Opportunity and Connectivity:

Selecting Land Managers for Involvement in a Conservation Corridor Linking Two Protected Areas in the Langkloof Valley, South Africa

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By

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Declaration

Unless specifically indicated to the contrary in the text, this thesis is my own original work. It has not been submitted for a degree at any other university

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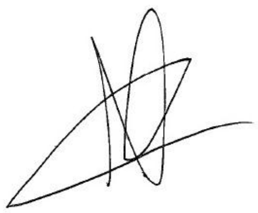

Abstract

The Eden To Addo Corridor Initiative aims to connect formally protected areas in a conservation corridor from the coastal area of the Eden District near Plettenberg Bay, Western Cape, South Africa to the Addo National Elephant Park, Eastern Cape, South Africa. The corridor will incorporate government and privately owned land, and will be an attempt to maintain ecological processes at a range of spatial and temporal scales. The Langkloof Valley lies between the Baviaanskloof World Heritage Area and the Tstitsikamma National Park; two formally protected areas that will be incorporated into the Eden To Addo Corridor. Spatial prioritization analyses allow conservation planners to select areas that should be targeted for conservation action based on a range of criteria. Historically, ecological criteria have been included mostly alone in spatial prioritization. Recently, the idea of 'conservation opportunity' has emerged in the field of conservation planning; the notion suggests that a range of different types of data should be included in processes to spatially prioritise for conservation. By including those data defined as 'human' and 'social' data into prioritising activities, the feasibility of conservation plans can be accounted for, but historically conservation planners have failed to do so. I conducted a literature review that demonstrated that although the importance of human and social data are acknowledged in the conservation planning literature, these data that define opportunity are rarely actually included in spatial prioritisation analyses. I then carried out a social assessment that allowed me to define the social and human context of our study area and, specifically, what stewardship instruments land managers in the Langkloof would be prepared to engage. We found that land managers were generally willing to engage, but lacked the financial capacity to adopt conservation methods. Using a subset of the social and human data that were collected in the social assessment, I trialled a new Decision Support Software to fuse those data with ecological data in a novel attempt to identify priority areas for conservation action based on ecological integrity and feasibility. We also scheduled (ranked) land managers to approach for conservation action with a focus on local champions and clusters of land managers displaying strong conservation characteristics. Two corridors were identified; a major corridor in the western region of the valley and a secondary corridor closer to the middle. The members of the Initiative have been briefed on the outcomes, which provided them an opportunity to provide feedback; it is hoped that the framework of this study can be used for planning future connections. The Eden To Addo Corridor Initiative sent out a stewardship extension officer in February 2011 to approach those land managers areas that were identified. This planning exercise is a good demonstration of how, by collaborating effectively, academic conservation planners can contribute to supporting decision making by organizations that are implementing conservation action.

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1 INTRODUCTION

The many global environmental crises of today are often caused or affected by, many spheres of human and social systems. One of these crises is the current and predicted rates of biodiversity loss due to urban or agricultural development. Conservation planning was adopted as a reaction to this crisis and is an approach to ensure the persistence of Nature – the components are stakeholder collaboration, strategy development and spatial prioritisation (Knight et al. 2006a).

Spatial prioritisation is the systematic act of selecting or prioritising areas based on criteria that help practitioners to make better informed decisions about where to implement conservation action (Rouget et al. 2006, Knight et al. 2010). Recently planners have called for a "knowing-by-doing" conservation planning environment where academics and practitioners aim, in a collaborative manner, to bridge the "research-implementation" gap by implementing (on-the-ground) the conservation planning theories, ideas or hypotheses that are formulated in the academic environment (Knight et al. 2008).

I was approached by the Eden To Addo Corridor Initiative (E2A hereafter) (www.edentoaddo.co.za) to fulfil the broad task of prioritising an area that links two formally protected areas (the Baviaanskloof World Heritage Area and the Tsitsikamma National Park) as part of a much larger Corridor Initiative (the Eden To Addo Corridor Initiative). The goal of the E2A Corridor Initiative is to create a conservation corridor from the coastal area of the Eden District near Plettenberg Bay (34^{o}3' South, 23^{o}22' East) which is situated in the Western Cape province, South Africa, to the Addo Elephant National Park which is situated near Grahamstown (33^{o}18'South, 26^{o}32' East) in the Eastern Cape, South Africa. It is hoped that private and government land will be incorporated in the corridor by linking the formally protected areas that lie between the two protected areas. These already existing protected areas are (1) The Garden Route National Park, (2) the Tsitsikamma National Park and the Formosa Nature Reserve, (3) the Baviaanskloof World Heritage Area, (4) the Groendal Nature Reserve and (5) the Addo Elephant National Park.

It was decided that a novel approach to the previously used least-cost corridor analysis (Rouget et al. 2006) would be carried out in order to prioritise areas for conservation action. The conceptual framework of this research was founded in the work of Rouget et al. (2006), but was expanded to include the concept of conservation opportunity (as presented by Knight et al. 2010). The inclusion of human and social information (that captures elements of conservation opportunity) was imperative for understanding the feasibility of proposed conservation actions in this particular context. There were several reasons for this decision.

Firstly, the inclusion of human and social data in conservation planning is an absolute necessity in most cases; the social context of an area defines the opportunities and constraints for conservation planning in terms of the political situation, limitations that are defined by human actions or reactions, and stakeholder support for, or buy-in of, a project. The feasibility of a conservation plan is therefore predominantly defined by the social context.

Secondly, E2A aims to meet its objectives of uniting private land managers with government officials and conservation agencies and formally protected areas by encouraging them to become involved in stewardship agreements. This necessitates a certain amount of trust between E2A and land managers; land managers will rely on E2A to inform them how to reap the benefits of implementing conservation action on their land, help them implement conservation or stewardship plans successfully, and to guide them in the long term so that the stewardship agreements will continue to benefit the land managers while simultaneously conserving biodiversity features. If stewardship agreements are signed, E2A will invest a certain level of trust in land managers since they will be the interested party responsible for implementing and monitoring conservation action, and ensuring that the land and its features is managed to achieve conservation goals.

