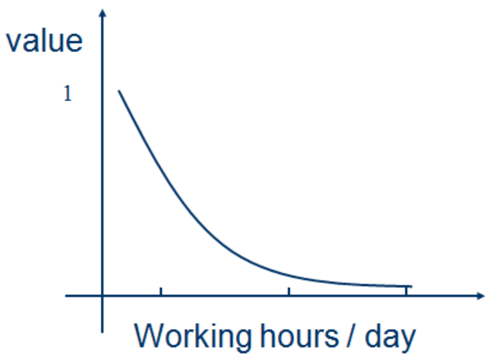
An increasing value function:

- A very small ice cream cone would not have a great value
- As the size of the cone increases, so does the value
- However, at a certain stage, the further increase in size of the cone (say from extra-large to huge) would not be valued as much (or have the same impact) as an increase from small to medium would.
- The function is therefore not linear (see Figure below)

A decreasing value function:

- Working for a very small number of hours per day has a high value
- As the hours increase, so the value decreases
- But again this decrease in value is not linear – the difference between working 4 hours and 8 hours, has a much higher impact than, say a difference between working 12 hours and 16 hours
- Thus the function is not linear (see Figure below)





(Adapted from: Powerpoint presentation "*Introduction to Value Tree Analysis", by* R.P. Hämäläinen, Helsinki University of Technology).

- So what is being achieved here is that one is 'mapping' ones values onto a function.

When scoring a value function one first needs to identify a measurable attribute scale which is closely related to the decision makers' values (In the above example one could used the total volume of the ice cream cone as a scale for the first example, and number of hours, for the second example). If it is not possible to identify an appropriate quantitative scale, then one needs to construct a scale.

The value function reflects the decision makers' preferences for different levels of achievement on the measurable scale

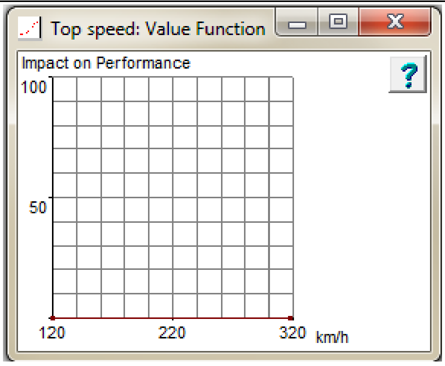
This workshop will involve the use of an indirect assessment of a value function. In this method one assumes that the value function is monotonically increasing or decreasing over the range of attribute measurement considered. The end points of the scale must be defined and then a method used to determine further points. In this case the Bisection Method will be used (more information about different methods is available from Belton & Stewart, 2002).

Bisection Method:

- Determine whether the value is increasing or decreasing
- Decide what scale and units will be used for the criteria – the scale is on the x-axis of the function
- The scale on the Y-axis is from 0 to 100; this is where one will read off the score for a criteria
- Define the end points of the x-axis scale - these are the lowest and highest points of the alternatives
- If the value function is increasing, the lowest point is automatically given a score of 0 and the highest point a score of 100.
- Now one needs to work out where further points on this function will be so one can determine the shape of the function
- Find the midpoint of the score (not necessarily the midpoint of the scale)
    - Ask the question, "At what point on the scale will the value/impact of going from the lowest point to the midpoint and the midpoint to the highest point be equal?"
    - Repeat this question, comparing first the lowest point to the midpoint and then the midpoint to the highest point
    - There will now be five points, enough to construct a value function

Car example: Scoring

- The selected criteria for this example is that of top speed (km/h)
- The value function is increasing - the car with a higher top speed has more value attached to it than one with a lower top speed.
- The end points of this scale are 120 km/h (top speed of Landrover) and 320 km/h (top speed of the Porsche)
- So 120 km/h is given a score of 0 and 320 km/h is given a value/score of 100 (see graph)

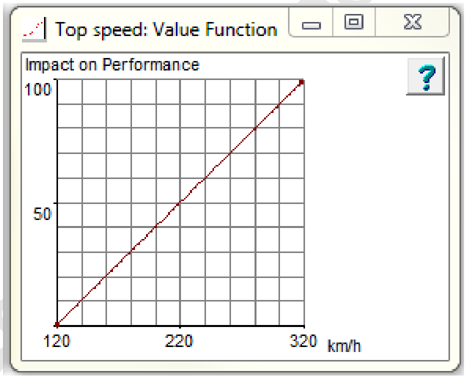


<u>Note:</u> the units of each block of the x-axis are 20 km/h

- To find the midpoint of the impact, consider the following:

Question: *Is the increase in speed from 120 km/h to 220km/h (middle of scale) equal in impact (or value) to the increase from 220 km/h to 320km/h?*
Answer: *No, the impact from 120 km/h to 220 km/h is much greater than the change from 220 km/h to 320 km/h(according to Joe)*

<u>Note:</u> if the answer to this question was yes, then the function would be linear as shown



- Now one needs to identify the point on the scale, which is halfway, in value terms, between the two end points.

Question: *At what point (ie speed) would the increase from the lowest point (120 km/h) to the highest point (320 km/h) be equal?*

Answer: *In this instance at about 180 km/h*

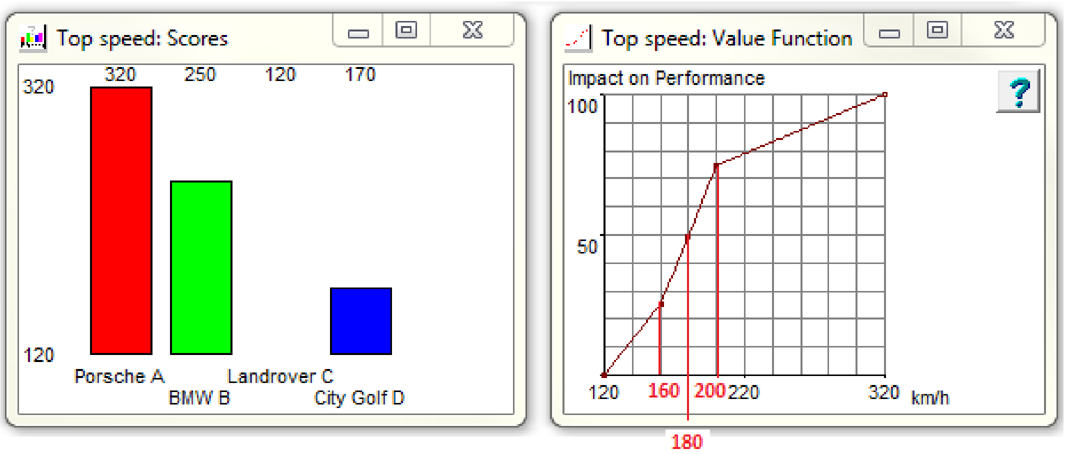
- This is then considered the midpoint - 180 km/h
- Now one needs to establish at least find two further points on the scale, in order to construct the value function
- Repeat the same questioning process, from now compare the lowest point on the scale to the established midpoint and then compare the established midpoint to the highest point on the scale

Question: *At what point (ie speed) would the increase from the lowest point (120 km/h) to the midpoint point (180 km/h) be equal?*
Answer*: At 160 km/h*

Question*: At what point (ie speed) would the increase from the mid point (180 km/h) to the highest point (320 km/h) be equal?*
Another way of phrasing the question*: At what point (speed) between 180 km/h and 320 km/h, will the difference (i.e. Impact) from the point 180 km/h to the highest point (320 km/h) be equal?*

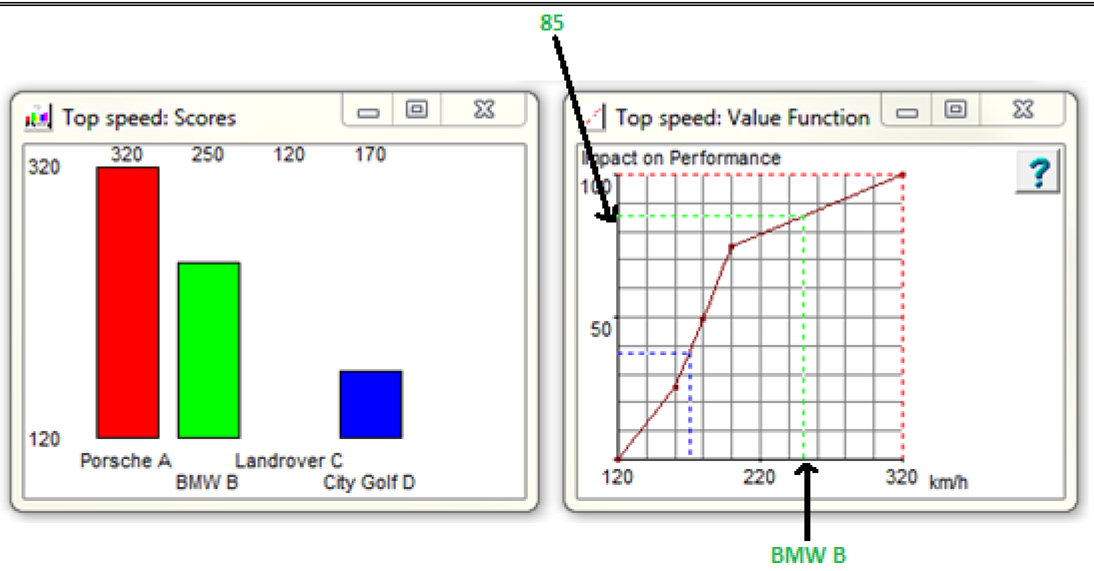
Answer*: At 200km/h*

- There are now five points on the scale – two end points and three defined points
- This is enough to construct a value function

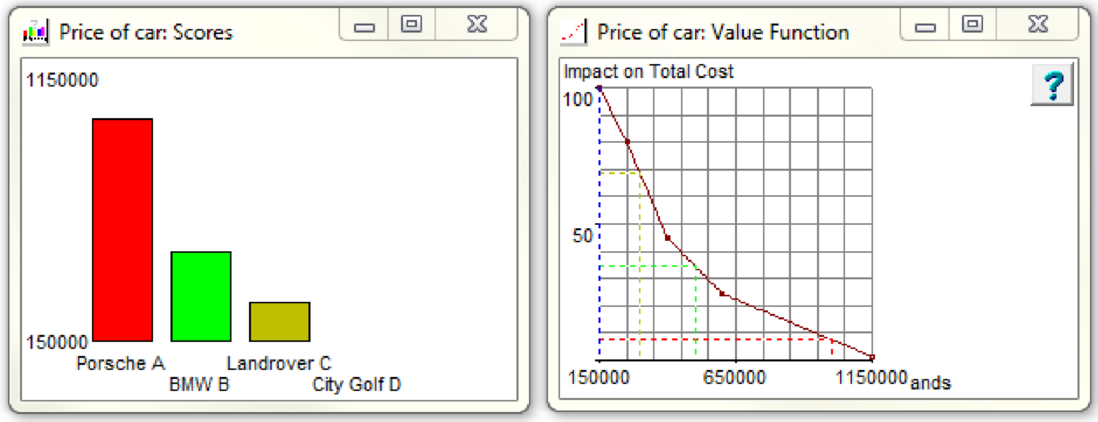


Note: a 'blank bar' means the score is at the lowest level – it is not "missing". So for the above graph the Landrover C has a score of 120.

- To determine the value/score of the criteria, one simply puts the figure of the alternative into the function and the score/value will be given – essentially reading of the corresponding y-value
- So a BMW has a top speed of 250 km/h the score that it gets is 85 – see graphic representation below



- The same process will be done for the other criteria, although in some cases the value function is decreasing (e.g. cost and acceleration time – more value is placed on a car which can accelerate to 100 km/h within a short time, therefore the value function decreases)
- A further example of a value function (this time decreasing) for the Price of a car is shown below.



This process has to be done for each 'end –level' criteria.

Note: Local and Global Scales

The minimum and maximum points used on the examples in the above scales were defined using a local scale. One can distinguish between two scales in the scoring process – a local scale and a global scale. Belton and Stewart (2004:121) define local and global scales as follows:

"A local scale is defined by the set of alternatives under consideration. The alternative which does best on a particular criterion is assigned a score of 100 and the one which does least well is assigned a score of 0. All other alternatives will receive intermediate scores which reflect their performance relative to these two end points. The use of local scales permits a relatively quick assessment of values and can be very useful for an initial 'roughing out' of a problem, or if operating under tight time constraints"

"A global scale is defined by reference to a wider set of possibilities. The end points may be defined by the ideal and the worst conceivable performance on the particular criterion, or by the best and worst performance which could realistically occur. The definition of a global scale requires more work than a local scale but it has the advantages that it is more general than a local scale and that it can be defined before consideration of specific alternatives."

A local scale is used throughout these examples as it allows for a quicker assessment of values – and the use of this example is mainly to allow the reader to become familiar with the way of thinking when scoring a value function. During the workshop a global scale will be used, because all birds occurring within South Africa will be assessed.

Constructing a Qualitative Value Scale

Sometimes it is not possible to find a measurable attribute which captures a criterion. In these instances one needs to construct an appropriate qualitative scale. As with the Bisection Method, one needs to define at least two points on the scale (these are usually taken as the end points). This method is best further explained by working through an example.

Car example: Comfort

For this criterion the following three factors were considered to make up the criterion:

- Comfort of seat
- Adjustability of seat /steering wheel
- Air conditioner

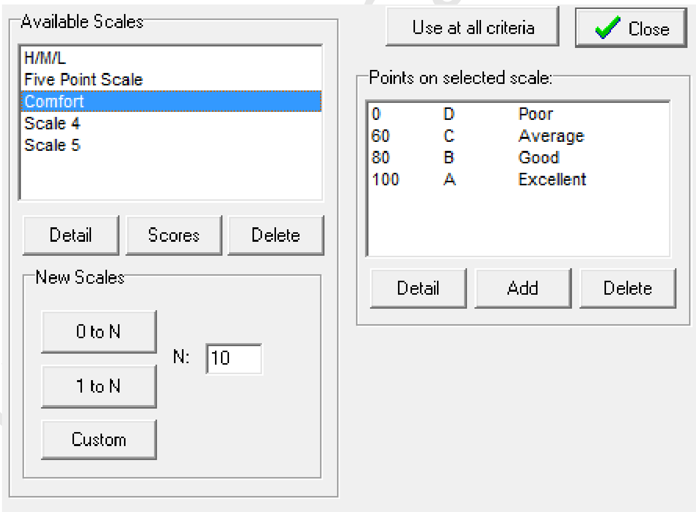
The following categories were constructed – the points are defined descriptively

A: Excellent Seat is very comfortable and made of good quality material, both the seat and the steering wheel can be adjusted at many levels, the air conditioner has multiple functions

B: Good	Seat is comfortable, the seat and steering wheel are both adjustable but at a limited number of levels, the air conditioner has two functions
C: Average	Seat is comfortable but made of poor quality material which wears easily, only the seat is adjustable, air conditioner only has one function
D: Poor	Seat is uncomfortable, neither the seat nor the steering wheel is adjustable, there is no air conditioning

Now one needs to construct a value function in which one is rating the categories. Initially one may think that because there are four categories, they will simply be given ratings along a linear function, eg. A = 100%, B =66%, C = 33%, D = 0%.

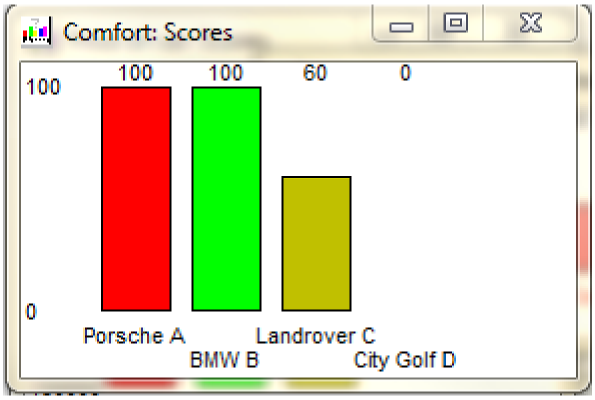
However, when thinking about how one values the different categories, the difference between moving from category D (Poor) to category C (Average) may not necessarily be the same as the difference between category B (Good) and category A (Excellent). So this is where one needs to construct a value function where one 'maps' the values of each category onto the function. In VISA this is not done graphically, but just by selecting points on a scale and allocating them a value, as shown below.



One then needs to decide into which category each of the alternatives belongs. The following was decided (based on the description for each category):

Porsche	A
BMW	A
Landrover	C
City Golf	D

The cars will then be given the score of the category into which they were placed – so the Landrover is given a score of 60% as it was placed in category C. A graphical representation of the scores is shown below:



Step 3: ***Weight*** the criteria in the value tree

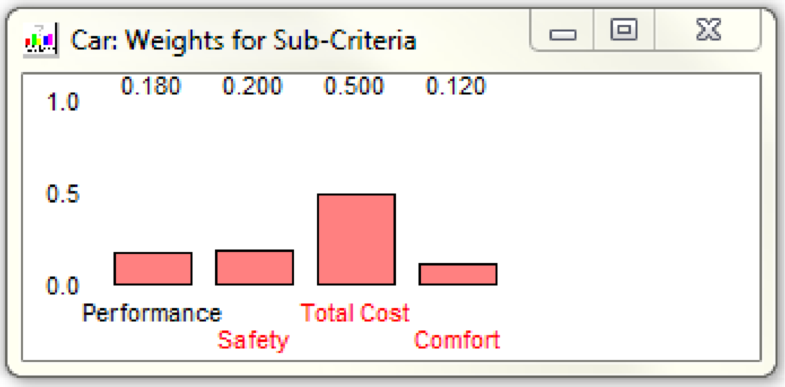
Not all criteria in a value-tree carry the same weight and it is therefore necessary to assess the relative importance of each of the criteria. The weight assigned to a criterion is essentially a scaling factor which relates scores on that criterion to scores on all other criteria.

e.g. If criterion A has a weight which is twice that of criterion B this should be interpreted that the decision maker values 10 value points on criterion A the same as 20 value points on criterion B and would be willing to trade one for the other.

All weights sum to 1 or 100%. There are different methods that are used for weighting. The swing weight method is the one that will be used in this workshop. In this approach, the participants are asked to consider a swing from worst to best status on each of the criteria (at a given level of the model) and to evaluate the contribution (to overall importance) of such a swing. The criterion whose swing is considered to have the most impact is given the highest weight and the other criterion weights are set at values relative to this maximum.

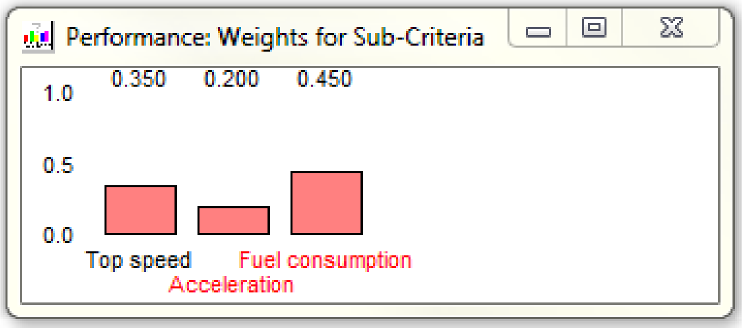
Car example: Swing weights

In this case the 'Total Cost' criteria is considered to have the greatest impact if it were to swing from worst to best, and given a weight of 0.500. The other criteria are then set at values relative to this – so safety is given a weight of 0.200, performance is given a weight of 0.180 and reliability of weight of 0.120.