Lastly, the social environment in which I was working is relatively sensitive in terms of the context of conservation; the area is predominantly fruit producing land and many of the land managers belong to families that have been farming in the area for generations. Fruit production is, as one expects, not highly conducive to implementing conservation action and land managers have already been at loggerheads with other conservation organisations and government officials in the area. In most cases, these parties have tried to implement conservation action that does not account for the needs of land managers, or that does not allow room for compromise. Win-win conservation-agricultural scenarios are difficult to achieve within the context and it must be realised that compromise and understanding between interested parties is always necessary to achieve conservation goals.

There is an ever-pressing need for theoretical and practical science and actions to be unanimous; in some cases the analysis that preludes the initiation of a conservation plan is too lengthy, or implementation is required from results that are poorly targeted to the specific characteristics of a planning region. I strongly believe that a balance needs to be achieved between taking the time to produce feasible, robust and defensible work, and carrying out efficient, repeatable and "not too scientific" spatial prioritisation analyses that can lead to implementation shortly after the need to prioritise arises. This is especially true in the case of conservation organisations such as E2A, which has a number of specific goals and deadlines, driven by funders, which must be met. The process carried out during this study could be used as a framework for connecting other areas within the E2A planning region.

This thesis has been presented as five sections, three of which have been written as peer-reviewed publications that explain the research undertaken in the context of systematic conservation planning, with a focus on the field of spatial prioritisation. The papers follow a systematic sequence, with each section designed to stand alone as a piece of novel research which not only contributes to the academic literature, but which can be practically applied for improving decision-making by E2A. Each paper prompts research questions addressed by the subsequent sections. Thus, the scale of each successive section is refined as the research questions and methodologies become more specific. An innovative approach was adopted for all three of the papers, and where possible, peer-reviewed ideas and methods used by other academics or practitioners were applied. The five sections are as follows;

Section One: This section – an overview describing the physical and "thought" context in which the project was initiated and how the three research papers in the body of the document (sections Two to Four) fit together.

Section Two: I aimed to demonstrate that human and social factors, although mentioned frequently in the conservation planning literature, have not been included enough in spatial prioritisation methods for conservation planning. It involved an assessment of conservation planning and spatial prioritisation literature with a specific interest in what data conservation planners have used in spatially-explicit prioritisation processes for conservation. An approach to examining the effectiveness of peer-reviewed literature for informing conservation action formulated by Smith et al. (2009) was integrated into the review process.

Section Three: I aimed to define the human and social context of the planning region in this paper by carrying out a social assessment in the Langkloof Valley. We defined an explicit method for collecting and interpreting human and social information. This information was also collected for the purpose of creating human and social data layers in a Geographical Information System (GIS) for the least-cost corridor analysis. The ideas of Winter et al. (2005), Winter et al. (2007) and Knight et al. (2010) were combined into a comprehensive social study.

Section Four: The fourth section is probably the most innovative in its approach since it fuses ideas of a systematic least-cost corridor analysis method that was conducted by Rouget et al. (2006) with the novel advances suggested by Knight et al. (2010) to include aspects of conservation opportunity in the spatial prioritisation process. A very recently developed Decision Support System (LandscapeDST_v011_01) was used to integrate ecological, human and social information (that was collected during the social assessment) systematically in a least-cost corridor analysis carried out using both ArcView 3.2 and ArcGIS 9.3. There is no evidence of previously published literature that describes the design of a conservation corridor using human and social data.

Section Five: The final section synthesizes the approaches and results of Sections Two, Three and Four, providing a summary of, and reflection on, the research project as a whole.

It is hoped that the products of this study will aid members of E2A in making better informed decisions about where and how to implement conservation action. An additional set of outcomes were produced for the members of E2A to represent ecological, human and social features graphically, and to provide the team with a suite of tools and recommendations for how to best interact with land managers and attempt to implement conservation action.

2 MISSING THE OPPORTUNITY: A REVIEW OF HUMAN AND SOCIAL FACTORS IN SPATIAL CONSERVATION PRIORITISATION

2.1 Abstract

A number of techniques have been used to carry out systematic spatial conservation prioritisation; many are computer based and allocate resources for conservation initiatives. When complemented with a process for co-developing implementation strategies, and maximising the probability of effective stakeholder collaboration, the process constitutes conservation planning. Recently, vulnerability and cost data that identifies limitations to conservation action (reactive data) have been included more frequently in conservation planning literature; it was hypothesised that few conservation plans have included social data that define where areas of opportunity for conservation are (proactive social data). The literature review described aimed to determine, through a systematic process, the trends in terms of what data sets conservation planners have been using over the past decade, with special interest in those data sets that relate to conservation opportunity. The authorship affiliations of the papers were also explored. All of the papers reviewed included ecological data in their spatial prioritisation design, and vulnerability data were utilised most extensively after ecological data. One fifth of all of the papers that were reviewed included data pertaining to the cost of conservation implementation while only one paper reviewed (between 1998 and 2009) included proactive social or human data in their spatial prioritisation design. Papers that were grouped into the "Academic" authorship affiliation group indicated the most comprehensive data set use between 1998 and 2009.