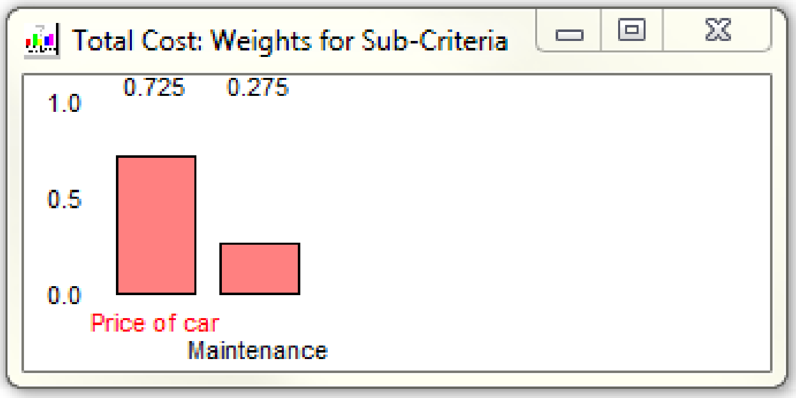


NOTE: the pink colour of the labels is of no significance

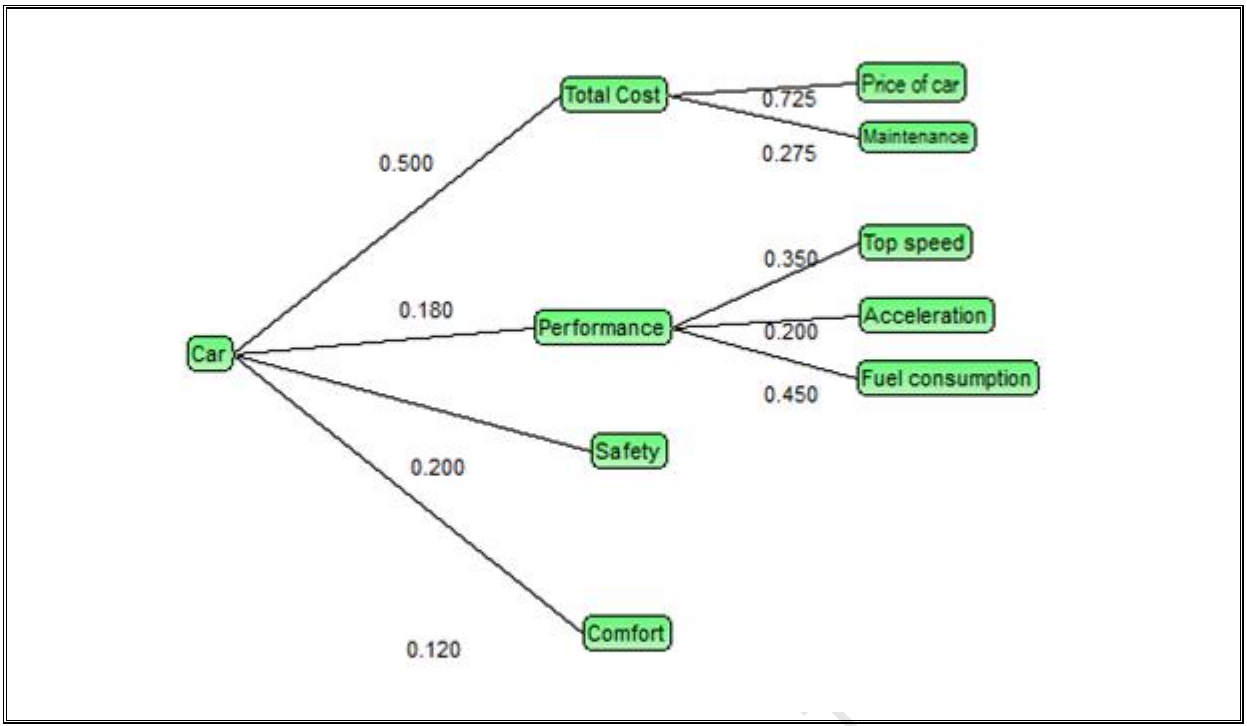
Similarly, for the criteria making up performance, fuel comsumption is considered to have the greatest impact if it were to swing from worst to best. This is followed by top speed and acceleration.



For the criteria making up Total Cost, the price of the car was considered to have the greatest impact, given a weight of 0.725 and the maintenance was given a weight of 0.275.



Summary of weights: the value tree with the weights on it looks as follows:



<u>**Step 4**: Calculate the ***overall value*** of the alternatives</u>

Once the scoring and weighting have been completed for a value tree (also known as calibrating a value tree) then the overall value (given as a score) can be calculated

A reminder of the value function of the additive model:

$$V(a) = \sum_{i=1}^{m} w_i v_i(a)$$

$V(a)$ is the overall value of alternative a

v_i(a) is the value score reflecting alternative a's performance on criterion i

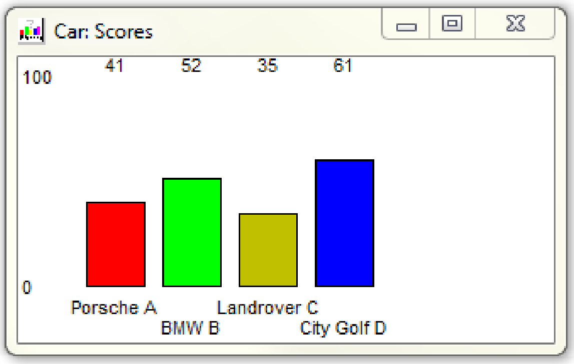
w_i is the weight assigned to reflect the importance of criterion i

m is the total number of criteria

In words: the value of an alternative is calculated by adding together all the score of the criteria or sub-criteria associated with each branch, multiplied by the weight of that branch

<u>Car example: Overall value of the alternatives (final score)</u>

A visual representation of the final scores of the cars is as follows. The City Golf has the highest score (61), followed but the BMW (52) and Landrover (36). The Porsche has the lowest score with 41.



Break down of score for City Golf (the first number given is the weight which is then multiplied by the score).

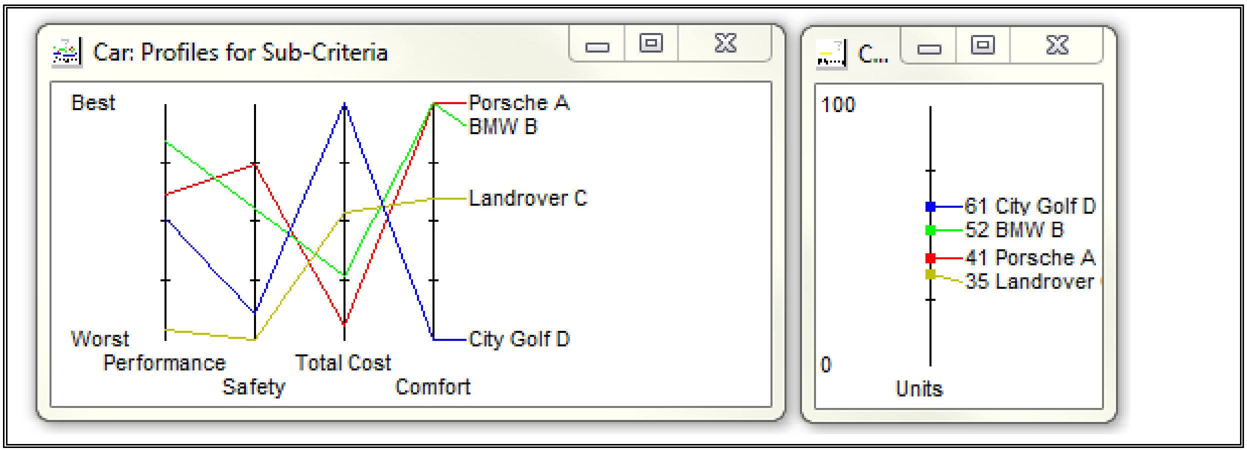
Cost (2nd level) = Total cost + maintanence
= (0.725)100 + (0.275)100
= 72.5 + 27.5 = 100
Cost (1st level) = (0.5)100
= **50**
Performance (2nd level) = top speed + acc. + fuel consumption
= (0.350)36 + (0.200)0 +(0.450)83
= 12.6 + 0 + 37.4 = 50
Performance (1st level) = (0.180)50
= **9**
Safety = (0.2)10 = **2**
Comfort = (0.120)0 = **0**

Add these all up = 50 + 9 +2 +0 = 61 (The total score for the City Golf is 61)

Summary of the contribution of the criteria:

Criteria	Score
Cost	50
Performance	9
Safety	2
Comfort	0

It is also possible to look at the profiles for subcriteria. This profile does not give the final score but allows one to get a good overall picture of how the alternatives compare to each other. A 'themometor" scale can also be used to display the final scores (simply an alternative visual representation of the final scores) :

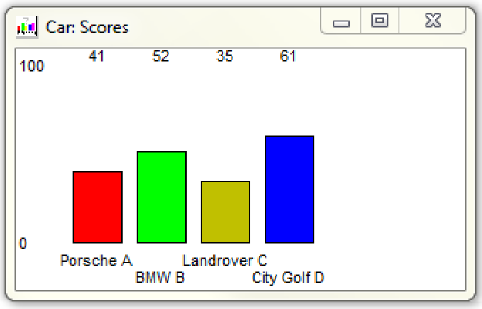


Step 5: Assess the model ***outputs***

This step is closely linked with Step 6. As mentioned in the introduction, the results produced by a value function model are not meant to be seen as 'set in stone'. Rather, the results should be looked at critically and assessed against the intuition of the decision maker. The 'numbers' produced by the model should encourage critical thinking and help to understand the ranges of impacts. It is important to remember that the final decision should not be left to the model. During this step one needs to ask and try and answer some questions relating to the relative scores that the model gives.

Car example: Assessing the model output

A recap of the results which the model produced:



Some questions to consider:

- Did you think that the City Golf would perform as well as it did?
- Why does the Porsche score so badly and is this what you expected?
- Looking at the performance score: did you expect the Landrover to score lower than the BMW?
- ...etc

Step 6: Perform a ***sensitivity analysis*** on the model

One way to try and understand discrepancies between one's intuition, and the answers the model provides, is to perform a sensitivity analysis.

A sensitivity analysis should be carried out on a model to investigate whether the preliminary conclusions are robust or if they are sensitive to changes in aspects of the model. Changes can be made to the model during the sensitivity analysis to investigate a number of things such as the significance of missing information, to explore the effect of a decision makers uncertainty about their values and priorities or to offer a different perspective on the problem.

So the overall aim of the sensitivity analysis is to explore how changes in the model influence the recommended decision. The sensitivity analysis for the model in the workshop will be conducted after the workshop is complete (restricted time will not allow this to take place during the workshop). Feedback from the sensitivity analysis will then be given to the participants. Details of how a sensitivity analysis is conducted are therefore not included in this document, but the process of a sensitivity analysis will be described and explained at the workshop.

Step 7: Make a ***final recommendation*** based on the model outputs

This step will not be done in the workshop but will be completed after the sensitivity analysis has been done and comments have been received from the participants.

This section has given a detailed description, together with an example, of the approach that will be used in this workshop. Instead of valuing criteria to select cars, the focus of the workshop will be valuing the criteria which will be used to prioritise bird species for monitoring and conservation action in protected areas.

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APPENDIX A: Criteria that have been used for prioritisation processes

There are many methods and criteria that have been used for prioritisation of species. A selection of published criteria used in prioritisation methods are shown below. This is to allow participants to comment on whether they feel there are criteria which should be included, in addition to the criteria provisionally selected (described in Part A). If you would like to obtain any of these papers for further reading, please contact esther.mostert@uct.ac.za.

Papers focused on *bird* species for prioritisation:

Avery et al. (1995)

The focus of this process was for British Red Data birds

Proposed three biological axes to be considered for assigning priorities for conservation action:

1. National threat – measured as rarity, localised distribution and population decline in the UK
2. International importance – the proportion of European population in the UK
3. International threat – European/global conservation status

Shaw (1995) used the following categories

1. Breeding Rate
2. Distribution
3. Habitat/vegetation
4. Population size
5. Taxonomic status
6. International status
7. Population trends
8. Natural stress
9. Human induced stress
10. Endemism
11. Additional factors

- 1 – 5: biological
- 6 – 11: non-biological
- Scored from 0 – 3
- Added up scores

Carter et al. (2000)

Chose seven parameters based on global and local information

1. Breeding Distribution
2. Non-breeding distribution
3. Relative abundance
4. Threats to Breeding
5. Threats to non-breeding
6. Population Trends
7. Area importance

- Each of these variables were given a score from 1 – 5.
- These scores were summed (ie total scores ranged from 1 – 35)
- Each variable was equally weighted

Rodriguez et al. (2004)

- Four dimensional priority setting process for the conservation of threatened birds in Venezuela (inspired by Avery et al. 1995)
- Axes:
    - extinction risk,
    - degree of endemicity,
    - taxonomic uniqueness,
    - public appeal
- Each attribute was given a score of 1 – 3
- Priority score was calculated by multiplying the value assigned to the attribute (value range of 1 – 81)
- But pre-selected 36 species – listed as threatened in Red Data Book of Animals of Venezuela or 2003 IUCN Red List of Threatened Species
- Details of how the criteria were assessed are described in paper

Shuford & Gardali (2008): used the following categories

1. Population trend
2. Range trend
3. Population size
4. Range size
5. Percentage of entire range within California
6. Population concentration
7. Vulnerability to threats

- Used a linear and categorical method

<u>Papers focused on the general prioritisation procedure</u>

Dunn et al. (1999)

- Generated two complementary lists
  - Scores for Concern – representing vulnerability and population trend
  - Scores for Responsibility – regionally characteristic fauna "based on the proportion of a species range in a jurisdiction relative to what would be expected given uniform distribution at the next highest jurisdictional level"
- Categories were given a score from 1 - 5
- Two rankings on these lists are calculated separately because they have different purposes and applications

Marsh et al (2006)

- Used a risk-assessment framework as the starting point for assigning management priority
- Criteria that were considered:
  - Threat category (extinction probability)
  - Consequence of Extinction
    - Ecological value
    - Evolutionary value
    - Social value
  - Potential for successful recovery
    - Threatening processes
    - Biological potential for recovery

- These three criteria are combined to produce a single management priority score
- Weighting and scoring as also used in this method

The following tables from Mace et al. 2007, are included to provide some more examples what can be considered in priority setting.

Table 2.1 Classes and kinds of issues that are considered in priority-setting exercises for single-species recovery

Biological value	Economic value	Social and cultural value	Urgency	Practical issues
Degree of endemism	Cost of management or recovery	Scientific and educational benefits	Threat status = extinction risk	Feasibility and logistics
Relictual status	Direct economic benefits	Cultural status (e.g. ceremonial)	Time limitation, i.e. opportunities will be lost later	Recoverability, i.e. reversibility of threats, rate of species response
Evolutionary uniqueness	Indirect economic benefit	Political status (e.g. symbolic or emblematic)	Timeliness, i.e. likelihood of success varies with time	Popularity – will there be support from the community?
Collateral benefits to other species	Ecological services	Popularity		Responsibility, i.e. how much is this also someone else's responsibility?
Collateral costs to other species		Local or regional significance		Land tenure
Ecological uniqueness				Governmental/agency jurisdictions
Keystone species status				
Umbrella species status				

Table 2.2 Criteria for setting prorities. The different kinds of considerations from Table 2.1 are classified into six criteria (rows), each of which can be qualitatively assessed for a particular species

Criterion	Explanation	Subcriteria	Scores
Importance	'Does anyone care?' A measure of how much support there is likely to be	Social and cultural importance (including charisma) Responsibility – how much of the species status depends on this project?	Important (I) Moderately important (M) Unimportant (U)
Feasibility	'How easy is this to achieve?' An assessment of the difficulty associated with this project	Logistical and political, source of funds, community attitudes Biological	Feasible (F) Moderately difficult (M) Difficult (D)
Benefits	'What good will it do?' A measure of how much good will result from the project.	Reduction in extinction risk, increase in population size, extent of occurrence Collateral biological benefits, to other species or processes	Highly beneficial (H) Moderately beneficial (M) Unclear benefits (U)
Costs	'What will it cost?' An assessment of the relative economic costs of the project (or gains). In this criterion there are both postive and negative aspects which have to be weighed against each other	Direct and indirect costs of project Direct and indirect social and economic costs and benefits that will flow from the project	Expensive Moderately costly Inexpensive
Urgency	'Can it be delayed?' A measure of whether the project is time-limited, or whether it can be delayed	Extinction risk, potential for loss of opportunity if delayed	Urgent Moderately urgent Less urgent
Chance of success	'Will it work?' An assessment of whether or not the project will work	Will it meet its specified objectives?	Achievable Uncertain Highly uncertain

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APPENDIX B: Data of bird species for four provisionally selected criteria

The following are the four provisionally selected criteria for this workshop:

1. Threat status – Threatened or Protected Species (TOPS) Regulations and Red Data List species
2. Endemic, near-endemics and range-restricted species
3. Peripheral species
4. SANParks 'core range' species

Data available for each of these criteria is described and shown below.