Keywords: conservation opportunity, conservation planning, feasibility, informed opportunism, spatial prioritisation

2.2 Introduction

The progress of spatial conservation prioritisation methods has led to a multitude of spatial conservation prioritisation techniques being utilized. Much of the time, these systematic procedures are computer-based algorithms that aim to allocate, most efficiently and effectively, resources for conservation (Cabeza and Moilanen 2003; Rothley et al. 2004; Sarkar et al 2006; Das et al. 2006; Oetting et al. 2006; Wood and Dragicevic 2007; Klar et al. 2008; Smith et al. 2008; Lagabrielle et al. 2009; Nel et al. 2009). The elements of representation and persistence are imperative factors that determine spatial prioritisation decisions (Ferrier 2002; Wilson *et al*. 2005). Due to this notion, and resource constraint factors, there has been an evolution in the methodology of area selection for conservation.

Previously specific areas were targeted for conservation on account of their individual or isolated conservation value or on an *ad hoc* basis because an opportunity to conserve land, or expand an existing protected area, presented itself (e.g. Pressey 1994; Pressey et al. 1996). More recently, conservation planners have targeted land based on the idea of conservation priority; where areas are subjected to a ranking system based on their vulnerability (the likelihood or imminence of biodiversity loss to current or impeding threatening processes) and irreplaceability (the likelihood that an area will be required as part of a conservation system that achieves specified set of targets, or, the extent to which the options for achieving the specified set of targets are reduced if the area is unavailable for conservation) (Pressey et al. 1994; Pressey et al. 1996; Ferrier et al. 2000; Pressey and Taffs 2001; Ferrier 2002; Wilson et al. 2005). Both of these concepts are a response to the sense of urgency that conservation necessitates.

Conservation prioritisation efforts have varied in terms of the data sets that have been used; Figure 1 shows these different data criterion and what each of them represents, or adds to a conservation prioritisation study. In some cases only ecological data are included in spatial prioritisations, while in other cases two or three of these criteria are included; ideally all of these criteria should be met by gathering a diverse range of data to pre-empt a conservation prioritisation study (Knight et al. 2010).

In an attempt to make well-informed and effective trade-offs, an innovative approach to conservation planning includes the notion of "conservation opportunity" (Knight and Cowling 2007; Knight et al. 2010). This approach manifests as an evolution of the concept of conservation priority, recognising the importance of "informed opportunity" for implementing feasible conservation plans (Noss et al. 2002, Knight and Cowling 2007; Pressey and Bottrill 2008). By measuring features of opportunity, fortuitous prospects for implementing actions more generally are seized (Noss et al. 2002; Knight and Cowling 2007 and Game et al. in press). Not only are aspects considered that influence or hinder the implementation of conservation projects, but more importantly landscape characteristics are explored that increase the feasibility of the conservation plan (Knight and Cowling 2007; Knight et al. 2010).

The act of seizing informed opportunities or integrating them into plans is recognised by authors in a range of fields including adaptive co-management (Folke et al. 2005), the policy sciences (Lober 1997), conservation planning (Game et al. in press) and bioregional planning (Brunckhorst 2005).

Ideally in order to define the conservation opportunity of a study area aspects of ecological, economic, vulnerability, human and social factors should be measured (Knight et al. 2010) in an attempt to consider and investigate all of the factors that affect the implementation success of a particular project. Figures 1 and 2 illustrate the evolution of conservation planning, from using only data that depicts conservation value, to incorporating all data sorts of data pertaining to conservation opportunity.

The inclusion of human and social factors (Figure 1), at a range of project-planning and implementation stages that allow for the development of real-world implementation strategies, constitutes not just strategic spatial conservation prioritisation, but conservation planning. The concept of conservation planning is one that embraces social and human factors in the prioritisation process and therefore accepts that many of these factors, like the social systems themselves, are complex and difficult to predict and adaptive management must be adopted in order to increase the chance of the conservation planning project's efficiency (Game et al. in press).

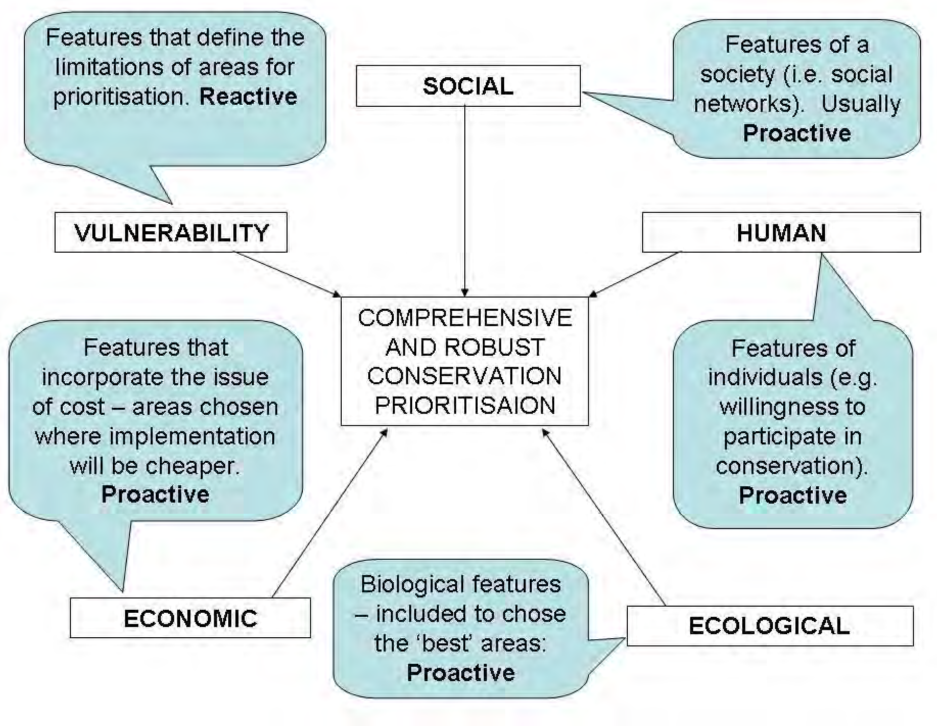


Figure 1: Data that should be included in conservation prioritisation methods for conservation planning