1. Threat status – Threatened or Protected Species (TOPS) Regulations and Red Data List species

A definition of these categories is as follows:

TOPS Categories		Definition
Threatened	Critically Endangered	Indigenous species facing an **extremely high risk** of extinction in the wild in the **immediate future**
	Endangered	Indigenous species facing a **high risk** of extinction in the wild in the **near future**, although they are not a critically endangered species
	Vulnerable	Indigenous species facing a **high risk** of extinction in the wild in the **medium-term future**, although they are not a critically endangered species
Protected	Protected	Indigenous species of **high conservation value** or national importance that require national protection

TOPS Species

Categories		Abrev
Threatened	Critically	tCR
	Endangered	tEN
	Vulnerable	tVU
Protected	Protected	tPR

Critically endangered species	Scientific name	Abrev
Wattled Crane	*Grus carunculatus*	tCR
Blue Swallow	*Hirundo atrocaerulea*	tCR
Egyptian Vulture	*Neophron percnopterus*	tCR
Cape Parrot	*Poicephalus robustus*	tCR
Endangered species		
Blue Crane	*Anthropoides paradisues*	tEN
Grey Crowned Crane	*Balearica regulorum*	tEN
Saddle-Billed Stork	*Ephippiorhynchus senegalensis*	tEN
Bearded Vulture	*Gypaetus barbatus*	tEN
White-Backed Vulture	*Gyps africanus*	tEN
Cape Vulture	*Gyps coprotheres*	tEN
Hooded Vulture	*Necrosyrtes monachus*	tEN
Pink-Backed Pelican	*Pelecanus rufescens*	tEN
Pel's Fishing Owl	*Scotopelia peli*	tEN
Lappet-faced Vulture	*Torgos tracheliotus*	tEN
Vulnerable species		
White-headed Vulture	*Trigonoceps occipitalis*	tVU
Tawny Eagle	*Aquila rapax*	tVU
Kori Bustard	*Ardeotis kori*	tVU
Black Stork	*Cicinia nigra*	tVU
Southern Banded Snake Eagle	*Circaetus fasciolatus*	tVU
Blue Korhaan	*Eupodotis caerulescens*	tVU
Taita Falcon	*Falco fasciinucha*	tVU
Lesser Kestrel	*Falco naumanni*	tVU
Peregrine Falcon	*Falco peregrinus*	tVU
Bald Ibis	*Geronticus calvus*	tVU
Ludwig's Bustard	*Neotis ludwigii*	tVU

Martial Eagle	*Polemaetus bellicosus*	tVU
Bateleur	*Terathopis ecaudatus*	tVU
Grass Owl	*Tyto capensis*	tVU
Protected species		
Southern Ground-Hornbill	*Bucowus leadeateri*	tPR
African Marsh Harrier	*Circus ranivorus*	tPR
Denham's Bustard	*Neotis denhami*	tPR
African Penguin	*Sphensicus demersus*	tPR

Red data Book

Categories	
Regionally Extinct	RE
Critically Endangered	CR
Endangered	EN
Vulnerable	VU
Near threatened	NT

CATEGORY DEFINITIONS AND STRUCTURE

(not that the Tables and Figures from the Red Data Book are not included in this document, but will be available at the workshop)

- **Extinct (EX):** A taxon is extinct when there is no reasonable doubt that the last individual has died.
- **Extinct in the wild (EW):** A taxon is extinct in the wild when it is known only to survive in cultivation, in captivity or as a naturalised population (or populations) well outside the past range. A taxon is presumed extinct in the wild when exhaustive surveys in known and/or expected habitat, at appropriate times, throughout its historic range have failed to record an individual. Surveys should be over a time frame appropriate to the taxon's life-cycle and form
- **Regionally Extinct (RE):** A taxon is regionally extinct when there is no reasonable doubt that the last individual potentially capable of reproduction within the region has died or disappeared from the region or, if a former visiting taxon, the last individual has died or disappeared from the region.
- **Critically Endangered (CR):** A taxon is Critically Endangered when available scientific evidence indicates that it meets any of the criteria A to E (Tables 2-5), and

is therefore considered to be facing an extremely high risk of extinction in the wild (Figure 3)

- **Endangered (EN):** A taxon is Endangered when available scientific evidence indicates that it meets any of the criteria A to E (Tables 2-5), and is therefore considered to be facing a very high risk of extinction in the wild (Figure 3).
- **Vulnerable (VU):** A taxon is Vulnerable when available scientific evidence indicates that it meets any of the criteria A to F (Tables 2-6), and is therefore considered to be facing a high risk of extinction in the wild (Figure 3).
- **Near-Threatened (NT):** A taxon which has been assessed against the criteria but does not currently qualify for Critically Endangered, Endangered or Vulnerable, but is close to qualifying for or is likely to become Vulnerable in the near future. Also included here are taxa that are the focus of a continuing taxon-specific or habitat-specific conservation programme targeted towards the taxon in question, the cessation of which would result in the taxon qualifying for one of the threatened categories above within a period of five years.
- **Least Concern (LC):** A taxon which has been assessed against the criteria but does not qualify for Critically Endangered, Endangered or Vulnerable and does not qualify for Near-Threatened.
- **Data Deficient (DD):** A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution are lacking. Data Deficient is therefore not a category of threat. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate (see Appendix 3). It is important to make positive use of whatever data are available.
- **Not evaluated (NE):** A taxon is Not Evaluated when it has not yet been assessed against the criteria.

Red Data Book status, 2000

	Regionally Extinct	
1	Egyptian Vulture	RE
2	African Skimmer	RE

	Critically Endangered	
1	Bittern	CR
2	Wattled Crane	CR
3	Whitewinged Flufftail	CR
4	Rudd's Lark	CR
5	Blue Swallow	CR

	Endangered	
1	Tristan Albatross	EN
2	Spectacled Petrel	EN
3	Saddlebilled Stork	EN

4	Bearded Vulture	EN
5	Blackrumped Buttonquail	EN
6	Roseate Tern	EN
7	Damara Tern	EN
8	Kerguelen Term	EN
9	Cape Parrot	EN
10	Botha's Lark	EN
11	Spotted Ground Thrush	EN
12	African Penguin	EN

	Vulnerable	
1	Wandering Albatross	VU
2	Shy Albatross	VU
3	Greyheaded Albatross	VU
4	Indian Yellownosed Albatross	VU
5	Cape Gannet	VU
6	Crozet Cormorant	VU
7	Bank Cormorant	VU
8	Whitebacked Night Heron	VU
9	Bald Ibis	VU
10	Hooded Vulture	VU
11	Cape Vulture	VU
12	African Whitebacked Vulture	VU
13	Lappetfaced Vulture	VU
14	Whiteheaded Vulture	VU
15	Tawny Eagle	VU
16	Martial Eagle	VU
17	Southern Banded Snake Eagle	VU
18	Bateleur	VU
19	African Marsh Harrier	VU
20	Lesser Kestrel	VU
21	Blue Crane	VU
22	Grey Crowned Crane	VU
23	Corncrake	VU
24	Striped Flufftail	VU
25	African Finfoot	VU
26	Kori Bustard	VU
27	Stanley's Bustard	VU
28	Ludwig's Bustard	VU
29	Whitebellied Korhaab	VU
30	Delegorgue's Pigeon	VU
31	Grass Owl	VU
32	Pel's Fishing Owl	VU
33	Natal Nightjar	VU
34	Mangrove Kingfisher	VU

35	Southern Ground Hornbill	VU
36	Woodward's Barbet	VU
37	Red Lark	VU
38	Knysna Warbler	VU
39	Shorttailed Pipit	VU
40	Yellowbreasted Pipit	VU
41	Yellowbilled Oxpecker	VU

	Near threatened	
1	Gentoo Penguin	NT
2	Rockhopper Penguin	NT
3	Macaroni Penguin	NT
4	Blackbrowed Albatross	NT
5	Atlantic Yellownosed Albatross	NT
6	Sooty Albatross	NT
7	Lightmantled Albatross	NT
8	Southern Giant Petrel	NT
9	Nothern Giant Petrel	NT
10	Whitechinned Petrel	NT
11	Grey Petrel	NT
12	Lesser Sheathbill	NT
13	White Pelican	NT
14	Cape Cormorant	NT
15	Crowned Cormorant	NT
16	Black Stork	NT
17	Wollynecked Stork	NT
18	Openbilled Stork	NT
19	Marabou Stork	NT
20	Yellowbilled Stork	NT
21	Greater Flamingo	NT
22	Lesser Flamingo	NT
23	Pygmy Goose	NT
24	Secretarybird	NT
25	Bat Hawk	NT
26	Ayres' Eagle	NT
27	Crowned Eagel	NT
28	Pallid Harrier	NT
29	Black Harrier	NT
30	Peregrine Falcon	NT
31	Lanner Falcon	NT
32	Blue Korhaan	NT
33	Blackbellied Korhaan	NT
34	Lesser Jacana	NT
35	Painted Snipe	NT
36	African Black Oystercatcher	NT

37	Chestnutbanded Plover	NT
38	Blackwinged Plover	NT
39	Whitecrowned Plover	NT
40	Redwinged Pratincole	NT
41	Blackwinged Pratincole	NT
42	Caspian Tern	NT

2. Endemic, near-endemics and range-restricted species

Common name	**Scientific name**	**Endemic**	**Near-endemic**
Agulhas Longbilled Lark	*Certhilauda previrostris*	x	
Bald Ibis	*Geronticus calvus*	x	
Blue Korhaan	*Eupodotis caerulescens*	x	
Botha's Lark	*Spizocorys fringillaris*	x	
Buffstreaked Chat	*Oenanthe bifasciata*	x	
Bush Blackcap	*Lioptilus nigricapillus*	x	
Cape Bulbul	*Pycnonotus capensis*	x	
Cape Rockjumper	*Chaetops frenatus*	x	
Cape Siskin	*Pseudochloroptila totta*	x	
Cape Sugarbird	*Promerops cafer*	x	
Chorister Robin	*Cossypha dichroa*	x	
Drakensberg Siskin	*Pseudochloroptila symonsi*	x	
Drakensberg Prinia	*Prinia hypoxantha*	x	
Forest Canary	*Serinus scotops*	x	
Greater Double-collared Sunbird	*Nectarinia afra*	x	
Greywing Francolin	*Francolinus africanus*	x	
Ground Woodpecker	*Geocolaptes olivaceus*	x	
Karoo Lark	*Certhiauda albescens*	x	
Knysna Lourie	*Tauraco corythaix*	x	
Knysna Warbler	*Bradupterus sylvaticus*	x	
Knysna Woodpecker	*Campethera notata*	x	
Mountain Pipit	*Anthus hoeschi*	x	
Orangebreasted Rockjumper	*Chaetops aurantius*	x	
Orangebreasted Sunbird	*Nectarinia violacea*	x	
Pied Starling	*Spreo bicolor*	x	
Protea Canary	*Serinus leucopterus*	x	
Red Lark	*Certhilauda burra*	x	
Rock Pipit	*Anthus crenatus*	x	
Rudd's Lark	*Heteromirafra ruddi*	x	
Sentinel Rock Thrush	*Monticola explorator*	x	
Southern Black Korhaan	*Eupodotis afra*	x	
Southern Tchagra	*Tchagra tchagra*	x	
Thickbilled Lark	*Galaerida magnirostris*	x	

Victorin's Warbler	*Bradupterus victorini*	x	
Yellowbreasted Pipit	*Anthus chloris*	x	
Black Harrier	*Circus maurus*		x
Blackeared Finchlark	*Eremopterix australis*		x
Blackheaded Canary	*Serinus melancephala*		x
Blue Crane	*Anthropoides paradiseus*		x
Brown Robin	*Erythropygia signata*		x
Cape Francolin	*Francolinus capensis*		x
Cape Longbilled Lark	*Certhilauda curvirostris*		x
Cape Rock Thrush	*Monticola rupestris*		x
Cape Vulture	*Gyps coprotheres*		x
Cape Weaver	*Ploceus capensis*		x
Cape White-eye	*Zosterops senegalensis*		x
Cinnamonbreasted Warbler	*Euryptila subcinnamomea*		x
Fiary Flycatcher	*Stenostria scita*		x
Fiscal Flycatcher	*Sigelus silens*		x
Forest Buzzard	*Buteo trizonatus*		x
Grassbird	*Sphenoeacus afer*		x
Jackal Buzzard	*Buteo rufofuscus*		x
Karoo Eremomela	*Eremomela gregalis*		x
Karoo Korhaan	*Eupodotis vigorsii*		x
Karoo Prinia	*Prinia maculosa*		x
Karoo Robin	*Erythropygia coryphaeus*		x
Lesser Double-collared Sunbird	*Nectarinia chalybea*		x
Melodious Lark	*Mirafra cheniana*		x
Namaqua Warbler	*Phragmacia substriata*		x
Sclater's Lark	*Spizocorys sclateri*		x
Sicklewinged Chat	*Cercomela sinuata*		x
Southern Grey Tit	*Parus afer*		x
Swee Waxbill	*Estrilda malanotis*		x

Restricted Range

Common name	**Scientific name**
Agulhas Longbilled Lark	*Certhilauda previrostris*
Barlow's Lark	*Certhilauda barlowi*
Botha's Lark	*Spizocorys fringillaris*
Brown Robin	*Erythropygia signata*
Bush Blackcap	*Lioptilus nigricapillus*
Cape Longbilled Lark	*Certhilauda curvirostris*
Cape Rockjumper	*Chaetops frenatus*
Cape Siskin	*Pseudochloroptila totta*
Cape Sugarbird	*Promerops cafer*
Chorister Robin	*Cossypha dichroa*
Drakensberg Siskin	*Pseudochloroptila symonsi*

Forest Canary	*Serinus scotops*
Knysna Lourie	*Tauraco corythaix*
Knysna Warbler	*Bradupterus sylvaticus*
Knysna Woodpecker	*Campethera notata*
Lemonbreasted Canary	*Serinus citrinipectus*
Mountain Pipit	*Anthus hoeschi*
Neergaard's Sunbird	*Nectarinia neergaardi*
Orangebreasted Rockjumper	*Chaetops aurantius*
Orangebreasted Sunbird	*Nectarinia violacea*
Pinkthroated Twinspot	*Hypargos margaritus*
Protea Canary	*Serinus leucopterus*
Red Lark	*Certhilauda burra*
Rudd's Apalis	*Apali ruddi*
Rudd's Lark	*Heteromirafra ruddi*
Victorin's Warbler	*Bradupterus victorini*
Yellowbreasted Pipit	*Anthus chloris*

3. Peripheral species

Peripheral species, common in the Afrotropics, which have small populations within the region

Common name	**Scientific name**
Rufousbellied Heron	*Butorides rufiventris*
Palmnut Vulture	*Gypohierax angolensis*
Sooty Falcon	*Falco concolor*
Dickinson's Kestrel	*Falco dickinsoni*
Rednecked Falcon	*Falco chicquera*
Redbilled Falcon	*Francolinus adspersus*
Streakybreasted Fulfftail	*Sarothrura boehmi*
Lesser Gallinule	*Porphyrula alleni*
Lesser Moorhen	*Gallinula angulata*
Longtoed Plover	*Vanellus crassirostris*
Lesser Blackwinged Plover	*Vanellus lugubris*
Livingstone's Lourie	*Tauraco livingstonii*
Thickbilled Cuckoo	*Pachycoccyx audeberti*
Mottled Spinetail	*Telacanthura ussheri*
Bohm's Spinetail	*Neafrapus boehmi*
Rackettailed Roller	*Coracias spatulata*
Mosque Swallow	*Hirundo senegalensis*
Whitebreasted Cuckooshrike	*Coracina pectoralis*
Arnot's Chat	*Thamnolaea arnoti*
Threebanded Courser	*Rhinoptilus cinctus*
Bluespotted Dove	*Turtur afer*

Rosyfaced Lovebird	*Agapornis roseicollis*
Pennantwinged Nightjar	*Macrodipteryx vexillarius*
Mashona Hyliota	*Hyliota australis*
Yellow White-eye	*Zosterops senegalensis*
Tropical Boubou	*Laniarius aethiopicus*
Blackfronted Bush Shrike	*Telophorus nigrifrons*
Lesser Blue-eared Glossy Starling	*Lamprotornis chloropterus*
Longtailed Glossy Starling	*Lamprotornis mevesii*
Goldenbacked Pytilia	*Pytilia afra*
Broadtailed Paradise Whydah	*Vidua obtusa*

4. SANParks 'core range' species

The tool to extract this data is still being developed at the ADU. Further explanation and discussion of this tool will take place at the workshop.

Evaluating the importance of a site to a species – "Core Range" criteria

Les G Underhill, Michael Brooks and Esther Mostert

For waterbirds, the "1% criterion" has been established for four decades. Using a concept developed by the Ramsar Convention in 1971, a wetland is decreed to be of "international importance" if it holds 1% of the global (or "flyway") population of a waterbird species. Terrestrial bird conservation has been held back by the lack of an analogous quantitative criterion. For example, one of the criteria for the selection of Important Bird Areas includes the statement "the site is known (or thought) to hold a significant component of a group of species..." The criterion includes no quantitative guidance as to its implementation.

The method presented here attempts to go some way to filling this gap, making use of bird atlas data. It operates in the spirit of the IBA criterion, quantifying the concept, "a significant component" of the range of a species is held by a site.

The application of the Ramsar "1% criterion" is fraught with uncertainty. The 1% values themselves are generated by Wetlands International in the Netherlands, and for many species they are based on data of dubious quality. But even if we accept these 1% threshold values, there are still question marks. Does a site meet the 1% threshold if this value is exceeded for a species on a single survey, or is it necessary for the mean (or median) of a series of counts of a species to exceed the threshold? Clearly, the latter is more convincing, because then the wetland regularly contains more the 1% of the population of a species that really does "want to be" at the wetland (as opposed to a potentially once off visitation). This latter concept is adopted here by making use of the "core" of the range. We will quantify the concept of "a significant component of a range" in relation to the core of the range of the species rather than in relation to its entire range, accepting the idea that the species does not really "want to be" in the margins of the range. The concept "core" of the range of a species is developed a few paragraphs below.

Another flaw with the Ramsar thinking is its dichotomy. A species either meets the threshold or does not, and we are generally provided with a list of species meeting the threshold. Species just missing the threshold are disregarded. The IBA site selection criteria recognised this flaw and created a third category of species, those that met the "half-percent criterion", ie with between 0.5% and 1% of their population at the site. A more logical approach to evaluating the "value" of a wetland to waterbirds is to sum the individual "Ramsar values" of all the species at a wetland, where the Ramsar value of a species is defined as the "count" for the species divided by the 1% threshold value. If the Ramsar value of a wetland is 45%, then this is equivalent to having 45% of the entire population of a single (imaginary) species at the wetland. This concept is fully developed in Doug Harebottle's forthcoming PhD. The analogous concept for the "value" of a terrestrial area for birds is developed here.

The Ramsar 1% criteria take no account of IUCN threat category. If the 1% criterion is exceeded for any species, the wetland is of international significance for the species.

The “core of the range” is defined as the part of the range where the atlas reporting rate exceeds a percentile. One could talk of the “95% core” as the subset of the range which excludes the smallest 5% of reporting rates. The “50% core” is the subset of the range for which reporting rates exceed their median value. This is definition used in this analysis. The 50% core includes the subset of the range where the species really does “want to be”, and provides an analogy to basing the Ramsar 1% criterion to the mean of the counts of the waterbird species, rather than the maximum value.

The “value” of a site to a species is now defined as the proportion of the core of the range, expressed as a percentage, which falls within the site. By analogy with Ramsar, the site is considered “important” for a species if more than 1% of the care of the range falls within the site. The overall value of a site is defined to be the sum of the individual species values for that site.

In the practical example used in this workshop, the sites are the National Parks, defined by the quarter degree grid cells that constitute them. The bird atlas data used is SABAP1 (plus the data from Vincent Parker’s atlases of southern and central Mozambique), because the SABAP2 coverage is not yet adequate to define the distributions of species. The core of the distribution for a species is defined using the range maps that flow out of the methods developed in the PhD thesis of Francesca Little; these maps cover South Africa, Lesotho, Swaziland, Namibia, Botswana, Zimbabwe, plus northern and central Mozambique, which we will refer to as “southern Africa”. These maps are available on the SABAP2 website, and still represent the best set of range maps for bird species in the southern African region based on SABAP1 information; almost certainly they represent a higher quality baseline for southern Africa than the “1% thresholds” produced by Wetlands Inetnational. Unfortunately, we do not have global distributions of species so the core of the distribution is defined here in relation to “southern Africa.”

To facilitate the mapping algorithm on the website, the SABAP2 database includes the medians of the reporting rates for each species for the Francesca Little distributions. It also includes further percentiles, so that the distribution maps on the website have six colours, with an equal number of quarter degree grid cells being of each colour. The percentiles may be dubbed the sextiles (by analogy with quartiles), and cut off 1/6 (first sextile), 2/6 =1/3 (first tertile), 3/6=1/2 (median), 4/6=2/3 (second tertile) and 5/6 (fifth sextile) of the distribution respectively. They define the 1/6th = 16.7% core, 33.3% core, 50% core, 66.7% core and 83.3% core respectively. Because they are easy to calculate, the results presented at this workshop include those defining the “core of the distribution” in these five ways (ie cutting off the distributions by excluding reporting rates below the first sextile, first tertile, median, second tertile and fifth tertile respectively). But for the time being, we recommend using the rates based on the median (the “50% core”). (The use of other percentiles to define the core range is also possible, but involves extensive calculations.)

The “values” of the species are defined in relation to South Africa, Lesotho and Swaziland (SALS), which represents a geographical entity. We have extracted the values for the larger national parks, and for the entire national park estate.

Now look at the document for the Kruger National Park. Search for Bateleur. Go the three columns headed “median”. This is the column that the table is sorted on, so is based on the idea of using the “50% core” as the way to determine the core of the range of a species, the area where it really wants to be. The middle column of the three tells us that 85 quarter degree grid cells in SALS have reporting rates above the median reporting rate. 43 of these are in the Kruger National Park. Thus 50.59% of the core of the range of the Bateleur falls within the Kruger National Park. The Kruger National Park therefore has a high level of responsibility for this species, containing 51% of the core of the range of this species. The “1% core range threshold” is exceeded for 344 species in the Kruger National Park. The sum of all the individual species values suggests that the bird value of the Kruger National Park is about 4300%, which can be interpreted as saying that the cores of the distribution of 43 (imaginary) species lie within the Kruger National Park.

If you now look at the document for all national parks, it tells us that 59 of the 85 core quarter degree grid cells for Bateleur are in the national park estate, 69% of the total. This can loosely be interpreted as suggest that SANParks carries 69% of the responsibility for the conservation of the Bateleur in SALS.

The document for all national parks also suggests that some 670 of the bird species in SALS have more than 1% of their core distributions in the SANParks estate and that 381 species have more than 10% of their core distributions in the SANParks.

These results provide a measure of quantification of terrestrial bird species distributions in relation to terrestrial sites that is broadly analogous to what the Ramsar Convention achieved for wetlands. As far as we are aware, no one has done arithmetic quite like this before.

Participant List for Workshop

		Name	Organisation	Email
	Facilitator	Leanne Scott	Department of Statistical Sciences - UCT	leanne.scott@uct.ac.za
1	Participant	Esther Mostert	Animal Demography Unit (ADU) - UCT	esther.mostert@uct.ac.za
2	Participant	Les Underhill	Animal Demography Unit (ADU) - UCT	les.underhill@uct.ac.za
3	Participant	Melodie McGeoch	SANParks - Cape Research Centre	melodiem@sanparks.org
4	Participant	Justin Buchman	SANParks - Table Mountain National Park	justinbu@sanparks.org
5	Participant	Monique Ruthenburg	SANParks - Table Mountain National Park	moniquer@sanparks.org
6	Participant	Chris Botes	SANParks - Table Mountain National Park	chrisb@sanparks.org
7	Participant	Hugo Bezuidenhout	SANParks - Kimberley	hugob@sanparks.org
8	Participant	Sharon Thompson	SANParks - Phalaborwa	sharonl@sanparks.org
9	Participant	Andrew Deacon	SANParks - Skukuza	andrewd@sanparks.org
10	Participant	Phoebe Barnard	SANBI	p.barnard@sanbi.org.za
11	Participant	Res Altwegg	SANBI	res.altwegg@gmail.com
12	Participant	Kevin Shaw	Cape Nature	shawka@capenature.co.za
13	Participant	David Allan	Durban Natural Science Museum	alland@durban.gov.za
14	Participant	Hanneline Smit	BirdLife SA conservation officer	conservation@birdlife.org.za
15	Participant	Brian vanderwalt	Birding Tourguide	info@brians-birding.co.za
16	Participant	Allan Kemp	Retired ornithologist, Transvaal Museum	leadbeateri@gmail.com
17	Participant	Rick Nuttall	National Museum, Bloemfontein	ornito@nasmus.co.za
1	Observer	Nashreen Williams	SANParks - Cape Research Centre	nashreenw@sanparks.org

Appendix 2

Workshop report

Notes on Workshop held on 25 & 26 January 2011, Tokai, Cape Research Centre

Prioritisation of Bird Species of Special Concern for Monitoring and Conservation Action in Protected Areas

A workshop was held on 25th and 26th January 2011 at the SANParks Cape Research Centre in Tokai, Cape Town. The main aim was to select criteria to develop a model to rank order bird species for prioritisation for monitoring and conservation action within SANParks.

The following people were present:

		Name	Organisation
	Facilitator	Leanne Scott	Department of Statistical Sciences - UCT
1	Participant	Esther Mostert	Animal Demography Unit (ADU) - UCT
2	Participant	Les Underhill	Animal Demography Unit (ADU) - UCT
3	Participant	Melodie McGeoch	SANParks - Cape Research Centre
4	Participant	Justin Buchman	SANParks - Table Mountain National Park
5	Participant	Monique Ruthenburg	SANParks - Table Mountain National Park
6	Participant	Chris Botes	SANParks - Table Mountain National Park
7	Participant	Hugo Bezuidenhout	SANParks - Kimberley
8	Participant	Sharon Thompson	SANParks - Phalaborwa
9	Participant	Andrew Deacon	SANParks - Skukuza
10	Participant	Phoebe Barnard	SANBI
11	Participant	Res Altwegg	SANBI
12	Participant	Kevin Shaw	Cape Nature
13	Participant	David Allan	Durban Natural Science Museum
14	Participant	Hanneline Smit	BirdLife SA conservation officer
16	Participant	Alan Kemp	Retired, formally with Transvaal Museum
17	Participant	Rick Nuttall	National Museum, Bloemfontein
1	Observer	Nashreen Williams	SANParks - Cape Research Centre

Apologies: Brian Vanderwalt Birding tour guide

DAY 1

Welcome and Overall objectives

- Melodie welcomed all to the Cape Research Centre and to the workshop.
- The broad objectives of the workshop were stated:
    1. Identify and prioritise bird species of special concern for monitoring and conservation action within protected areas, using SANParks as a case study
    2. Evaluate the usefulness of the approach and process for possible broader application across protected areas and different taxa

- Melodie gave a brief introduction of herself, Leanne Scott , Esther Mostert and Les Underhill
- Esther enquired if there were any objections to recording the workshop – there were none, and the workshop was recorded

Introductions

- Esther asked the participants to introduce themselves, giving some of their background and also mentioning what their expectations for the workshop were

General background information

- Melodie gave some background about SANParks Biodiversity Monitoring System (BMS) as well as the Species of Special Concern Monitoring Programme (SSC MP)
- She highlighted the fact that SSC monitoring in parks is conducted for the following reasons:
    1. To identify threats and threatening processes to which SSC are exposed that can be ameliorated by park management action
    2. To assess population trends in individual species so that conservation action can be wherever possible to avoid on-going declines.
    3. To focus conservation attention and action where it is most needed and balance the degree of conservation attention across taxa
    4. To evaluate and monitor the performance of parks and the effectiveness of management actions, and to feed into and inform broader scale processes (national and global) aimed at conducting species conservation status assessments and monitoring national and global biodiversity.
- Also raised points about questions which the workshop will not be addressing:
    1. Who is going to do it?
    2. If it is/is not already being done?
    3. How it should be done?
    4. Who is going to pay for it?

- Esther gave some more background about the academic aspect of her work and gave the objectives and aims of the workshop:

  Objectives:

5. To prioritise bird species for monitoring and conservation action in the South African National Parks using a value-function approach
6. To debate and agree on criteria to be used in this process
7. To construct and 'calibrate' a value-tree with criteria relating to the prioritisation of birds for monitoring and conservation action (this process is described in Part B of this document)
8. To receive feedback from stakeholders and decision makers on the method used in this workshop

Envisioned outputs

5. A prioritised list of bird Species of Special Concern (SSC) for all SANParks
6. A calibrated value function model
7. Co-authored publication of the workshop process and results in a peer reviewed journal

8. Contribution towards MSc research project at UCT – entitled “Bird Monitoring in Protected Areas”

- Les gave some background to the Animal Demography Unit (ADU) and the links between SANParks and the ADU as well as some background to the research field Leanne Scott works in, Operations Research.

MCDA – Value function method &worked example

- Leanne Scott gave a presentation titled “Decision aids, tools and approaches. This included more information about Decision Modelling and Multi-Criteria Decision Analysis (MCDA) in particular.

- Esther went through the “Buying a car” example that was sent out in a background document (page 8 - 25) to all the participants on 16 December 2010 to provide an example of the approach that will be used in the workshop (this is in Part B of the background document).

Bird Species of Special Concern – definitions

- There was a discussion of the definition of Bird Species of Special Concern, as given in the background document.
- The following definition was decided on (based largely on the SSC MP)

Principally:

(xiii) Red List taxa in the following categories: Critically Endangered (CE), Endangered (EN), Vulnerable (VU) and also Near Threatened (NT), locally Extinct (LEX) or Extinct in the Wild (EW) (IUCN, sub-global or national Red List status and additional national categories where necessary; IUCN 2001, Victor & Keith 2004) ;

(xiv) Taxa that are thought to be threatened but that are currently Data Deficient (IUCN 2001), or whose conservation status has not yet been formally assessed (also for example species whose taxonomic status is uncertain and may be rare or threatened).

(xv) Threatened or protected species as listed in the NEM:BA TOPS Regulations (as well as those identified by CITES as being subject to high levels of international trade in the few cases where they are not part of TOPS);

(xvi) A species which is the subject of a biodiversity management plan published by the Minister in terms of Section 43 of NEM:BA, which may be applicable to a park management plan as stipulated in Section 41 of NEM:PAA.

(xvii) Endemic taxa, defined as taxa with over 80% of their range, or 80% of their populations or individuals, confined to the park or region (Rebelo *et al.* submitted

(xviii) Reintroduced taxa that were extinct or threatened, or indigenous species that have recently been reintroduced.

(xix) Locally threatened populations (e.g. populations of species at geographic range margins or key migrant populations; nationally or internationally important populations);

Species of Special Concern may (and in some cases should) also include the following:

Taxa that have been monitored in the past because they were threatened, but whose conservation status has improved to the point where they are of lower conservation concern;

(xx) Functionally important or keystone species (Mace *et al.* 2007);

(xxi) Selected abundant or common species (Gaston 2010);

(xxii) Other species with social and cultural value (e.g. iconic species, Mace *et al.* 2007).

(xxiii) Taxa subject to resource use via legitimate sustainable harvesting and/or illegal extraction (although these will be covered by the *Resource Use Monitoring Programme*);

(xxiv) Species listed under relevant international conventions (e.g. Appendices I and II of the Convention on the Conservation of Migratory Species of Wild Animals (CMS) (http://www.cms.int)).

SABAP bird lists for parks

- SABAP2 bird lists exist for all parks
- It was decided to use the SABAP2 lists as well as existing list of records for parks to compile a comprehensive list of bird species for a park

Provisional Criteria

The four provisional criteria suggested in the Background Document were as follows:

1. Threat status – Threatened or Protected Species (TOPS) Regulations and IUCN: Red Data List species

2. Endemic, near-endemics and range-restricted species
3. Peripheral species
4. Core range species

Explanation of 'core range' tool

- Les explained how the bird atlas data was used to calculate the core of the range of a species for the "Core range" criterion (detailed in Appendix 1).

Discussion of provisionally selected criteria and available data

- There was discussion around the provisional criteria of 'Peripheral Species'. These peripheral species refer to the 31 species listed in the appendix of the Red Data Book (Barnes 2000). Initially it was decided to amend this criterion to only include peripheral species which had a globally assigned threat status. However, after subsequent discussion (on both Day 1 & 2), it was found that only one species, Sooty Falcon, fell in this category, and therefore this criterion was excluded.
- After looking at some trial outputs from the models (Mosque Swallow as an example of a trial species), it was decided to remove peripheral species altogether, and not consider them in this prioritisation process.

Discussion and finalisation of criteria to be used

- Discussion followed on which criteria to choose for the model
- Issues were raised relating to more management and resource allocation aspects of monitoring – this was discussed further (both on Day 1 and Day 2) and it was decided that a 'biological model' would be used and that other considerations (such as management and resource allocation, etc) would take place at a further step.
- This was done in order to try and keep the process simple.
- It was also decided that a biological assessment can take place without management input, but a management assessment cannot take place without biological input.
- During discussions about the provisional criterion of Endemism and range size, the problem with "endemic" (to South Africa) was identified as being too vague, because it meant that widespread endemic species, such as the Cape Weaver, were considered as equivalent to range restricted endemics such as the Cape Sugarbird.
- It was decided therefore to replace the criterion with one that was based on range size, as determined by the bird atlas project (Appendix 2 contains a detailed explanation of this calculation for this criterion).
- There was also discussion around including a criterion relating to legally mandated species to be monitored, such as CITIES and RAMSAR, however…

- There was concern over the overlap between the threat status criterion (from the Red Data book) and the criterion of range size/endemism of a species. It was pointed out that although there is a category (D) in the Red Data book of small range and declining, which contributes to determining the threat status of a species, there are only a few species in the Red Data Book in which this category is used. Therefore there will not be much of an overlap between these two criteria.

Final Selected criteria

- The following biological criteria were selected:
    1. ***Threat status***
        - **REASON** – threat status indicates the extinction risk of a species which is a factor when considering conservation priorities and actions
        - **DATA** - The Eskom Read Data Book of Birds of South Africa, Lesotho and Swaziland (Barnes 2000) will be used
        - **ASSUMPTIONS/PITFALLS**
            - The Red Data Book was published in 2000 the status of some species may have changed (the process to update this book is currently underway – with the goal to be completed in 2012)

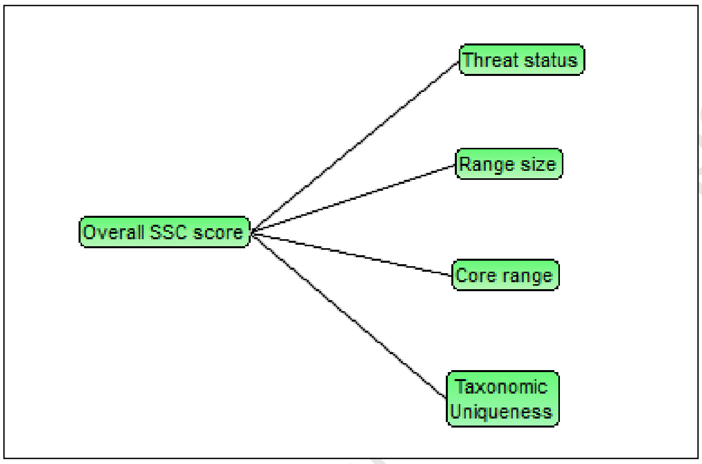
    2. ***Core range***
        - **REASON** – this was selected as it provides an indication of the 'responsibility of a park' towards the conservation of a species
        - **DATA** – From SABAP1 (Southern African Bird Atlas Project 1)
        - **ASSUMPTIONS/PITFALLS**
            - Data for this criteria is used from SABAP1 – there have been some species splits and name changes which will have to be dealt with
            - There have been some changes to species distributions as the SABAP1 data were collected mainly from 1987 – 1991
            - The whole pentad in which a park occurs is used in this calculation, even if the park does not cover the whole pentad and therefore there may be some species which have been recorded outside the proximity of the park on the SABAP1 list

    3. ***Range size***
        - **REASON** –species which are endemic or have a restricted range are more prone to extinction
        - **DATA** – this is from SABAP1(see Appendix 2)
        - **ASSUMPTIONS/PITFALLS**
            - Data for this criterion is used from SABAP1 – there have been some species splits and name changes which will have to be dealt with

4. ***Taxonomic value***
   - **REASON** – certain species with unique taxonomic status should be valued more than those with a common taxonomic status
   - **DATA**: The criteria prepared at the workshop were subsequently refined (Appendix 3). List of species was obtained from the International Ornithological Congress (IOC) website.
   - **ASSUMPTIONS /PITFALLS**
     - the taxonomy is changing and is not fixed
   - **NOTE**: The idea to add this criterion was brought up in discussions from the workshop, and was inspired by Table 2.1 (taken from Mace *et at* 2007) from Appendix A of the Background Document on pg. 3.

Finalising value tree from chosen criteria

- The criteria were finalised and were then used in the construction of a value tree as follows:



Scoring of criteria & creating of value function

- An appropriate scale was developed for each criterion, where the endpoints of the scale were determined and the subsequent values attached to this scale were developed.
- The scores and scales developed for each criterion are as follows:

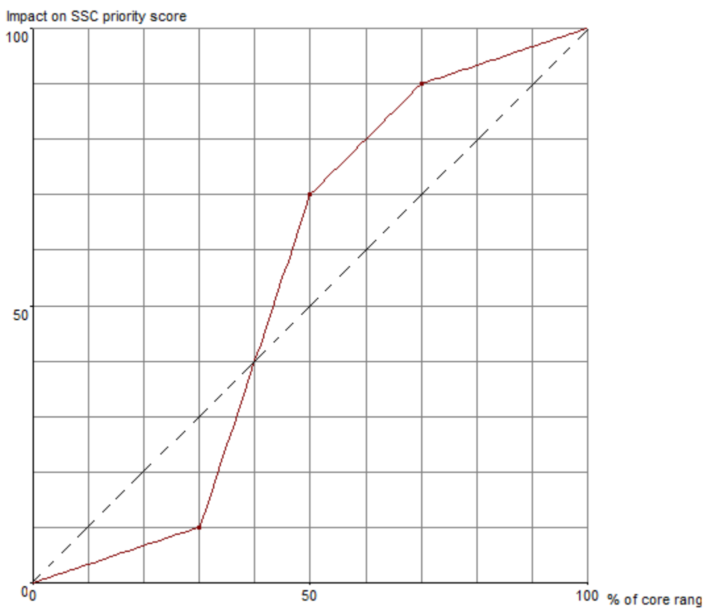
1. **Scoring for Threat status:**

Threat category		Score
Extinct	EX	100
Extinct in the Wild	EW	100
Critically Endangered	CR	100
Endangered	EN	90
Vulnerable	VU	70
Near Threatened	NT	50
Data Deficient	DD	20
Least Concern	LC	0

- These scores were developed after some discussion, particularly around the scores attached to the higher threat categories, and the difference in scores between the successive categories
- In the sensitivity analysis, a 'linear scoring' was tested, where equally spaced scores were given to the threat categories

2. Scoring for Core Range

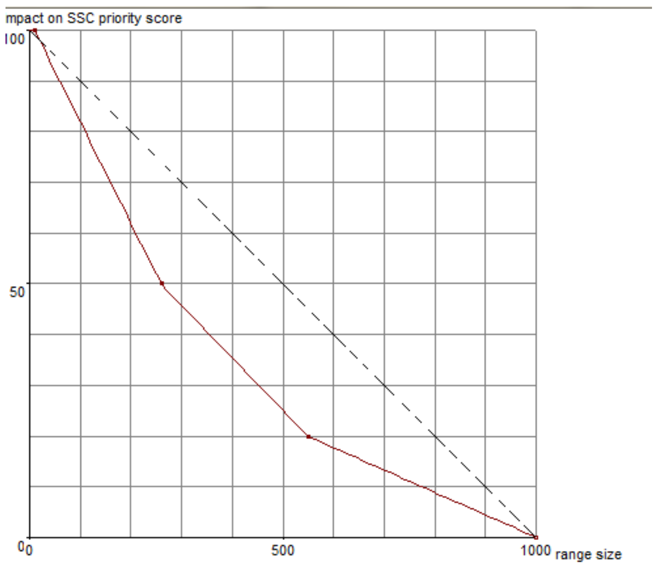
- In scoring for this criterion, a large value was attached to species whose majority of their core range falls in a specified National Park.
- Species for which the percentage of their core range only contributes a small part of a national Park, were given lower scores as it was felt that a park cannot do a great deal in terms of conservation of these species.