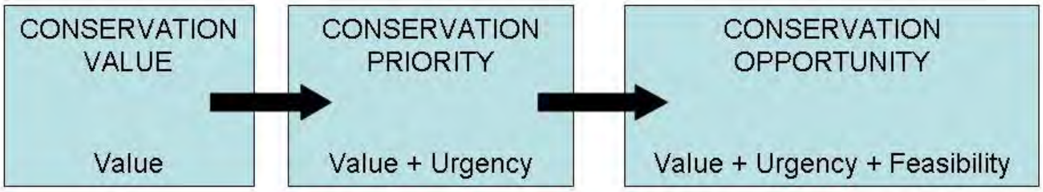


Figure 2: Representation of the evolution of conservation planning

It has even been suggested that the inclusion of human and social data for spatial prioritisation might even be more important than ecological data (Grantham et al. 2008, Knight et al. 2010) since conservation planners have realised that private land needs to be targeted for conservation if what is left of our biodiversity is to be secured; 80 percent of South Africa's threatened vegetation falls within privately owned land (Botha 2001b). Resource constraints have also necessitated the inclusion of cost factors in spatial prioritisation for conservation since proposed area network configurations need to be cost-effective, in most real-world situations, and especially in developing countries (for review see Hockley et al. 2006, Naidoo et al. 2006 and Naidoo et al. 2007). By measuring and taking into account the characteristics of a planning region that define the social context and, therefore, those areas where conservation implementation will be less costly, the likelihood of project implementation subsequent to conservation prioritisation, due to feasibility (*sensu* Hobbs et al. 2003), will be increased greatly (Perhans et al. 2008; Knight et al. 2010).

The rationale for this literature review was based on the belief that understanding conservation opportunity (feasibility) is a prerequisite for effectively translating prioritisation maps into action, because ecologically important areas do not necessarily coincide with locations where conservation action can be feasibly implemented (Hobbs et al. 2003; Knight et al. 2010). The importance of measuring, and taking into account, human and social factors in conservation planning is evident in the conservation planning literature (Margules and Sarkar 2000; Ferrier et al. 2002; Knight and Cowling 2007; Game et al. in press;), however, these factors are hardly ever incorporated into the systematic and repeatable practical methodologies for the conservation prioritisation of areas.

The objective of the review was to identify the trends in the applications of various data categories (Table 1.), specifically the human and social data that define feasibility. A second objective of the literature review was introduced based on an intellectual extension of a paper written by Smith et al. (2009) who explored authorship affiliations based on the assumption that "on-the-ground agencies" are more likely to implement successful conservation plans than "distant academics and non-governmental organisations" and therefore should be leading the way in terms of paper outputs/idea sharing. The authorship affiliations relevant to the different data types were therefore explored in the literature review.

2.3 Methods

Each of the mentioned data criteria, that have been used in conservation prioritisation studies as either proactive or reactive data (see Table 1, adapted from Brooks et al. 2006), were defined.

A journal search was carried out on the Web of Science (http://www.newiswebofknowledge.com) to create a database of English language, peer-reviewed papers that were published between (and including) the years 1998 to 2009 that explain conservation prioritisation methods. Due to the huge extent of literature on the topic, the papers were limited to those that were published in either "Conservation Biology", "Biological Conservation" or "Biodiversity and Conservation". These journals were chosen on the basis that they are the three highest impact 'conservation' focussed journals (i.e. have the word "conservation" in their title) (Fazey et al. 2005a).

The phrases "conservation assessment*", "conservation plan*", "conservation evaluation", "conservation value", "reserve selection", "area selection", "area identification", "priority area*", "bioregional conservation", "bioregional planning", "ecoregional assessment*", "ecoregional conservation", "integrated conservation" and "natural areas identification" were used in the journal paper search (Egoh et al. 2007). Papers were only included if they explained spatially explicit, repeatable processes that identified areas as potential priorities for nature conservation activities (Knight et al. 2008). Expert-based approaches were excluded from the study since they are less defensible (Knight et al. 2008). Gap analyses and assessments of representativeness were also excluded because they usually describe a conservation status assessment and fail to describe a prioritisation process – the two processes are inherently different (Pressey and Cowling 2001). However, if a process was described where a gap analysis or representativeness assessment was carried out prior to area prioritisation, the studies were included. 82 journal papers between the years 1998 to 2002 and 85 papers between the years 2003 and 2009 were identified that fulfilled all of the above categories.

Table 1: Data criteria that should be included in spatial prioritisation methods for conservation planning

Data criteria	Definition	Example	Proactive / Reactive	Rationale
Ecological	Data pertaining to vegetation and its characteristics.	Species types/distribution (Bonn and Gaston 2005)	Proactive	Guides conservation planners towards areas of significant ecological characteristics.
Economic	Data pertaining to (and comparing) the cost of implementing conservation plans in different areas	Funding required to protect biological value (Cabeza and Moilanen 2006)	Proactive	Guides conservation planners towards areas where conservation will be less costly to implement.
Vulnerability	Data pertaining to the likelihood of biodiversity loss due to current or impeding threatening processes (for the purpose of this study, current transformation data is not included in the definition of vulnerability)	Threat of land transformation for anthropogenic purposes (Cowling et al. 2003)	Reactive	Guides conservation planners away from areas they should avoid.
Human	Data pertaining to the individual characteristics of possible stakeholders	Land manager willingness to collaborate with conservation agencies (e.g. Knight et al. 2010)	Proactive	Guides conservation planners towards areas where there is opportunity to implement conservation with human/stakeholder support
Social	Data pertaining to networks of people or societies (groups of people) that may influence the feasibility of conservation plans	Cultural significance of an ecological aspects to a society (Coppolillo et al. 2004)	Proactive	Guides conservation planners towards areas where there is opportunity to implement conservation with community/stakeholder support

*Proactive data, in this context, is that data which allows conservation planners to take advantage of favourable/opportunistic biological or social conditions. Reactive (i.e. anti-active) data informs conservation planners where less favourable conservation areas are and hence, those areas that should be avoided.

*Human data refers to the data that is captured for individuals and that signifies the presence or absence of conservation opportunism (i.e. that person should be targeted for conservation). Social data pertains to the generalisations or observations that can be made about a group of people that indicates the presence or absence of conservation opportunism (i.e. most members of that community are likely to behave in a conservation-friendly way and that area/those people should therefore be targeted for conservation opportunism)

The database of papers was then studied in order to determine what data criteria were included in the spatial prioritisation methods described in each one (ecological, economic, vulnerability, social and human). Each paper was also designated an authorship affiliation depending on the constitution of authors; papers were classified as "academic" if all of the authors belonged to an academic institution, "NGO" if at least one author was affiliated with and NGO but any others were affiliated with an academic institute and "Agency" if at least one of the authors was affiliated with a government agency (*sensu* Smith et al. 2009).

Basic statistics were carried out to determine the proportion of journal papers that included different data criteria (percentage of journal articles that include each criterion per time frame) and to see if there were any trends between authorship affiliation and the data criteria that were used. A test of equality of two proportions (StatSoft 2009) was carried out in order to determine whether there was a significant increase or decrease in the frequency of the different data types used between the two time frames and to determine if there was a significant difference in data use between authorship affiliations. A test of equality of three proportions (StatSoft 2009) was carried out in order to test whether there was a significant increase or decrease in the different data type uses between the time frames and between the authorship affiliations

2.4 Results

2.4.1 General trends in data use

All of the papers described conservation prioritisation methods that included the use of ecological data (Table 2). Vulnerability (reactive data) was the second most commonly used data category with over a third of all of the papers reviewed including it in their prioritisation techniques, while one fifth of the papers (n = 33) that were reviewed included data relating to cost of implementation. Only 1% (n = 1) of the journal papers made use of social data while none of the papers described the use of human data (Table 2).

The use of economic data increased significantly ($z = 2.508$; $p < 0.05$) by 27% between the two time periods (1998 – 2002 and 2003 – 2009) but there is no significant increase or decrease in the use of other data; vulnerability data use increased by only 3%, social data use increased by 1% and human data use remained the same at 0% for both time periods (Table 2).

Table 2: Proportions of journal papers that include specific data categories in their spatial prioritisation methods for conservation planning

Data category	1998 - 2002	2003 – 2009	1998 - 2009
Ecological	100%	100%	100%
Economic	11%	28%	20%
Vulnerability	35%	38%	37%
Social	0%	1%	1%
Human	0%	0%	0%

2.4.2 Are the locals leading?

Papers that had "Academic" authorship affiliations made use of the most comprehensible set of data from 1998 to 2009 (Table 3). "Academic" authorship affiliation papers demonstrated the most extensive use of economic data for the entire time period and the papers in this category included a higher percentage of vulnerability data than those in the other two categories. Only one paper was found to include social data (within the "NGO" category) while neither of the other categories included papers that incorporated social or human data.

The use of ecological data remained the same for each authorship affiliation category between the two time periods (1998 – 2002 and 2003 – 2009) as all of the papers included ecological data (Table 2 and Table 3). There was a significant increase in the use of economic factors from time period 1998 – 2002 to 2003 – 2009 ($U = 6.8334$; $p < 0.05$) for papers in all three of the authorship affiliation categories, with the percentage of papers that included economic factors in each category doubling at least (Table 3). There was a significant difference in vulnerability data between the two time frames for all of the authorship affiliation categories ($U = 10.1729$; $p < 0.01$); "Academic" and "NGO" papers showed a decrease (of about 10%) while "Agency" papers illustrated an increase of 55% for vulnerability data use.

Table 3: Proportions of journal articles that include specific data categories in their spatial prioritisation methods for conservation planning based on authorship affiliations

	Academic			Agency			NGO		
Data category	1998-2002	2003-2009	1998-2009	1998-2002	2003-2009	1998-2009	1998-2002	2003-2009	1998-2009
Ecological	100%	100%	100%	100%	100%	100%	100%	100%	100%
Economic	13%	31%	30%	10%	24%	15%	8%	28%	19%
Vulnerability	38%	29%	44%	10%	65%	30%	46%	39%	42%
Social	0%	0%	0%	0%	0%	0%	0%	6%	3%
Human	0%	0%	0%	0%	0%	0%	0%	0%	0%

2.5 Discussion

2.5.1 Knowing but not doing pre-empts missing the opportunity

Conservation planners and academics have long recognised that people, and their actions, are key role players in determining whether conservation implementation is effective or not (Abbit et al. 2000; Faith and Walker 2002; Williams et al. 2003; Cowling et al. 2004; Moffett et al. 2005; Knight et al. 2006a; Knight and Cowling 2007; Sugimura and Howard 2008; Knight et al. 2010; Waylen et al. 2010). This concept has also been acknowledged by people who have carried out spatial prioritisations (O'Connor et al. 2003; Moore et al. 2004; Curtis et al. 2005; Chomitz et al. 2006) however, most conservation planners have focussed specifically and exclusively on utilising social data to adopt a reactive approach (i.e. vulnerability of species/habitats to anthropogenic effects). This 'reactive' mind-set is in contrast to the notion of conservation opportunity since such data only fulfils the requirement of determining areas that should be avoided or excluded from conservation plans. It contributes minimally to developing an understanding of how feasible it is to implement conservation plans or actions in areas that have been identified and prioritised (Knight and Cowling 2007). It is logical to assume that in some conservation planning cases where biologically important areas have been prioritised based on ecological criteria alone, and where no effort has been made to determine the conservation opportunity aspect of the area, the feasibility and implementation opportunity of conservation plans may be inadequate. In these instances resources will be wasted since conservation efforts will need to be repeated (Knight et al. 2010).