Core range value function indicated by red line(dashed line indicates a simple linear value function)

3. Scoring for range size

- Range size was calculated using the Quarter Degree Grid Cells (QDGCs) occupied in southern Africa by a species above a threshold (which allowed vagrant occurrences to be excluded)
- In southern Africa there are 4537 QDGCs
- When determining the value attached to the scale of this criterion, it was decided that any species which occupy more than 1000 cells would be given a score of zero (as they have a large range and are therefore of a lesser concern for conservation).
- Species which occupy a small number of QDGCs (i.e. range restricted) were given a higher score
- The discussing and scoring of this criterion took place on both day 1 & 2 of the workshop



Value function for range size for South African endemics indicated by red line (dashed line indicates a simple linear value function)

4. **Scoring taxonomic uniqueness/rarity:**

- Although ideally one would want to make use of a phylogenetic tree, where one makes use of a calculation incorporating branch lengths to determine a taxonomic value, it was decided that because the tree is constantly changing and being updated, another measure would be developed which looks at the taxonomic uniqueness of a species.
- It was decided to initially use a scale in which the monotypic status of a species was determined, at the level of Order, Family and Genus.
- The following scores were allocated:

Category	Score
Monotypic Order	100
Monotypic Family	75
Monotypic Genus	25
Not monotypic	0

- It was also agreed that there would be more discussions after the workshop to develop a more refined method to measure taxonomic uniqueness (details given in Appendix 3).

DAY 2

Review and finalise scoring of criteria on value tree

- Leanne went through the scoring that was done on Day 1 and asked for suggestions or thoughts that people had had overnight.
- There was more discussion and finalisation of the range size criterion.

Weighting of criteria on value tree

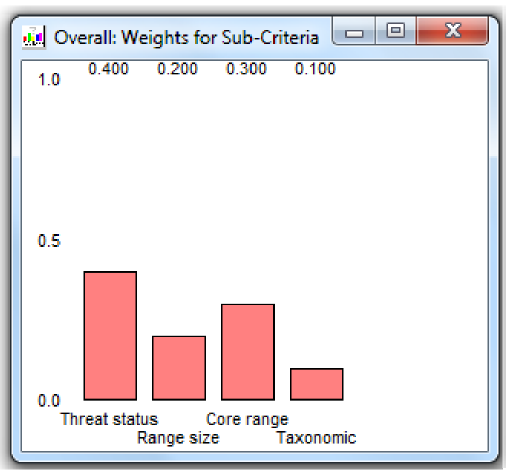
- Once the scoring was complete the relative weighting of the criteria was undertaken. Leanne recapped the idea of a swing-weight approach.
- Two models with different sets of weights came out of discussions at the workshop.
- In the first model threat status and core range were given equal weights of 35%, with the next highest weight given to range size (20%) followed by taxonomic uniqueness (10%).
- In the second model, threat status was thought to be the most important criteria and given the highest score (40%), followed by core range (30%), range size (20%) and taxonomic uniqueness (10%).
- It should be noted that this process of assigning initial weights to criteria and then looking at the output of selected species is an iterative one and what is presented here is a summary of the outcome discussed in the workshop

Summary of two models with weights:

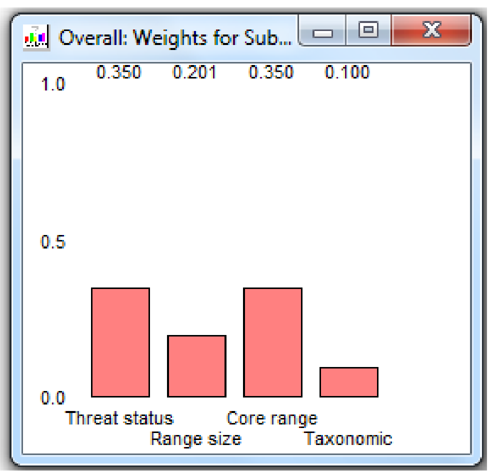
	Model 1	Model 2
Threat status	40	35
Range size	20	20
Core range	30	35
Taxonomic uniqueness	10	10

Weights displayed in VISA:

Model 1



Model 2



- It was decided that both these models would be tested (as part of the sensitivity analysis) and then a decision would be a made as to which model produced the most desirable outcome, after feedback from workshop participants

Asses outputs of calibrated value tree using 12 pre-selected trial species

- Once the weighting was complete, 12 trial species (with data for each category) were selected

- Birds were selected from a broad spectrum and to provide an idea of the performance of the model. The birds selected were as follows:

1	African Penguin	9	Violet-eared Waxbill
2	Bateleur	10	Cape Parrot
3	Cape Sugarbird	11	Hadeda Ibis
4	Cape Vulture	12	Mosque Swallow
5	Cape Wagtail	13	Ground Woodpecker
6	Kori Bustard	14	Southern Tchagra
7	Pel's Fishing Owl	15	Cape Gannet
8	Southern Ground Hornbill		

- It was decided to initially look at species for 'SANParks as an estate' – consisting of a calculation for all national parks (the main criterion affected by choosing SANParks estate, or a particular park, is Core Range).

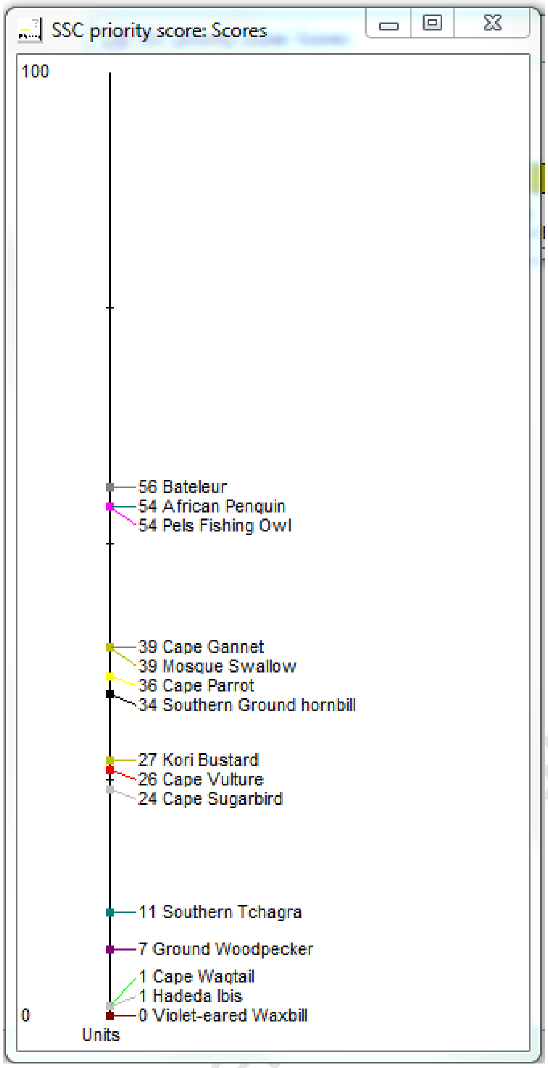
- The input data in VISA for SANParks as an estate was as follows:

	Threat statu	range size for...	Core Rang	Taxonomic uniq...
African Pengu	EN	111	33	Not mono
Bateleur	VU	1000	69	Not mono
Cape Sugarbi	LC	149	16	family
Cape Vulture	VU	1000	11	Not mono
Cape Wagtail	LC	1000	6	Not mono
Kori Bustard	VU	1000	19	Not mono
Pels Fishing O	VU	215	44	Not mono
Southern Gro	VU	1000	36	Not mono
Violet-eared V	LC	1000	2	Not mono
Cape Parrot	EN	625	13	Not mono
Ground Wood	LC	599	7	genus
Southern Tch	LC	324	17	Not mono
Cape Gannet	VU	212	22	Not mono
Hadeda Ibis	LC	1000	8	Not mono
Mosque Swal	LC	529	94	Not mono

Note on input values for range size: There were some errors in the values inputed during the workshop for range size, in terms of the number of QDGCs occupied, but the above figures reflect the correct number of QDGCs occupied by a species in southern Africa

Model outputs

Output for MODEL 1: Threat status given highest weight

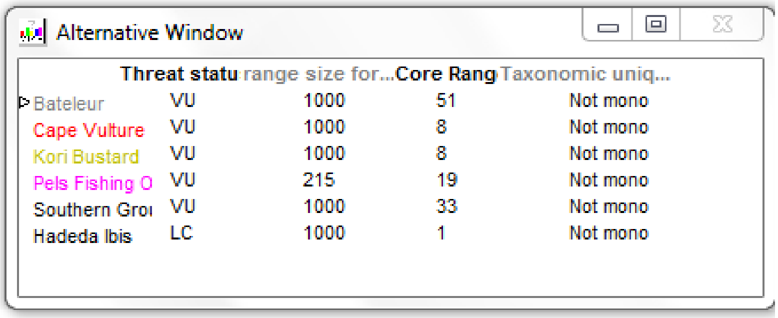


Results of scores of selected species in 'SANParks Estate' using Model 1 weights

- The highest scoring species was the Bateleur (56), followed by the Pel's Fishing Owl (54) and African Penguin (54) with the lowest scoring species being the Violet-eared Waxbill (0).
- It was felt that the Mosque Swallow, a peripheral species, had a score which was too high and after various discussions, it was decided to exclude any peripheral species altogether from this process (those listed in The Eskom Red Data Book of Birds of South Africa, Lesotho and Swaziland, Barnes 2000).

Second model: Kruger National Park as an example

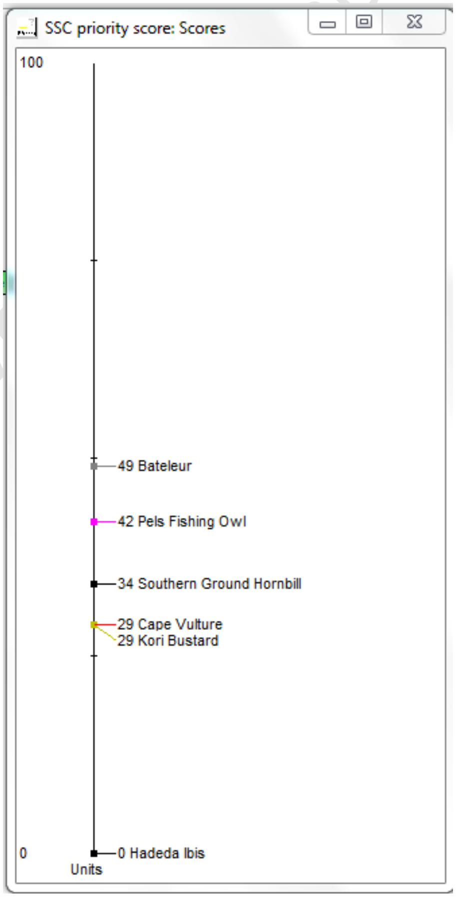
- It was decided to look at a specific national park, using the second set of weights to see what the results were.
- The Kruger National Park (KNP) was selected as it is a large park with good SABAP1 data coverage, but only 6 of the 15 trial species occurred in the KNP.
- The input data for the KNP species was as follows:



Alternative Window

	Threat statu	range size for...	Core Rang	Taxonomic uniq...
Bateleur	VU	1000	51	Not mono
Cape Vulture	VU	1000	8	Not mono
Kori Bustard	VU	1000	8	Not mono
Pels Fishing O	VU	215	19	Not mono
Southern Groı	VU	1000	33	Not mono
Hadeda Ibis	LC	1000	1	Not mono

Output for MODEL 2: Threat status and Core Range were given equal weights (for KNP)



Results of scores of selected species in Kruger National Park, using Model 2 weights

- No major problems were raise by these outputs however, it was decided that the results from both these two models would be looked at to decide which one captures the desired prioritisation of species

Way forward after the workshop

- Way forward after the workshop was discussed, this included
    - An initial report of the workshop which will be compiled by Esther and sent out to all participants for comment
    - Further discussion will follow on the taxonomic criteria to be used in the model (this was done and is included in Appendix 3).
- Once the taxonomic scoring has been decided on, a selection of species will be put through the model and the results (prioritisation of the species) and will be sent to stakeholders for further comments and discussion
- The sensitivity analysis will be undertaken as a backroom exercise (i.e. not interactive) and the results will be emailed to the stakeholders

Thanks, closure & evaluation/feedback

- Esther thanked SANParks for hosting the workshop, Melodie for all her input, Les for his guidance and ideas and Leanne for the background she brought with regards to Operations Research and statistical knowledge.
- Esther also thanked Jolene Waller for all her help with the logistics – accommodation and flights
- Time was allowed for people to provide any feedback as to the workshop in general and the usefulness of the method/approach used
- Les requested everyone to complete a questionnaire before they left so as to provide us with written feedback on the workshop

Appendix 3

List of Peripheral Species

Peripheral Species in Red Data Book (Barnes 2000)

	Common Name	Scientific Name
1	Heron, Rufous-bellied	*Ardeola rufiventris*
2	Vulture, Palm-nut	*Gypohierax angolensis*
3	Falcon, Sooty	*Falco concolor*
4	Kestrel, Dickinson's	*Falco dickinsoni*
5	Falcon, Red-necked	*Falco chicquera*
6	Spurfowl, Redbilled	*Falco chicquera*
7	Flufftail, Streaky-breasted	*Sarothrura boehmi*
8	Gallinule, Allen's	*Porphyrio alleni*
9	Moorhen, Lesser	*Gallinula angulata*
10	Plover, Long-toed	*Vanellus crassirostirs*
11	Lapwing, Senegal	*Vanellus lugubris*
12	Tauraco, Livingstone's	*Tauraco livingstonii*
13	Cuckoo, Thick-billed	*Pachycoccyx audeberti*
14	Spinetail, Motteld	*Pachycoccyx audeberti*
15	Spinetail, Bohm's	*Neafrapus boehmi*
16	Roller, Racket-tailed	*Coracias spatulatus*
17	Swallow, Mosque	*Hirundo senegalensis*
18	Cuckooshrike, White-breasted	*Coracina pectoralis*
19	Chat, Arnot's	*Thamnolaea arnoti*
20	Courser, Three-banded	*Rhinoptilus cinctus*
21	Wood-dove, Blue-spotted	*Turtur afer*
22	Lovebird, Rosy-faced	*Agapornis roseicollis*
23	Nightjar, Pennant-winged	*Macrodipteryx vexillarius*
24	Hyliota, Southern	*Hyliota australis*
25	White-eye, African Yellow	*Zosterops senegalensis*
26	Boubou, Tropical	*Laniarius aethiopicus*
27	Bush-shrike, Black-fronted	*Telophorus nigrifrons*
28	Starling, Miombo Blue-eared	*Lamprotornis chloropterus*
29	Starling, Meve's	*Lamprotornis mevesii*
30	Pytilia, Orange-winged	*Pytilia afra*
31	Paradise Whydah, long-tailed	*Vidua interjecta*

Appendix 4

Complete list of prioritised Species of Special Concern for the Kruger National Park

Appendix 4. Kruger National Park list of species sorted on Grand Score ('W' refers to the Weight assigned to the criterion)

		Threat Status				Range Size				Core Range				Taxonomic Uniqueness			Grand Score
	Common Name	**Status**	**Raw**	**W**	**Final Score**	**Raw**	**Scale**	**W**	**Final Score**	**Raw**	**Scale**	**W**	**Final Score**	**Raw**	**W**	**Final Score**	
1	Oxpecker, Yellow-billed	VU	70	0.35	24.5	349	40.1	0.20	8.0	100.0	100.0	0.35	35.0	12.6	0.10	1.3	68.8
2	Vulture, Hooded	VU	70	0.35	24.5	506	24.4	0.20	4.9	90.9	97.0	0.35	33.9	12.5	0.10	1.3	64.6
3	Stork, Saddle-billed	EN	90	0.35	31.5	894	4.7	0.20	0.9	53.8	73.8	0.35	25.8	27.9	0.10	2.8	61.0
4	Lapwing, White-crowned	NT	50	0.35	17.5	302	44.8	0.20	9.0	58.8	78.8	0.35	27.6	8.2	0.10	0.8	54.9
5	Bateleur, Bateleur	VU	70	0.35	24.5	2245	0.0	0.20	0.0	50.6	70.6	0.35	24.7	12.5	0.10	1.3	50.5
6	Openbill, African	NT	50	0.35	17.5	791	9.3	0.20	1.9	56.7	76.7	0.35	26.8	27.9	0.10	2.8	49.0
7	Vulture, White-headed	VU	70	0.35	24.5	1212	0.0	0.20	0.0	46.7	60.2	0.35	21.1	12.5	0.10	1.3	46.8
8	Night-Heron, White-backed	VU	70	0.35	24.5	174	67.2	0.20	13.4	32.5	17.5	0.35	6.1	11.7	0.10	1.2	45.2
9	Hawk, Bat	NT	50	0.35	17.5	234	55.2	0.20	11.0	40.0	40.0	0.35	14.0	12.5	0.10	1.3	43.8
10	Crake, Corn	VU	70	0.35	24.5	107	80.6	0.20	16.1	5.3	1.8	0.35	0.6	11.5	0.10	1.2	42.4
11	Parrot, Brown-headed	LC	0	0.35	0.0	474	27.6	0.20	5.5	97.5	99.2	0.35	34.7	9.0	0.10	0.9	41.1
12	Fishing-Owl, Pel's	VU	70	0.35	24.5	215	59.0	0.20	11.8	18.8	6.3	0.35	2.2	13.8	0.10	1.4	39.9
13	Finfoot, African	VU	70	0.35	24.5	267	48.3	0.20	9.7	19.6	6.5	0.35	2.3	24.0	0.10	2.4	38.8
14	Ground-Hornbill, Southern	VU	70	0.35	24.5	1388	0.0	0.20	0.0	32.8	18.4	0.35	6.5	33.3	0.10	3.3	34.3
15	Canary, Lemon-breasted	NT	50	0.35	17.5	141	73.8	0.20	14.8	12.5	4.2	0.35	1.5	5.7	0.10	0.6	34.3
16	Stork, Marabou	NT	50	0.35	17.5	1253	0.0	0.20	0.0	40.2	40.5	0.35	14.2	24.0	0.10	2.4	34.1
17	Owlet, African Barred	LC	0	0.35	0.0	873	5.6	0.20	1.1	66.7	86.7	0.35	30.3	9.6	0.10	1.0	32.4
18	Oxpecker, Red-billed	NT	50	0.35	17.5	937	2.8	0.20	0.6	38.8	36.4	0.35	12.7	12.6	0.10	1.3	32.1
19	Dove, African Mourning	LC	0	0.35	0.0	679	14.3	0.20	2.9	59.7	79.7	0.35	27.9	11.0	0.10	1.1	31.8
20	Eagle, Lesser Spotted	LC	0	0.35	0.0	535	21.5	0.20	4.3	54.2	74.2	0.35	26.0	8.5	0.10	0.9	31.1
21	Wattle-eye, Black-throated	NT	50	0.35	17.5	229	56.2	0.20	11.2	9.7	3.2	0.35	1.1	7.9	0.10	0.8	30.7