The fact that none of the papers that were reviewed included social or human data in their spatial prioritisation techniques is notable since recently, Cowling et al. (2010) have suggested that sometimes, in hotspots especially, human and social data alone might be more useful than ecological data alone. The identification of areas that represent the maximum opportunity for conservation provides a technique which, in integrating different types of data, addresses or mirrors the complexity of the real world socio-ecological systems, and the 'messy' problems that they present. Including social and human data (conservation opportunity data) and, consequently, bridging the gap between the biological/natural and social sciences therefore aids in reducing the research-implementation gap described by Knight et al. (2008) as "pragmatic solutions to conservation planning problems" are developed.

2.5.2 Natural and social sciences: the great divide

Most conservation planners have failed to incorporate human and social data that constitutes part of conservation opportunity in their mapping and prioritisation techniques. But why is this the case? Typically and historically there has been a divide between the natural and social sciences in both the academic and applied disciplines (Freudenburg et al. 1995; Goldman and Schurman 2000). Conservation biologists are historically wildlife biologists and it seems that biological interests are therefore fundamentally engrained in them. Much of the conservation biology literature that is available is not inter-disciplinary and therefore lacks relevance to policy and management (Fazey et al. 2005) Academic institutions are not aiding in changing this mind-set, or encouraging an interdisciplinary approach, since academics or practitioners in conservation disciplines are not being trained in the practice of social methodology research (Saberwal & Kothari 1996). Baxter et al. (1999) reported that only 13% of compulsory courses for 12 degrees in Australia are non-ecological.

By encouraging conservation biologists to adopt an interdisciplinary approach when tackling issues of land prioritisation for conservation, it will become more widely accepted that aspects of conservation opportunity are an essential data source for systematic spatial conservation prioritisation techniques. Conservation biologists need to attempt to close the natural and social sciences divide and incorporate aspects of human and social capital into their conservation planning techniques.

2.5.3 The lack of local leadership

The results displayed in Table 3 are disappointing in the context of the argument that Smith et al. (2009) proposes. It is hypothesised that papers published by agency members that describe conservation prioritisation techniques and solutions are more likely to be implemented "on-the-ground" since conservation planners at an agency level have the capacity to implement action, and their goals are formulated within a political, institutional and organisational context (Smith et al. 2009). Researchers or academics focus on publishing information relating to topics which they are interested in or which will make an impact in the scientific literature, while NGO's are often pressurised or swayed by its members and donors to follow a particular mandate (Smith et al. 2009).

The importance of utilising proactive social and human data that identifies areas of conservation opportunity has not been recognised by any of the authors, let alone those that belong to the "Agency" category (Table 3). Those papers that were clumped into the "Agency" category display the lowest frequency of economic and vulnerability data use for the entire time period (1998 – 2009) and the increase in economic data use between the two time periods, that is evident in all the authorship affiliation categories, is the lowest for the "Agency" category. In order to enhance the feasibility of the conservation studies and encourage on-the-ground implementation, agencies should include those data that describe areas of conservation opportunity more frequently in their spatial prioritisation techniques.

2.6 Conclusion

Spatial prioritisation techniques for conservation need to include both reactive and proactive data in order to ensure maximum feasibility of studies when they are to be implemented. Based on the results of the literature review, it seems that conservation planners have acknowledged this need but have failed to incorporate data in conservation prioritisation analyses that indicate and target areas where the opportunity for conservation action is the highest. Proactive social and human data, that guides conservation planners towards areas where conservation implementation should be more feasible, has hardly been utilised at all while reactive vulnerability data, that indicates which areas conservation planners should avoid, has been utilised most extensively after ecological data. Conservation planners, with special reference to those in government agencies, should incorporate all of the different data criteria described (ecological, economic, vulnerability, social and human) in an attempt to describe robust and feasible studies. The divide between the natural and social sciences needs to be bridged so that conservation planners become familiar with, and embrace, social research methodologies and concepts.

3 SOCIAL ASSESSMENT OF THE OPPORTUNITIES AND CONSTRAINTS FOR IMPLEMENTING EFFECTIVE CONSERVATION ACTION ON PRIVATE LAND IN THE LANGKLOOF VALLEY, SOUTH AFRICA

3.1 Abstract

Social assessments are increasingly being viewed as an essential stage in effective operational models for spatial prioritization; they provide conservation planners with an understanding of the socio-ecological context in which they are working, even though what needs to be assessed has not yet been clearly identified. The E2A Corridor Initiative aims to link existing protected areas by using private and government land to produce a functional conservation corridor. To assess (or gauge) local attitudes towards such an initiative, interviews with land managers in the Langkloof Valley (Western Cape, South Africa) were carried out. The valley lies between two existing protected areas, in an area in which it is hoped that conservation-action can be implemented through stewardship agreements. Information on a range of social and environmental attitudes was gathered and the resulting answer-sets were subjected to consistency and reliability testing. Internally consistent subsets (factors) were extracted and subjected to further analyses after converting the scores to the range 0 to 1. Mean scores for the quantitative social factors were all greater than 0.5, except for the factors "champions scores" and "likelihood of selling property." All of the land managers interviewed were white, male, aged between 30 and 67 years, and most were married. Of those who were married, most had two or more children. Almost all had lived on their land for 30 years or longer and the majority were fruit or crop producers. With one exception, all were (at the very least) interested in learning more about the possibilities for conservation in the area. From a land managers' perspective, the biggest hindrance to implementing conservation-action in the area is a lack of resources.