22	Eremomela, Green-capped	LC	0	0.35	0.0	675	14.4	0.20	2.9	56.3	76.3	0.35	26.7	6.6	0.10	0.7	30.2
23	Harrier, Pallid	NT	50	0.35	17.5	315	43.5	0.20	8.7	21.4	7.1	0.35	2.5	8.4	0.10	0.8	29.5
24	Vulture, Lappet-faced	VU	70	0.35	24.5	2122	0.0	0.20	0.0	28.6	9.5	0.35	3.3	12.5	0.10	1.3	29.1
25	Stork, Woolly-necked	NT	50	0.35	17.5	668	14.8	0.20	3.0	32.5	17.6	0.35	6.2	18.5	0.10	1.9	28.5
26	Eagle, Tawny	VU	70	0.35	24.5	2269	0.0	0.20	0.0	22.0	7.3	0.35	2.6	8.5	0.10	0.9	27.9
27	Eagle, Steppe	LC	0	0.35	0.0	765	10.4	0.20	2.1	51.4	71.4	0.35	25.0	8.5	0.10	0.9	27.9
28	Vulture, White-backed	VU	70	0.35	24.5	2452	0.0	0.20	0.0	17.8	5.9	0.35	2.1	9.1	0.10	0.9	27.5
29	Bustard, Kori	VU	70	0.35	24.5	2176	0.0	0.20	0.0	8.0	2.7	0.35	0.9	18.3	0.10	1.8	27.3
30	Eagle, Martial	VU	70	0.35	24.5	3233	0.0	0.20	0.0	6.5	2.2	0.35	0.8	12.5	0.10	1.3	26.5
31	Vulture, Cape	VU	70	0.35	24.5	1108	0.0	0.20	0.0	7.6	2.5	0.35	0.9	9.1	0.10	0.9	26.3
32	Starling, Greater Blue-eared	LC	0	0.35	0.0	1264	0.0	0.20	0.0	52.8	72.8	0.35	25.5	6.1	0.10	0.6	26.1
33	Lark, Flappet	LC	0	0.35	0.0	1143	0.0	0.20	0.0	51.6	71.6	0.35	25.1	6.3	0.10	0.6	25.7
34	Lark, Dusky	LC	0	0.35	0.0	885	5.1	0.20	1.0	49.3	68.0	0.35	23.8	8.1	0.10	0.8	25.6
35	Pratincole, Collared	NT	50	0.35	17.5	439	31.1	0.20	6.2	5.3	1.8	0.35	0.6	11.0	0.10	1.1	25.4
36	Bustard, Black-bellied	NT	50	0.35	17.5	850	6.7	0.20	1.3	25.6	8.5	0.35	3.0	22.4	0.10	2.2	24.1
37	Painted-snipe, Greater	NT	50	0.35	17.5	770	10.2	0.20	2.0	25.0	8.3	0.35	2.9	16.0	0.10	1.6	24.1
38	Kingfisher, Half-collared	NT	50	0.35	17.5	570	19.1	0.20	3.8	5.1	1.7	0.35	0.6	10.4	0.10	1.0	23.0
39	Wren-Warbler, Stierling's	LC	0	0.35	0.0	877	5.5	0.20	1.1	46.7	60.0	0.35	21.0	7.3	0.10	0.7	22.8
40	Pygmy-Goose, African	NT	50	0.35	17.5	621	16.8	0.20	3.4	2.6	0.9	0.35	0.3	11.4	0.10	1.1	22.3
41	Eagle, African Crowned	NT	50	0.35	17.5	656	15.3	0.20	3.1	2.2	0.7	0.35	0.3	12.5	0.10	1.3	22.1
42	Pelican, Great White	NT	50	0.35	17.5	754	10.9	0.20	2.2	1.9	0.7	0.35	0.2	18.8	0.10	1.9	21.8
43	Falcon, Peregrine	NT	50	0.35	17.5	696	13.5	0.20	2.7	2.1	0.7	0.35	0.2	11.4	0.10	1.1	21.6
44	Goshawk, Dark Chanting	LC	0	0.35	0.0	1261	0.0	0.20	0.0	45.9	57.7	0.35	20.2	11.1	0.10	1.1	21.3
45	Secretarybird, Secretarybird	NT	50	0.35	17.5	2950	0.0	0.20	0.0	3.8	1.3	0.35	0.4	33.3	0.10	3.3	21.3
46	Stork, Yellow-billed	NT	50	0.35	17.5	1368	0.0	0.20	0.0	13.6	4.5	0.35	1.6	21.8	0.10	2.2	21.3
47	Helmet-Shrike, Retz's	LC	0	0.35	0.0	1196	0.0	0.20	0.0	45.3	55.9	0.35	19.6	10.0	0.10	1.0	20.6
48	Stork, Black	NT	50	0.35	17.5	1964	0.0	0.20	0.0	6.0	2.0	0.35	0.7	18.5	0.10	1.9	20.1
49	Bittern, Dwarf	LC	0	0.35	0.0	662	15.0	0.20	3.0	41.7	45.0	0.35	15.8	10.5	0.10	1.0	19.8

50	Harrier, Montagu's	LC	0	0.35	0.0	364	38.6	0.20	7.7	36.4	29.1	0.35	10.2	8.4	0.10	0.8	18.7
51	Nightjar, Square-tailed	LC	0	0.35	0.0	1104	0.0	0.20	0.0	42.3	46.9	0.35	16.4	8.4	0.10	0.8	17.3
52	Twinspot, Green	LC	0	0.35	0.0	139	74.2	0.20	14.8	1.6	0.5	0.35	0.2	8.4	0.10	0.8	15.9
53	Courser, Bronze-winged	LC	0	0.35	0.0	967	1.5	0.20	0.3	40.0	40.0	0.35	14.0	12.1	0.10	1.2	15.5
54	Kingfisher, Grey-headed	LC	0	0.35	0.0	1071	0.0	0.20	0.0	39.4	38.2	0.35	13.4	9.7	0.10	1.0	14.3
55	Flufftail, Buff-spotted	LC	0	0.35	0.0	211	59.8	0.20	12.0	3.5	1.2	0.35	0.4	17.4	0.10	1.7	14.1
56	Finch, Cuckoo	LC	0	0.35	0.0	212	59.6	0.20	11.9	4.0	1.3	0.35	0.5	12.6	0.10	1.3	13.6
57	Swallow, Wire-tailed	LC	0	0.35	0.0	1089	0.0	0.20	0.0	38.3	35.0	0.35	12.3	6.6	0.10	0.7	12.9
58	Sunbird, Olive	LC	0	0.35	0.0	216	58.8	0.20	11.8	1.1	0.4	0.35	0.1	7.3	0.10	0.7	12.6
59	Roller, Broad-billed	LC	0	0.35	0.0	975	1.1	0.20	0.2	36.7	30.0	0.35	10.5	17.9	0.10	1.8	12.5
60	Sandpiper, Green	LC	0	0.35	0.0	257	49.3	0.20	9.9	15.4	5.1	0.35	1.8	8.1	0.10	0.8	12.5
61	Weaver, Red-headed	LC	0	0.35	0.0	1322	0.0	0.20	0.0	37.4	32.1	0.35	11.2	9.6	0.10	1.0	12.2
62	Pipit, Bushveld	LC	0	0.35	0.0	294	45.6	0.20	9.1	14.5	4.8	0.35	1.7	6.7	0.10	0.7	11.5
63	Dove, Lemon	LC	0	0.35	0.0	275	47.5	0.20	9.5	1.4	0.5	0.35	0.2	9.6	0.10	1.0	10.6
64	Ostrich, Common	LC	0	0.35	0.0	2844	0.0	0.20	0.0	5.1	1.7	0.35	0.6	100.0	0.10	10.0	10.6
65	Guineafowl, Crested	LC	0	0.35	0.0	380	37.0	0.20	7.4	10.0	3.3	0.35	1.2	18.8	0.10	1.9	10.5
66	Honeyguide, Scaly-throated	LC	0	0.35	0.0	334	41.6	0.20	8.3	6.4	2.1	0.35	0.8	11.6	0.10	1.2	10.2
67	Tinkerbird, Yellow-rumped	LC	0	0.35	0.0	308	44.2	0.20	8.8	1.5	0.5	0.35	0.2	10.8	0.10	1.1	10.1
68	Nightjar, European	LC	0	0.35	0.0	434	31.6	0.20	6.3	24.8	8.3	0.35	2.9	8.4	0.10	0.8	10.1
69	Crested-Flycatcher, Blue-mantled	LC	0	0.35	0.0	303	44.7	0.20	8.9	0.7	0.2	0.35	0.1	8.4	0.10	0.8	9.9
70	Crake, African	LC	0	0.35	0.0	413	33.7	0.20	6.7	15.8	5.3	0.35	1.8	11.5	0.10	1.2	9.7
71	Drongo, Square-tailed	LC	0	0.35	0.0	316	43.4	0.20	8.7	1.4	0.5	0.35	0.2	8.0	0.10	0.8	9.6
72	Plover, Caspian	LC	0	0.35	0.0	347	40.3	0.20	8.1	5.9	2.0	0.35	0.7	7.9	0.10	0.8	9.5
73	Woodpecker, Olive	LC	0	0.35	0.0	322	42.8	0.20	8.6	0.5	0.2	0.35	0.1	8.3	0.10	0.8	9.5
74	Sandgrouse, Double-banded	LC	0	0.35	0.0	1398	0.0	0.20	0.0	33.6	20.7	0.35	7.3	20.8	0.10	2.1	9.3
75	Quail, Harlequin	LC	0	0.35	0.0	1165	0.0	0.20	0.0	34.4	23.1	0.35	8.1	9.5	0.10	1.0	9.0

76	Cisticola, Red-faced	LC	0	0.35	0.0	891	4.8	0.20	1.0	33.3	20.0	0.35	7.0	5.7	0.10	0.6	8.5
77	Wagtail, Mountain	LC	0	0.35	0.0	377	37.3	0.20	7.5	1.8	0.6	0.35	0.2	7.6	0.10	0.8	8.4
78	Osprey, Osprey	LC	0	0.35	0.0	522	22.8	0.20	4.6	7.4	2.5	0.35	0.9	27.9	0.10	2.8	8.2
79	Bush-Shrike, Olive	LC	0	0.35	0.0	429	32.1	0.20	6.4	1.8	0.6	0.35	0.2	8.1	0.10	0.8	7.4
80	Robin-Chat, Red-capped	LC	0	0.35	0.0	480	27.0	0.20	5.4	11.9	4.0	0.35	1.4	6.1	0.10	0.6	7.4
81	Scrub-Robin, Bearded	LC	0	0.35	0.0	549	20.1	0.20	4.0	22.0	7.3	0.35	2.6	7.9	0.10	0.8	7.4
82	Bush-Shrike, Gorgeous	LC	0	0.35	0.0	483	26.7	0.20	5.3	8.2	2.7	0.35	1.0	8.1	0.10	0.8	7.1
83	Waxbill, Swee	LC	0	0.35	0.0	446	30.4	0.20	6.1	1.1	0.4	0.35	0.1	7.4	0.10	0.7	7.0
84	Mannikin, Red-backed	LC	0	0.35	0.0	489	26.1	0.20	5.2	7.9	2.6	0.35	0.9	5.9	0.10	0.6	6.7
85	Hawk, African Cuckoo	LC	0	0.35	0.0	515	23.5	0.20	4.7	7.3	2.4	0.35	0.9	9.7	0.10	1.0	6.5
86	Weaver, Thick-billed	LC	0	0.35	0.0	517	23.3	0.20	4.7	6.7	2.2	0.35	0.8	9.6	0.10	1.0	6.4
87	Indigobird, Purple	LC	0	0.35	0.0	541	20.9	0.20	4.2	11.4	3.8	0.35	1.3	8.2	0.10	0.8	6.3
88	Indigobird, Dusky	LC	0	0.35	0.0	556	19.7	0.20	4.0	11.5	3.8	0.35	1.3	8.2	0.10	0.8	6.1
89	Cuckoo, Common	LC	0	0.35	0.0	539	21.1	0.20	4.2	5.9	2.0	0.35	0.7	11.8	0.10	1.2	6.1
90	Nicator, Eastern	LC	0	0.35	0.0	570	19.1	0.20	3.8	9.1	3.0	0.35	1.1	11.7	0.10	1.2	6.1
91	Turaco, Purple-crested	LC	0	0.35	0.0	935	2.9	0.20	0.6	11.5	3.8	0.35	1.3	38.7	0.10	3.9	5.8
92	Warbler, Dark-capped Yellow	LC	0	0.35	0.0	464	28.6	0.20	5.7	0.6	0.2	0.35	0.1	0.0	0.10	0.0	5.8
93	Parrot, Cape	LC	0	0.35	0.0	625	16.7	0.20	3.3	13.2	4.4	0.35	1.5	9.0	0.10	0.9	5.8
94	Trogon, Narina	LC	0	0.35	0.0	697	13.5	0.20	2.7	5.0	1.7	0.35	0.6	22.8	0.10	2.3	5.6
95	Mousebird, Red-faced	LC	0	0.35	0.0	3583	0.0	0.20	0.0	4.6	1.5	0.35	0.5	50.0	0.10	5.0	5.5
96	Pipit, Striped	LC	0	0.35	0.0	519	23.1	0.20	4.6	1.8	0.6	0.35	0.2	6.7	0.10	0.7	5.5
97	Longclaw, Yellow-throated	LC	0	0.35	0.0	629	16.5	0.20	3.3	11.5	3.9	0.35	1.4	8.0	0.10	0.8	5.4
98	Honeybird, Brown-backed	LC	0	0.35	0.0	598	17.9	0.20	3.6	2.3	0.8	0.35	0.3	14.8	0.10	1.5	5.3
99	Swallow, Grey-rumped	LC	0	0.35	0.0	853	6.5	0.20	1.3	26.5	8.8	0.35	3.1	8.9	0.10	0.9	5.3
100	Olive-Pigeon, African	LC	0	0.35	0.0	549	20.1	0.20	4.0	1.0	0.3	0.35	0.1	9.6	0.10	1.0	5.1
101	Dove, Tambourine	LC	0	0.35	0.0	647	15.7	0.20	3.1	5.0	1.7	0.35	0.6	13.0	0.10	1.3	5.0
102	Francolin, Shelley's	LC	0	0.35	0.0	756	10.8	0.20	2.2	15.9	5.3	0.35	1.9	9.3	0.10	0.9	5.0
103	Saw-wing, Black	LC	0	0.35	0.0	555	19.8	0.20	4.0	1.1	0.4	0.35	0.1	7.4	0.10	0.7	4.8

104	Hamerkop, Hamerkop	LC	0	0.35	0.0	2990	0.0	0.20	0.0	4.3	1.4	0.35	0.5	43.1	0.10	4.3	4.8
105	Cuckoo, Levaillant's	LC	0	0.35	0.0	1115	0.0	0.20	0.0	28.8	9.6	0.35	3.4	14.3	0.10	1.4	4.8
106	Grassbird, Cape	LC	0	0.35	0.0	593	18.1	0.20	3.6	0.6	0.2	0.35	0.1	10.5	0.10	1.1	4.7
107	Go-away-bird, Grey	LC	0	0.35	0.0	2235	0.0	0.20	0.0	18.3	6.1	0.35	2.1	24.0	0.10	2.4	4.5
108	Bee-eater, Southern Carmine	LC	0	0.35	0.0	1153	0.0	0.20	0.0	28.8	9.6	0.35	3.4	11.5	0.10	1.2	4.5
109	Pygmy-Kingfisher, African	LC	0	0.35	0.0	789	9.4	0.20	1.9	11.3	3.8	0.35	1.3	12.8	0.10	1.3	4.5
110	Firefinch, African	LC	0	0.35	0.0	699	13.4	0.20	2.7	9.5	3.2	0.35	1.1	6.5	0.10	0.7	4.4
111	Korhaan, Red-crested	LC	0	0.35	0.0	2146	0.0	0.20	0.0	19.6	6.5	0.35	2.3	19.8	0.10	2.0	4.3
112	Martin, Sand	LC	0	0.35	0.0	651	15.5	0.20	3.1	3.7	1.2	0.35	0.4	7.3	0.10	0.7	4.3
113	Widowbird, Fan-tailed	LC	0	0.35	0.0	609	17.4	0.20	3.5	0.8	0.3	0.35	0.1	6.9	0.10	0.7	4.3
114	Plover, White-fronted	LC	0	0.35	0.0	704	13.2	0.20	2.6	6.8	2.3	0.35	0.8	7.9	0.10	0.8	4.2
115	Eagle-Owl, Verreaux's	LC	0	0.35	0.0	1282	0.0	0.20	0.0	27.2	9.1	0.35	3.2	10.1	0.10	1.0	4.2
116	Eagle, Long-crested	LC	0	0.35	0.0	701	13.3	0.20	2.7	2.3	0.8	0.35	0.3	12.5	0.10	1.3	4.2
117	Warbler, Marsh	LC	0	0.35	0.0	659	15.2	0.20	3.0	4.0	1.3	0.35	0.5	6.9	0.10	0.7	4.2
118	Hornbill, Trumpeter	LC	0	0.35	0.0	895	4.7	0.20	0.9	17.0	5.7	0.35	2.0	12.5	0.10	1.3	4.2
119	Weaver, Golden	LC	0	0.35	0.0	703	13.2	0.20	2.6	7.5	2.5	0.35	0.9	6.1	0.10	0.6	4.1
120	Scops-Owl, African	LC	0	0.35	0.0	1871	0.0	0.20	0.0	27.3	9.1	0.35	3.2	9.0	0.10	0.9	4.1
121	Wood-Dove, Emerald-spotted	LC	0	0.35	0.0	2009	0.0	0.20	0.0	23.7	7.9	0.35	2.8	13.0	0.10	1.3	4.1
122	Woodpecker, Bearded	LC	0	0.35	0.0	2074	0.0	0.20	0.0	26.9	9.0	0.35	3.1	8.3	0.10	0.8	4.0
123	Tit-Flycatcher, Grey	LC	0	0.35	0.0	908	4.1	0.20	0.8	20.0	6.7	0.35	2.3	7.3	0.10	0.7	3.9
124	Roller, Purple	LC	0	0.35	0.0	2288	0.0	0.20	0.0	20.1	6.7	0.35	2.4	15.2	0.10	1.5	3.9
125	Mousebird, Speckled	LC	0	0.35	0.0	1486	0.0	0.20	0.0	4.4	1.5	0.35	0.5	33.3	0.10	3.3	3.9
126	Woodpecker, Bennett's	LC	0	0.35	0.0	1203	0.0	0.20	0.0	25.7	8.6	0.35	3.0	8.6	0.10	0.9	3.9
127	Cisticola, Croaking	LC	0	0.35	0.0	695	13.6	0.20	2.7	4.6	1.5	0.35	0.5	5.7	0.10	0.6	3.8
128	Helmet-Shrike, White-crested	LC	0	0.35	0.0	1926	0.0	0.20	0.0	23.8	7.9	0.35	2.8	10.0	0.10	1.0	3.8
129	Hornbill, Red-billed	LC	0	0.35	0.0	1590	0.0	0.20	0.0	23.5	7.8	0.35	2.8	10.1	0.10	1.0	3.8
130	Penduline-Tit, Grey	LC	0	0.35	0.0	1152	0.0	0.20	0.0	24.8	8.3	0.35	2.9	8.7	0.10	0.9	3.8