Key words: social context, social assessment, conservation opportunity

3.2 Introduction

Effective conservation activities are recognised as being inherently social processes, especially in more recent times (Salafsky and Wollenberg 2000; Payet 2007; Game et al. 2010). World-wide, and in South Africa, there has been a trend towards conservation initiatives that encourage private land managers to engage in, or become stakeholders of, conservation efforts (Carr and Tait 1991; Winter et al. 2007; Scherr and McNeely 2008). Winter et al. (2007) attribute the occurrence of such a trend to resource constraints and to the fact that the majority of threatened vegetation in South Africa (80%) occurs on privately owned land (Botha 2001b). The establishment of conservation initiatives centred on privately owned land, or the expansion of such initiatives, underscores the need to focus on, and include, social aspects in conservation planning (Wallace et al. 2008).

This paradigm shift from preservation (where land is fenced off for the purpose of protecting certain endangered species) to conservation (where the land involved in conservation planning is also used to meet the objectives of land managers) leads to mosaic landscapes that are managed together in order to achieve a variety of common goals (Brunckhorst 2005). The inclusion of human and social aspects (see Table 1 in Section 2) has become an essential feature of operational models in conservation planning, involving, specifically, the integration of stakeholder collaboration (Cowling & Pressey 2003; Knight et al. 2006a; Polasky 2008; Pressey & Bottrill 2008), visioning (Knight et al. 2006a), strategy development (Knight et al. 2006a), mainstreaming (Cowling and Pressey 2003; Knight et al. 2006a), and reflection (Knight et al. 2006a). A diverse range of human and social factors determine the effectiveness of conservation initiatives (Table 4).

Systematic conservation planning is the action of methodically and efficiently comparing alternative parcels of land and choosing or prioritising the land best suited for conservation, based on a set of pre-defined targets or criteria that need to be met (Margoluis and Salafsky 1998; Cowling et al. 2003). The process of systematic conservation planning is usually spatially explicit (Cowling et al. 2003); such methods are increasingly being used to direct conservation planning activities at a range of spatial scales (Clark and Slusher 2000; Cabeza and Moilanen 2001; Cowling and Pressey 2003; Gonzales et al. 2003; Lawler et al. 2003; Costello and Polasky 2004; Arponen et al. 2005, Bowker et al. 2008). However, many of the operational models defined for systematic conservation planning fail to include social processes; for instance, Margules and Pressey (2007) mention the importance of social factors in their text but do not include them as an aspect in their suggested operational model.

Recent research has served to emphasize that strategic conservation planning, or the spatial prioritization of conservation-areas, and, in fact, the entire ecological process, has an holistic social dimension (Airame et al. 2003; Arendt 2004; Chomitz et al. 2006; Knight et al. 2006a; Cowling and Wilhelm Rechmann

2007; Ban et al. 2008). Consequently, conducting a social assessment is now recognised as an essential pre-requisite for effective conservation planning (Game et al. in press)

Social assessments should precede spatial prioritization activities when carrying out conservation planning (Knight et al. 2006a; Fischer and Bliss 2008), since they provide essential information on 1) how to situate the spatial prioritization within institutional contexts relevant for implementation, 2) the type of analysis required, 3) what data are required, 4) how targets should be defined, and 5) the types of products required. More generally, it provides a broader holistic context. For example, when scheduling conservation actions for the Cape Floristic Region, Cowling et al. (2003) conducted an irreplaceability analysis (using C-plan software), but, following subsequent discussion with implementers in local government, realised that minimum set analyses would have more effectively met the implementers needs. When aiming to mainstream maps of Critical Biodiversity Areas into local government policies and practices, Pierce et al. (2005) initially intended to provide this spatial data over the internet – until discussions with implementers revealed that many of the officials did not know how to use Geographical Information Systems (GIS). Both studies cite the importance of a social assessment for ensuring that conservation planners understand the human and social context of a planning region so that the science of spatial prioritization can be tailored to the area of implementation.

In conservation planning, evaluating the opportunities for, and constraints on, implementing effective conservation action is considered to be important (Knight et al. 2006a; Cowling and Wilhelm-Rechmann 2007; Knight and Cowling 2007). Cowling and Wilhelm-Rechmann (2007) identify some of these opportunities and constraints as being defined by the values, norms, institutions, organisations and human well-being elements of a particular area. Conservation (or restoration) opportunity is a relatively recent concept, applied primarily by pragmatic conservation planners (Knight & Cowling 2007; Game et al. 2010; Guererro et al. 2010; Knight et al. 2010), which maps factors defining the opportunities and constraints to the effective implementation of conservation action. For example, ascertaining which land managers are more willing to take part in stewardship agreements or who are willing to collaborate with conservation organisation officials. Including land managers who are highly willing and/or able to implement conservation activities will improve the likelihood of effective implementation (Fischer and Bliss 2008).

Table 4: Human and social factors that contribute towards defining areas of conservation opportunity

Factor		Measure	Rationale
1	Conservation Knowledge	Knowledge of issues relating to endangered species, environmental legislation and general conservation issues.	• It is acknowledged that a complex and interrelated suite of psychological variables affect a land manager's behaviour (Lynn *et al.* 1998); knowledge may be one of these variables. • Knowler and Bradshaw (2007) carried out a study to investigate which variables have an effect on the success of conservation-agriculture; the most reliably significant variable that they found was a landowner's awareness of particular threats pertaining to the environment.
2	Conservation Behaviour	'Conservation friendly' behaviour of land managers in their daily lives and in their farming methods.	• Resources can be saved if land managers who have already adopted conservation-friendly techniques are targeted since no incentives to make trade-offs for conservation need to be introduced. • Behaviour is a direct measure of values and beliefs (Curtis and de Lacy 1998).
3	Professional Life	Individual landowners motivation, enthusiasm and success regarding work, the working environment and goal achievement.	• Land managers who feel they have the capacity to accomplish tasks and who are not emotionally exhausted by work projects are suitable targets in any conservation project since they have the ability to positively influence other stakeholders and to commit to the project until the goals are achieved.
4	Willingness-to-Collaborate	The extent to which landowners are willing to collaborate with conservation agencies, government officials or other potential stakeholders, and which of these stakeholders are most favourable as collaborating bodies.	• Since collaboration in this context is an essential aspect of the proposed conservation instruments it is important to decipher whether land managers are hesitant to collaborate with a conservation body representative, and, if not, which stakeholder they would be inclined to collaborate with.