131	Buffalo-Weaver, Red-billed	LC	0	0.35	0.0	1498	0.0	0.20	0.0	24.7	8.2	0.35	2.9	8.8	0.10	0.9	3.8
132	Lark, Monotonous	LC	0	0.35	0.0	1079	0.0	0.20	0.0	26.7	8.9	0.35	3.1	6.3	0.10	0.6	3.7
133	Shrike, Magpie	LC	0	0.35	0.0	1444	0.0	0.20	0.0	21.9	7.3	0.35	2.6	11.2	0.10	1.1	3.7
134	Heron, Black	LC	0	0.35	0.0	723	12.3	0.20	2.5	2.0	0.7	0.35	0.2	9.6	0.10	1.0	3.7
135	Warbler, Garden	LC	0	0.35	0.0	676	14.4	0.20	2.9	1.4	0.5	0.35	0.2	6.2	0.10	0.6	3.7
136	Roller, Lilac-breasted	LC	0	0.35	0.0	2754	0.0	0.20	0.0	18.2	6.1	0.35	2.1	15.2	0.10	1.5	3.6
137	Hawk-Eagle, African	LC	0	0.35	0.0	1732	0.0	0.20	0.0	23.7	7.9	0.35	2.8	8.5	0.10	0.9	3.6
138	Sparrowhawk, Black	LC	0	0.35	0.0	706	13.1	0.20	2.6	2.0	0.7	0.35	0.2	7.3	0.10	0.7	3.6
139	Oriole, Eurasian Golden	LC	0	0.35	0.0	1437	0.0	0.20	0.0	23.9	8.0	0.35	2.8	7.8	0.10	0.8	3.6
140	Bee-eater, Little	LC	0	0.35	0.0	1830	0.0	0.20	0.0	20.5	6.8	0.35	2.4	11.5	0.10	1.2	3.6
141	Heron, Green-backed	LC	0	0.35	0.0	1318	0.0	0.20	0.0	19.8	6.6	0.35	2.3	12.3	0.10	1.2	3.5
142	Green-Pigeon, African	LC	0	0.35	0.0	1390	0.0	0.20	0.0	22.0	7.3	0.35	2.6	9.8	0.10	1.0	3.5
143	Jacana, African	LC	0	0.35	0.0	1546	0.0	0.20	0.0	19.3	6.5	0.35	2.3	12.8	0.10	1.3	3.5
144	Apalis, Yellow-breasted	LC	0	0.35	0.0	1222	0.0	0.20	0.0	24.9	8.3	0.35	2.9	6.1	0.10	0.6	3.5
145	Thick-knee, Water	LC	0	0.35	0.0	1110	0.0	0.20	0.0	19.6	6.5	0.35	2.3	12.1	0.10	1.2	3.5
146	Kingfisher, Striped	LC	0	0.35	0.0	1981	0.0	0.20	0.0	21.5	7.2	0.35	2.5	9.7	0.10	1.0	3.5
147	Scimitarbill, Common	LC	0	0.35	0.0	3150	0.0	0.20	0.0	11.1	3.7	0.35	1.3	21.8	0.10	2.2	3.5
148	Hobby, Eurasian	LC	0	0.35	0.0	1023	0.0	0.20	0.0	19.6	6.5	0.35	2.3	11.4	0.10	1.1	3.4
149	Kingfisher, Woodland	LC	0	0.35	0.0	1125	0.0	0.20	0.0	20.9	7.0	0.35	2.4	9.7	0.10	1.0	3.4
150	Cisticola, Lazy	LC	0	0.35	0.0	703	13.2	0.20	2.6	1.5	0.5	0.35	0.2	5.7	0.10	0.6	3.4
151	Duck, Comb	LC	0	0.35	0.0	1667	0.0	0.20	0.0	18.3	6.1	0.35	2.1	12.2	0.10	1.2	3.4
152	Cuckoo, African	LC	0	0.35	0.0	1712	0.0	0.20	0.0	18.4	6.1	0.35	2.2	11.8	0.10	1.2	3.3
153	Hoopoe, African	LC	0	0.35	0.0	3782	0.0	0.20	0.0	4.6	1.5	0.35	0.5	27.9	0.10	2.8	3.3
154	Babbler, Arrow-marked	LC	0	0.35	0.0	1642	0.0	0.20	0.0	22.9	7.6	0.35	2.7	6.4	0.10	0.6	3.3
155	Cuckoo, Great Spotted	LC	0	0.35	0.0	1324	0.0	0.20	0.0	16.1	5.4	0.35	1.9	14.3	0.10	1.4	3.3
156	Snake-Eagle, Brown	LC	0	0.35	0.0	2096	0.0	0.20	0.0	20.0	6.7	0.35	2.3	9.4	0.10	0.9	3.3
157	Bush-Shrike, Orange-breasted	LC	0	0.35	0.0	1594	0.0	0.20	0.0	21.0	7.0	0.35	2.5	8.1	0.10	0.8	3.3
158	Masked-Weaver, Lesser	LC	0	0.35	0.0	1288	0.0	0.20	0.0	22.4	7.5	0.35	2.6	6.1	0.10	0.6	3.2

159	Eagle, Wahlberg's	LC	0	0.35	0.0	1976	0.0	0.20	0.0	20.2	6.7	0.35	2.4	8.5	0.10	0.9	3.2
160	Francolin, Crested	LC	0	0.35	0.0	1641	0.0	0.20	0.0	16.7	5.6	0.35	1.9	12.5	0.10	1.3	3.2
161	Wood-Hoopoe, Green	LC	0	0.35	0.0	2458	0.0	0.20	0.0	12.1	4.0	0.35	1.4	17.9	0.10	1.8	3.2
162	Roller, European	LC	0	0.35	0.0	2029	0.0	0.20	0.0	14.2	4.7	0.35	1.7	15.2	0.10	1.5	3.2
163	Bush-Shrike, Grey-headed	LC	0	0.35	0.0	1468	0.0	0.20	0.0	20.1	6.7	0.35	2.3	8.0	0.10	0.8	3.1
164	Darter, African	LC	0	0.35	0.0	2157	0.0	0.20	0.0	5.1	1.7	0.35	0.6	25.0	0.10	2.5	3.1
165	Buttonquail, Kurrichane	LC	0	0.35	0.0	1850	0.0	0.20	0.0	17.2	5.7	0.35	2.0	10.8	0.10	1.1	3.1
166	Shikra, Shikra	LC	0	0.35	0.0	2067	0.0	0.20	0.0	20.1	6.7	0.35	2.4	7.3	0.10	0.7	3.1
167	Scops-Owl, Southern White-faced	LC	0	0.35	0.0	1737	0.0	0.20	0.0	13.5	4.5	0.35	1.6	15.1	0.10	1.5	3.1
168	Robin-Chat, White-browed	LC	0	0.35	0.0	1013	0.0	0.20	0.0	21.0	7.0	0.35	2.4	6.1	0.10	0.6	3.1
169	Puffback, Black-backed	LC	0	0.35	0.0	2059	0.0	0.20	0.0	19.2	6.4	0.35	2.2	8.0	0.10	0.8	3.0
170	Starling, Burchell's	LC	0	0.35	0.0	1337	0.0	0.20	0.0	20.4	6.8	0.35	2.4	6.1	0.10	0.6	3.0
171	Bee-eater, White-fronted	LC	0	0.35	0.0	1081	0.0	0.20	0.0	15.7	5.2	0.35	1.8	11.5	0.10	1.2	3.0
172	Flycatcher, African Dusky	LC	0	0.35	0.0	770	10.2	0.20	2.0	3.1	1.0	0.35	0.4	5.8	0.10	0.6	3.0
173	Tchagra, Black-crowned	LC	0	0.35	0.0	2060	0.0	0.20	0.0	18.4	6.1	0.35	2.2	8.4	0.10	0.8	3.0
174	Robin-Chat, White-throated	LC	0	0.35	0.0	904	4.3	0.20	0.9	12.7	4.2	0.35	1.5	6.1	0.10	0.6	2.9
175	Wood-Owl, African	LC	0	0.35	0.0	899	4.5	0.20	0.9	8.5	2.8	0.35	1.0	10.0	0.10	1.0	2.9
176	Hornbill, Southern Yellow-billed	LC	0	0.35	0.0	2528	0.0	0.20	0.0	16.2	5.4	0.35	1.9	10.1	0.10	1.0	2.9
177	Francolin, Coqui	LC	0	0.35	0.0	1231	0.0	0.20	0.0	16.2	5.4	0.35	1.9	10.0	0.10	1.0	2.9
178	Hornbill, African Grey	LC	0	0.35	0.0	2590	0.0	0.20	0.0	15.9	5.3	0.35	1.9	10.1	0.10	1.0	2.9
179	Sunbird, Collared	LC	0	0.35	0.0	896	4.6	0.20	0.9	10.0	3.3	0.35	1.2	7.7	0.10	0.8	2.9
180	Starling, Violet-backed	LC	0	0.35	0.0	2188	0.0	0.20	0.0	17.1	5.7	0.35	2.0	8.4	0.10	0.8	2.8
181	Shrike, Southern White-crowned	LC	0	0.35	0.0	1722	0.0	0.20	0.0	15.7	5.2	0.35	1.8	10.0	0.10	1.0	2.8
182	Flycatcher, Pale	LC	0	0.35	0.0	1308	0.0	0.20	0.0	18.4	6.2	0.35	2.2	6.7	0.10	0.7	2.8
183	Courser, Temminck's	LC	0	0.35	0.0	1717	0.0	0.20	0.0	13.8	4.6	0.35	1.6	11.7	0.10	1.2	2.8
184	Buzzard, Lizard	LC	0	0.35	0.0	1358	0.0	0.20	0.0	12.8	4.3	0.35	1.5	12.5	0.10	1.3	2.7

185	Guineafowl, Helmeted	LC	0	0.35	0.0	3686	0.0	0.20	0.0	3.7	1.2	0.35	0.4	23.1	0.10	2.3	2.7
186	Bee-eater, Blue-cheeked	LC	0	0.35	0.0	885	5.1	0.20	1.0	4.6	1.5	0.35	0.5	11.5	0.10	1.2	2.7
187	Palm-Swift, African	LC	0	0.35	0.0	1979	0.0	0.20	0.0	11.4	3.8	0.35	1.3	13.8	0.10	1.4	2.7
188	Spurfowl, Natal	LC	0	0.35	0.0	1216	0.0	0.20	0.0	16.2	5.4	0.35	1.9	8.0	0.10	0.8	2.7
189	Flycatcher, Southern Black	LC	0	0.35	0.0	1598	0.0	0.20	0.0	16.9	5.6	0.35	2.0	6.8	0.10	0.7	2.7
190	Flycatcher, Ashy	LC	0	0.35	0.0	1117	0.0	0.20	0.0	17.4	5.8	0.35	2.0	5.8	0.10	0.6	2.6
191	Indigobird, Village	LC	0	0.35	0.0	1079	0.0	0.20	0.0	15.2	5.1	0.35	1.8	8.2	0.10	0.8	2.6
192	Tit, Southern Black	LC	0	0.35	0.0	1895	0.0	0.20	0.0	16.4	5.5	0.35	1.9	6.8	0.10	0.7	2.6
193	Scrub-Robin, White-browed	LC	0	0.35	0.0	2127	0.0	0.20	0.0	15.4	5.1	0.35	1.8	7.9	0.10	0.8	2.6
194	Sunbird, Scarlet-chested	LC	0	0.35	0.0	1649	0.0	0.20	0.0	16.0	5.3	0.35	1.9	7.3	0.10	0.7	2.6
195	Waxbill, Blue	LC	0	0.35	0.0	2185	0.0	0.20	0.0	16.2	5.4	0.35	1.9	7.0	0.10	0.7	2.6
196	Batis, Chinspot	LC	0	0.35	0.0	1860	0.0	0.20	0.0	15.6	5.2	0.35	1.8	7.4	0.10	0.7	2.6
197	Brubru, Brubru	LC	0	0.35	0.0	3068	0.0	0.20	0.0	13.4	4.5	0.35	1.6	10.0	0.10	1.0	2.6
198	Petronia, Yellow-throated	LC	0	0.35	0.0	1883	0.0	0.20	0.0	13.9	4.6	0.35	1.6	9.5	0.10	1.0	2.6
199	Goshawk, Gabar	LC	0	0.35	0.0	2676	0.0	0.20	0.0	12.4	4.1	0.35	1.4	11.1	0.10	1.1	2.6
200	Nightjar, Freckled	LC	0	0.35	0.0	988	0.5	0.20	0.1	13.6	4.5	0.35	1.6	8.4	0.10	0.8	2.5
201	Owlet, Pearl-spotted	LC	0	0.35	0.0	2249	0.0	0.20	0.0	13.3	4.4	0.35	1.6	9.6	0.10	1.0	2.5
202	Prinia, Tawny-flanked	LC	0	0.35	0.0	1868	0.0	0.20	0.0	16.1	5.4	0.35	1.9	6.1	0.10	0.6	2.5
203	Bittern, Little	LC	0	0.35	0.0	950	2.2	0.20	0.4	8.4	2.8	0.35	1.0	10.5	0.10	1.0	2.5
204	Cuckoo, Jacobin	LC	0	0.35	0.0	2089	0.0	0.20	0.0	8.8	3.0	0.35	1.0	14.3	0.10	1.4	2.5
205	Reed-Warbler, Great	LC	0	0.35	0.0	839	7.2	0.20	1.4	2.9	1.0	0.35	0.3	6.9	0.10	0.7	2.5
206	Wagtail, African Pied	LC	0	0.35	0.0	1613	0.0	0.20	0.0	13.6	4.5	0.35	1.6	7.6	0.10	0.8	2.4
207	Barbet, Crested	LC	0	0.35	0.0	1779	0.0	0.20	0.0	9.6	3.2	0.35	1.1	12.1	0.10	1.2	2.3
208	Stork, White	LC	0	0.35	0.0	2277	0.0	0.20	0.0	4.0	1.3	0.35	0.5	18.5	0.10	1.9	2.3
209	Tchagra, Brown-crowned	LC	0	0.35	0.0	2717	0.0	0.20	0.0	12.7	4.3	0.35	1.5	8.4	0.10	0.8	2.3
210	Honeyguide, Greater	LC	0	0.35	0.0	1919	0.0	0.20	0.0	9.8	3.3	0.35	1.1	11.6	0.10	1.2	2.3
211	Kite, Black	LC	0	0.35	0.0	1117	0.0	0.20	0.0	10.8	3.6	0.35	1.3	10.4	0.10	1.0	2.3
212	Crake, Black	LC	0	0.35	0.0	1563	0.0	0.20	0.0	11.5	3.9	0.35	1.4	9.4	0.10	0.9	2.3

213	Coucal, Burchell's	LC	0	0.35	0.0	1529	0.0	0.20	0.0	10.7	3.6	0.35	1.3	10.2	0.10	1.0	2.3
214	Owl, Barn	LC	0	0.35	0.0	3060	0.0	0.20	0.0	5.0	1.7	0.35	0.6	16.9	0.10	1.7	2.3
215	Woodpecker, Golden-tailed	LC	0	0.35	0.0	2379	0.0	0.20	0.0	12.1	4.0	0.35	1.4	8.6	0.10	0.9	2.3
216	Cuckooshrike, Black	LC	0	0.35	0.0	1642	0.0	0.20	0.0	12.0	4.0	0.35	1.4	8.7	0.10	0.9	2.3
217	Cisticola, Rattling	LC	0	0.35	0.0	2157	0.0	0.20	0.0	14.5	4.8	0.35	1.7	5.7	0.10	0.6	2.3
218	Kingfisher, Pied	LC	0	0.35	0.0	2360	0.0	0.20	0.0	6.5	2.2	0.35	0.8	14.6	0.10	1.5	2.2
219	Weaver, Spectacled	LC	0	0.35	0.0	1184	0.0	0.20	0.0	13.7	4.6	0.35	1.6	6.1	0.10	0.6	2.2
220	Grebe, Little	LC	0	0.35	0.0	2844	0.0	0.20	0.0	2.3	0.8	0.35	0.3	19.3	0.10	1.9	2.2
221	Nightjar, Fiery-necked	LC	0	0.35	0.0	2064	0.0	0.20	0.0	11.6	3.9	0.35	1.4	8.4	0.10	0.8	2.2
222	Kite, Yellow-billed	LC	0	0.35	0.0	3007	0.0	0.20	0.0	9.9	3.3	0.35	1.2	10.4	0.10	1.0	2.2
223	Sparrowhawk, Little	LC	0	0.35	0.0	1497	0.0	0.20	0.0	12.4	4.1	0.35	1.5	7.3	0.10	0.7	2.2
224	Cuckoo, Klaas's	LC	0	0.35	0.0	1959	0.0	0.20	0.0	8.8	2.9	0.35	1.0	11.5	0.10	1.2	2.2
225	Heron, Goliath	LC	0	0.35	0.0	1219	0.0	0.20	0.0	10.0	3.3	0.35	1.2	9.9	0.10	1.0	2.2
226	Falcon, Amur	LC	0	0.35	0.0	1124	0.0	0.20	0.0	8.4	2.8	0.35	1.0	11.4	0.10	1.1	2.1
227	Oriole, Black-headed	LC	0	0.35	0.0	1854	0.0	0.20	0.0	11.5	3.8	0.35	1.3	7.8	0.10	0.8	2.1
228	Thrush, Kurrichane	LC	0	0.35	0.0	1668	0.0	0.20	0.0	13.3	4.4	0.35	1.6	5.6	0.10	0.6	2.1
229	Firefinch, Red-billed	LC	0	0.35	0.0	1717	0.0	0.20	0.0	12.4	4.1	0.35	1.4	6.5	0.10	0.7	2.1
230	Harrier-Hawk, African	LC	0	0.35	0.0	2127	0.0	0.20	0.0	8.1	2.7	0.35	1.0	11.1	0.10	1.1	2.1
231	Finch, Cut-throat	LC	0	0.35	0.0	943	2.5	0.20	0.5	6.6	2.2	0.35	0.8	7.7	0.10	0.8	2.1
232	Dove, Namaqua	LC	0	0.35	0.0	3852	0.0	0.20	0.0	1.6	0.5	0.35	0.2	18.5	0.10	1.9	2.0
233	Widowbird, White-winged	LC	0	0.35	0.0	1292	0.0	0.20	0.0	11.6	3.9	0.35	1.4	6.9	0.10	0.7	2.0
234	Swallow, Lesser Striped	LC	0	0.35	0.0	1752	0.0	0.20	0.0	11.7	3.9	0.35	1.4	6.6	0.10	0.7	2.0
235	Paradise-Whydah, Long-tailed	LC	0	0.35	0.0	1982	0.0	0.20	0.0	10.4	3.5	0.35	1.2	8.2	0.10	0.8	2.0
236	Barbet, Black-collared	LC	0	0.35	0.0	1810	0.0	0.20	0.0	8.4	2.8	0.35	1.0	10.5	0.10	1.1	2.0
237	Snake-Eagle, Black-chested	LC	0	0.35	0.0	2897	0.0	0.20	0.0	9.2	3.1	0.35	1.1	9.4	0.10	0.9	2.0
238	Plover, Common Ringed	LC	0	0.35	0.0	872	5.7	0.20	1.1	0.7	0.3	0.35	0.1	7.9	0.10	0.8	2.0
239	Kingfisher, Brown-hooded	LC	0	0.35	0.0	1940	0.0	0.20	0.0	8.9	3.0	0.35	1.0	9.7	0.10	1.0	2.0

240	Sunbird, White-bellied	LC	0	0.35	0.0	2034	0.0	0.20	0.0	12.1	4.0	0.35	1.4	6.0	0.10	0.6	2.0
241	Bee-eater, European	LC	0	0.35	0.0	3077	0.0	0.20	0.0	7.3	2.4	0.35	0.9	11.5	0.10	1.2	2.0
242	Weaver, Village	LC	0	0.35	0.0	1417	0.0	0.20	0.0	11.9	4.0	0.35	1.4	6.1	0.10	0.6	2.0
243	Owl, Marsh	LC	0	0.35	0.0	928	3.2	0.20	0.6	1.1	0.4	0.35	0.1	12.2	0.10	1.2	2.0
244	Sunbird, Marico	LC	0	0.35	0.0	1945	0.0	0.20	0.0	11.9	4.0	0.35	1.4	6.0	0.10	0.6	2.0
245	Pytilia, Green-winged	LC	0	0.35	0.0	2366	0.0	0.20	0.0	11.0	3.7	0.35	1.3	7.0	0.10	0.7	2.0
246	Shrike, Red-backed	LC	0	0.35	0.0	3059	0.0	0.20	0.0	10.8	3.6	0.35	1.3	7.2	0.10	0.7	2.0
247	Stork, Abdim's	LC	0	0.35	0.0	1971	0.0	0.20	0.0	0.9	0.3	0.35	0.1	18.5	0.10	1.9	2.0
248	Egret, Great	LC	0	0.35	0.0	1912	0.0	0.20	0.0	8.5	2.8	0.35	1.0	9.6	0.10	1.0	2.0
249	Woodpecker, Cardinal	LC	0	0.35	0.0	3177	0.0	0.20	0.0	9.2	3.1	0.35	1.1	8.3	0.10	0.8	1.9
250	Thrush, Groundscraper	LC	0	0.35	0.0	2263	0.0	0.20	0.0	8.9	3.0	0.35	1.0	8.7	0.10	0.9	1.9
251	Fish-Eagle, African	LC	0	0.35	0.0	2195	0.0	0.20	0.0	8.2	2.7	0.35	1.0	9.1	0.10	0.9	1.9
252	Kingfisher, Giant	LC	0	0.35	0.0	1859	0.0	0.20	0.0	6.3	2.1	0.35	0.7	11.3	0.10	1.1	1.9
253	Canary, Yellow-fronted	LC	0	0.35	0.0	1961	0.0	0.20	0.0	10.9	3.6	0.35	1.3	5.7	0.10	0.6	1.8
254	Waxbill, Orange-breasted	LC	0	0.35	0.0	895	4.7	0.20	0.9	1.1	0.4	0.35	0.1	7.4	0.10	0.7	1.8
255	Duck, White-faced	LC	0	0.35	0.0	1904	0.0	0.20	0.0	7.0	2.3	0.35	0.8	9.8	0.10	1.0	1.8
256	Bunting, Golden-breasted	LC	0	0.35	0.0	2774	0.0	0.20	0.0	10.4	3.5	0.35	1.2	5.8	0.10	0.6	1.8
257	Goose, Egyptian	LC	0	0.35	0.0	3105	0.0	0.20	0.0	3.3	1.1	0.35	0.4	14.0	0.10	1.4	1.8
258	Drongo, Fork-tailed	LC	0	0.35	0.0	3555	0.0	0.20	0.0	8.3	2.8	0.35	1.0	8.0	0.10	0.8	1.8
259	Quelea, Red-billed	LC	0	0.35	0.0	3418	0.0	0.20	0.0	7.9	2.6	0.35	0.9	8.3	0.10	0.8	1.8
260	Sandpiper, Common	LC	0	0.35	0.0	2736	0.0	0.20	0.0	6.0	2.0	0.35	0.7	10.4	0.10	1.0	1.7
261	Cuckoo, Red-chested	LC	0	0.35	0.0	1784	0.0	0.20	0.0	4.8	1.6	0.35	0.6	11.8	0.10	1.2	1.7
262	Tinkerbird, Yellow-fronted	LC	0	0.35	0.0	1327	0.0	0.20	0.0	5.7	1.9	0.35	0.7	10.8	0.10	1.1	1.7
263	Honeyguide, Lesser	LC	0	0.35	0.0	1704	0.0	0.20	0.0	5.0	1.7	0.35	0.6	11.6	0.10	1.2	1.7
264	Warbler, Bleating	LC	0	0.35	0.0	2143	0.0	0.20	0.0	8.7	2.9	0.35	1.0	7.1	0.10	0.7	1.7
265	Spurfowl, Swainson's	LC	0	0.35	0.0	1908	0.0	0.20	0.0	7.9	2.6	0.35	0.9	8.0	0.10	0.8	1.7
266	Night-Heron, Black-crowned	LC	0	0.35	0.0	1500	0.0	0.20	0.0	3.2	1.1	0.35	0.4	13.2	0.10	1.3	1.7
267	Kingfisher, Malachite	LC	0	0.35	0.0	2093	0.0	0.20	0.0	5.4	1.8	0.35	0.6	10.4	0.10	1.0	1.7

268	Heron, Squacco	LC	0	0.35	0.0	1355	0.0	0.20	0.0	4.9	1.6	0.35	0.6	10.9	0.10	1.1	1.7
269	Paradise-Flycatcher, African	LC	0	0.35	0.0	2290	0.0	0.20	0.0	8.4	2.8	0.35	1.0	6.8	0.10	0.7	1.7
270	Egret, Cattle	LC	0	0.35	0.0	3216	0.0	0.20	0.0	2.8	0.9	0.35	0.3	13.2	0.10	1.3	1.6
271	Dove, Red-eyed	LC	0	0.35	0.0	2752	0.0	0.20	0.0	4.6	1.5	0.35	0.5	11.0	0.10	1.1	1.6
272	Cuckoo, Diderick	LC	0	0.35	0.0	3278	0.0	0.20	0.0	4.2	1.4	0.35	0.5	11.5	0.10	1.2	1.6
273	Sparrowlark, Chestnut-backed	LC	0	0.35	0.0	1568	0.0	0.20	0.0	8.0	2.7	0.35	0.9	7.1	0.10	0.7	1.6
274	Thick-knee, Spotted	LC	0	0.35	0.0	3388	0.0	0.20	0.0	3.6	1.2	0.35	0.4	12.1	0.10	1.2	1.6
275	Eremomela, Burnt-necked	LC	0	0.35	0.0	983	0.8	0.20	0.2	7.0	2.3	0.35	0.8	6.6	0.10	0.7	1.6
276	Sandpiper, Wood	LC	0	0.35	0.0	2731	0.0	0.20	0.0	6.8	2.3	0.35	0.8	8.1	0.10	0.8	1.6
277	Swift, Alpine	LC	0	0.35	0.0	1763	0.0	0.20	0.0	1.9	0.6	0.35	0.2	13.8	0.10	1.4	1.6
278	Greenbul, Yellow-bellied	LC	0	0.35	0.0	1228	0.0	0.20	0.0	7.6	2.5	0.35	0.9	7.1	0.10	0.7	1.6
279	Bulbul, Dark-capped	LC	0	0.35	0.0	1895	0.0	0.20	0.0	8.6	2.9	0.35	1.0	5.8	0.10	0.6	1.6
280	Goose, Spur-winged	LC	0	0.35	0.0	2324	0.0	0.20	0.0	1.6	0.5	0.35	0.2	14.0	0.10	1.4	1.6
281	Ibis, Hadeda	LC	0	0.35	0.0	1988	0.0	0.20	0.0	3.2	1.1	0.35	0.4	12.0	0.10	1.2	1.6
282	Turtle-Dove, Cape	LC	0	0.35	0.0	4139	0.0	0.20	0.0	4.1	1.4	0.35	0.5	11.0	0.10	1.1	1.6
283	Cuckoo, Black	LC	0	0.35	0.0	1999	0.0	0.20	0.0	3.3	1.1	0.35	0.4	11.8	0.10	1.2	1.6
284	Crombec, Long-billed	LC	0	0.35	0.0	3639	0.0	0.20	0.0	6.7	2.3	0.35	0.8	7.9	0.10	0.8	1.6
285	Widowbird, Red-collared	LC	0	0.35	0.0	919	3.6	0.20	0.7	1.3	0.4	0.35	0.2	6.9	0.10	0.7	1.6
286	Swallow, Red-breasted	LC	0	0.35	0.0	1563	0.0	0.20	0.0	7.5	2.5	0.35	0.9	6.6	0.10	0.7	1.5
287	Cormorant, Reed	LC	0	0.35	0.0	2534	0.0	0.20	0.0	2.4	0.8	0.35	0.3	12.5	0.10	1.3	1.5
288	Ruff, Ruff	LC	0	0.35	0.0	2081	0.0	0.20	0.0	3.1	1.0	0.35	0.4	11.6	0.10	1.2	1.5
289	Warbler, Willow	LC	0	0.35	0.0	2984	0.0	0.20	0.0	6.9	2.3	0.35	0.8	7.2	0.10	0.7	1.5
290	Flycatcher, Spotted	LC	0	0.35	0.0	3315	0.0	0.20	0.0	8.1	2.7	0.35	0.9	5.8	0.10	0.6	1.5
291	Cormorant, White-breasted	LC	0	0.35	0.0	2279	0.0	0.20	0.0	2.1	0.7	0.35	0.3	12.5	0.10	1.3	1.5
292	Duck, White-backed	LC	0	0.35	0.0	1011	0.0	0.20	0.0	0.6	0.2	0.35	0.1	14.0	0.10	1.4	1.5
293	Stilt, Black-winged	LC	0	0.35	0.0	2579	0.0	0.20	0.0	2.1	0.7	0.35	0.2	12.3	0.10	1.2	1.5
294	Lark, Sabota	LC	0	0.35	0.0	2589	0.0	0.20	0.0	6.6	2.2	0.35	0.8	7.0	0.10	0.7	1.5

295	Dove, Laughing	LC	0	0.35	0.0	4039	0.0	0.20	0.0	3.0	1.0	0.35	0.4	11.0	0.10	1.1	1.5
296	Sandpiper, Marsh	LC	0	0.35	0.0	1762	0.0	0.20	0.0	5.4	1.8	0.35	0.6	8.1	0.10	0.8	1.4
297	Sparrow, Greyheaded	LC	0	0.35	0.0	3504	0.0	0.20	0.0	6.7	2.2	0.35	0.8	6.6	0.10	0.7	1.4
298	Cliff-Chat, Mocking	LC	0	0.35	0.0	1007	0.0	0.20	0.0	6.0	2.0	0.35	0.7	7.3	0.10	0.7	1.4
299	Heron, Purple	LC	0	0.35	0.0	1328	0.0	0.20	0.0	3.5	1.2	0.35	0.4	9.9	0.10	1.0	1.4
300	Swift, Little	LC	0	0.35	0.0	2984	0.0	0.20	0.0	3.6	1.2	0.35	0.4	9.7	0.10	1.0	1.4
301	Hornbill, Crowned	LC	0	0.35	0.0	993	0.3	0.20	0.1	2.7	0.9	0.35	0.3	10.1	0.10	1.0	1.4
302	Starling, Wattled	LC	0	0.35	0.0	3000	0.0	0.20	0.0	4.7	1.6	0.35	0.6	8.4	0.10	0.8	1.4
303	Bunting, Cinnamon-breasted	LC	0	0.35	0.0	2212	0.0	0.20	0.0	6.9	2.3	0.35	0.8	5.8	0.10	0.6	1.4
304	Heron, Grey	LC	0	0.35	0.0	3066	0.0	0.20	0.0	3.3	1.1	0.35	0.4	9.9	0.10	1.0	1.4
305	Swift, White-rumped	LC	0	0.35	0.0	2613	0.0	0.20	0.0	3.3	1.1	0.35	0.4	9.7	0.10	1.0	1.4
306	House-Martin, Common	LC	0	0.35	0.0	2119	0.0	0.20	0.0	5.0	1.7	0.35	0.6	7.8	0.10	0.8	1.4
307	Firefinch, Jameson's	LC	0	0.35	0.0	1321	0.0	0.20	0.0	6.0	2.0	0.35	0.7	6.5	0.10	0.7	1.4
308	Greenshank, Common	LC	0	0.35	0.0	2742	0.0	0.20	0.0	4.6	1.5	0.35	0.5	8.1	0.10	0.8	1.3
309	Eagle-Owl, Spotted	LC	0	0.35	0.0	3538	0.0	0.20	0.0	2.8	0.9	0.35	0.3	10.1	0.10	1.0	1.3
310	Egret, Little	LC	0	0.35	0.0	2233	0.0	0.20	0.0	3.1	1.0	0.35	0.4	9.6	0.10	1.0	1.3
311	Goshawk, African	LC	0	0.35	0.0	1240	0.0	0.20	0.0	5.0	1.7	0.35	0.6	7.3	0.10	0.7	1.3
312	Greenbul, Sombre	LC	0	0.35	0.0	1006	0.0	0.20	0.0	3.9	1.3	0.35	0.5	8.5	0.10	0.9	1.3
313	Spoonbill, African	LC	0	0.35	0.0	2246	0.0	0.20	0.0	1.1	0.4	0.35	0.1	11.6	0.10	1.2	1.3
314	Kite, Black-shouldered	LC	0	0.35	0.0	3595	0.0	0.20	0.0	2.5	0.8	0.35	0.3	10.0	0.10	1.0	1.3
315	Swift, Horus	LC	0	0.35	0.0	1092	0.0	0.20	0.0	2.7	0.9	0.35	0.3	9.7	0.10	1.0	1.3
316	Starling, Cape Glossy	LC	0	0.35	0.0	3145	0.0	0.20	0.0	5.7	1.9	0.35	0.7	6.1	0.10	0.6	1.3
317	Egret, Yellow-billed	LC	0	0.35	0.0	1669	0.0	0.20	0.0	2.4	0.8	0.35	0.3	9.6	0.10	1.0	1.3
318	Brownbul, Terrestrial	LC	0	0.35	0.0	1377	0.0	0.20	0.0	5.4	1.8	0.35	0.6	6.2	0.10	0.6	1.3
319	Sparrowhawk, Ovambo	LC	0	0.35	0.0	1033	0.0	0.20	0.0	4.4	1.5	0.35	0.5	7.3	0.10	0.7	1.2
320	Quail, Common	LC	0	0.35	0.0	1825	0.0	0.20	0.0	2.3	0.8	0.35	0.3	9.5	0.10	1.0	1.2
321	Whydah, Pin-tailed	LC	0	0.35	0.0	2432	0.0	0.20	0.0	3.3	1.1	0.35	0.4	8.2	0.10	0.8	1.2
322	Lapwing, Crowned	LC	0	0.35	0.0	3572	0.0	0.20	0.0	3.2	1.1	0.35	0.4	8.2	0.10	0.8	1.2

323	Warbler, Icterine	LC	0	0.35	0.0	1495	0.0	0.20	0.0	2.7	0.9	0.35	0.3	8.9	0.10	0.9	1.2
324	Plover, Three-banded	LC	0	0.35	0.0	3392	0.0	0.20	0.0	3.3	1.1	0.35	0.4	7.9	0.10	0.8	1.2
325	Lapwing, Blacksmith	LC	0	0.35	0.0	3498	0.0	0.20	0.0	3.0	1.0	0.35	0.4	8.2	0.10	0.8	1.2
326	Sandpiper, Curlew	LC	0	0.35	0.0	1528	0.0	0.20	0.0	3.2	1.1	0.35	0.4	7.8	0.10	0.8	1.2
327	Swift, African Black	LC	0	0.35	0.0	1459	0.0	0.20	0.0	1.5	0.5	0.35	0.2	9.7	0.10	1.0	1.1
328	Swallow, Barn	LC	0	0.35	0.0	4058	0.0	0.20	0.0	4.0	1.3	0.35	0.5	6.6	0.10	0.7	1.1
329	Swallow, Pearl-breasted	LC	0	0.35	0.0	1208	0.0	0.20	0.0	4.1	1.4	0.35	0.5	6.6	0.10	0.7	1.1
330	Tern, White-winged	LC	0	0.35	0.0	1572	0.0	0.20	0.0	1.6	0.5	0.35	0.2	9.3	0.10	0.9	1.1
331	Waxbill, Common	LC	0	0.35	0.0	2916	0.0	0.20	0.0	4.0	1.3	0.35	0.5	6.3	0.10	0.6	1.1
332	Mannikin, Bronze	LC	0	0.35	0.0	1293	0.0	0.20	0.0	4.2	1.4	0.35	0.5	5.9	0.10	0.6	1.1
333	Swift, Common	LC	0	0.35	0.0	2346	0.0	0.20	0.0	0.7	0.2	0.35	0.1	9.7	0.10	1.0	1.1
334	Eagle, Booted	LC	0	0.35	0.0	1369	0.0	0.20	0.0	1.5	0.5	0.35	0.2	8.5	0.10	0.9	1.0
335	Dove, Rock	LC	0	0.35	0.0	1914	0.0	0.20	0.0	0.5	0.2	0.35	0.1	9.6	0.10	1.0	1.0
336	Boubou, Southern	LC	0	0.35	0.0	997	0.1	0.20	0.0	2.5	0.8	0.35	0.3	7.0	0.10	0.7	1.0
337	Shrike, Lesser Grey	LC	0	0.35	0.0	2437	0.0	0.20	0.0	2.4	0.8	0.35	0.3	7.2	0.10	0.7	1.0
338	Duck, African Black	LC	0	0.35	0.0	1683	0.0	0.20	0.0	1.7	0.6	0.35	0.2	7.9	0.10	0.8	1.0
339	Stint, Little	LC	0	0.35	0.0	2135	0.0	0.20	0.0	1.8	0.6	0.35	0.2	7.8	0.10	0.8	1.0
340	Rush-Warbler, Little	LC	0	0.35	0.0	1205	0.0	0.20	0.0	2.8	0.9	0.35	0.3	6.6	0.10	0.7	1.0
341	Lark, Rufous-naped	LC	0	0.35	0.0	2405	0.0	0.20	0.0	3.1	1.0	0.35	0.4	6.3	0.10	0.6	1.0
342	Plover, Kittlitz's	LC	0	0.35	0.0	2114	0.0	0.20	0.0	1.6	0.5	0.35	0.2	7.9	0.10	0.8	1.0
343	Nightjar, Rufous-cheeked	LC	0	0.35	0.0	2114	0.0	0.20	0.0	0.8	0.3	0.35	0.1	8.4	0.10	0.8	0.9
344	Eagle, Verreaux's	LC	0	0.35	0.0	1911	0.0	0.20	0.0	0.6	0.2	0.35	0.1	8.5	0.10	0.9	0.9
345	Pipit, African	LC	0	0.35	0.0	3252	0.0	0.20	0.0	2.1	0.7	0.35	0.3	6.7	0.10	0.7	0.9
346	Sunbird, Amethyst	LC	0	0.35	0.0	1579	0.0	0.20	0.0	1.5	0.5	0.35	0.2	7.3	0.10	0.7	0.9
347	Sparrow, House	LC	0	0.35	0.0	3266	0.0	0.20	0.0	1.8	0.6	0.35	0.2	6.6	0.10	0.7	0.9
348	Buzzard, Steppe	LC	0	0.35	0.0	2956	0.0	0.20	0.0	0.7	0.2	0.35	0.1	7.7	0.10	0.8	0.9
349	Starling, Red-winged	LC	0	0.35	0.0	1727	0.0	0.20	0.0	1.2	0.4	0.35	0.1	6.5	0.10	0.7	0.8
350	Pipit, Buffy	LC	0	0.35	0.0	1433	0.0	0.20	0.0	1.0	0.3	0.35	0.1	6.7	0.10	0.7	0.8
351	Cisticola, Zitting	LC	0	0.35	0.0	2626	0.0	0.20	0.0	1.5	0.5	0.35	0.2	5.7	0.10	0.6	0.8

352	Seedeater, Streaky-headed	LC	0	0.35	0.0	1509	0.0	0.20	0.0	1.3	0.4	0.35	0.2	5.7	0.10	0.6	0.7
353	Apalis, Bar-throated	LC	0	0.35	0.0	1183	0.0	0.20	0.0	0.6	0.2	0.35	0.1	6.1	0.10	0.6	0.7
354	Neddicky, Neddicky	LC	0	0.35	0.0	2355	0.0	0.20	0.0	0.9	0.3	0.35	0.1	5.7	0.10	0.6	0.7
355	Crow, Pied	LC	0	0.35	0.0	3189	0.0	0.20	0.0	0.7	0.2	0.35	0.1	5.8	0.10	0.6	0.7
356	Stonechat, African	LC	0	0.35	0.0	1927	0.0	0.20	0.0	0.5	0.2	0.35	0.1	6.0	0.10	0.6	0.7
357	White-eye, Cape	LC	0	0.35	0.0	1769	0.0	0.20	0.0	0.6	0.2	0.35	0.1	5.8	0.10	0.6	0.6