5	Willingness to Participate	The extent to which landowners are willing to participate in conservation related activities, specifically their willingness to 1) adopt conservation friendly methods, 2) make trade-offs for the sake of conservation, 3) adopt conservation instruments and 4) accept incentives that encourage participation in instruments/'conservation-friendly' behaviour.	• Instruments that encourage conservation on privately owned land are becoming a popular method of conservation action; it is vital to determine which conservation options, and incentives for conservation, landowners find more favourable (Cumming and Botha 2008, Hutton and Leader-Williams 2003).
6	Likelihood of Selling Property	Whether or not the landowner is thinking about selling his property or has definite plans to do so.	• It is important that land managers involved in a conservation scheme do not sell their property (or are unlikely to in the foreseeable future) since a new land manager might not share the same commitments pertaining to conservation action. • On the other hand, if a land manager is thinking about selling his/her property, the relevant conservation organisation (E2A) should think about purchasing the land to incorporate it into the broader conservation scheme.
7	Champion	To what extent a land manager is deemed to be successful, influential and/or demonstrate community leadership by his/her peers.	• Land managers who're influential within the community are primary targets for involvement in conservation action since other members of the local community may be more willing to follow in his/her footsteps if he/she has proved to be successful in his/her farming venture(s).

The notion of beginning a conservation planning initiative with a social assessment raises a pertinent question: which factors should be assessed? Whilst the importance of a social assessment has been highlighted in operational models for conservation planning (e.g., Cowling & Pressey 2003; Knight et al. 2006a; Pressey & Bottrill 2009), conservation planners have yet to specifically define a protocol for what constitutes a social assessment. In contrast, the importance of social assessments has long been realized by other disciplines.

Social assessments (SA’s) are described as interdisciplinary actions or approaches to applied planning activities that involve identifying the future consequences of a current or proposed action on individuals, organizations and social macro-systems (Craig 1990; Becker 2001). SA’s have been used as a strategic tool in a number of different decision-making contexts or disciplines (Craig 1990; Vanclay 1999a), especially those related to technical and policy planning or development (Craig 1990). The purpose for which a social assessment is undertaken is defined by the planning context in which it is carried out, although in most cases a set of particular fundamental principles can be applied (Vanclay 2003). Policy makers, regulatory agencies, developers, financiers, conservationists and many other active stakeholders or influential citizens in a number of other disciplines should recognise that social and biophysical aspects are interconnected; they should therefore appreciate the value that SA’s add to any planning project since SA's provide a description of the environment in which they are working. This encourages social learning atmospheres and mitigates negative social impacts (Craig 1990; Becker 2001; Vanclay 2003). The assessments also have the potential to increase the efficiency of planning processes as the possibly diverse, complex and changing values and beliefs of stakeholders can be incorporated into plans for progress (Clark 1999; Ajzen 2001; Fischer and Bliss 2008).

Social and human characteristics that define an area or a community are highly complex, can be affected by a large number of variables, and can be measured in various ways (see Lynne et al. 1988; Beedell and Rehman 1999; Lichtenberg and Zimmerman 1999; Winter et al. 2007). Lynne et al. (1988) describe a suite of psychological inter-related variables that affect an individual’s conservation behaviour, and propose a simple model describing the behaviour of land managers;

[Social Situational Factors (Ym, Pm, Fm) + Attitudes (Am) + Social Norm (Sm)] = Behavioural Intention = Behaviour

Ym = Income

Pm =Pprices paid for conservation effort

Fm = Features of the farm/land

Am = Land managers attitudes

Sm = social norms

Winter et al (2007) summarize the factors identified by Lynne et al. (1988) into four distinct groups that influence the social profile of a region and its inhabitants; "farm-structure" (i.e. features of the farm/land), "land manager characteristics" (i.e. attitude), "business characteristics of the farm/land" (i.e. income) and "institutional or social environmental factors" (i.e. social norms, costs of conservation). A land manager's attitude is influenced by the context of social norms, as well as by his/her personal context, e.g., income, the costs imposed by adopting pro-conservation behaviour, and the features of the land or the state it is in. Lynne et al. (1988) assert that, as expressed in the model, attitudes directly influence behaviour, and an attitude is formed by the combination of a land manager's beliefs and valence. Valence is the attraction or repulsion that a land manager may have to a particular activity; i.e. it is a positive or a negative evaluation carried out by a land manager when considering that activity (Lynne et al. 1988).

The intricate variables that are included in the model highlight the complexity of social assessments. One of the most important considerations in any conservation or management plan is that of context.

The E2A Corridor Initiative is a conservation-corridor initiative that aims to connect areas within the Eden Municipality near Plettenberg Bay (Western Cape, South Africa) to the Addo National Park (Eastern Cape, South Africa) (www.edentoaddo.co.za) (Figure 3).

It is hoped that this goal will be achieved by linking the already-protected areas through stewardship agreements involving privately-owned and government-owned land to create a functional matrix landscape (Brunckhorst 2005). The protected areas that fall under this umbrella comprise of the following: (1) The Garden Route National Park, north of Knysna and north-west of Plettenberg Bay (Western Cape); (2) the Tsitsikamma National Park and the Formosa Nature Reserve, which straddle the Western Cape and the Eastern Cape; (3) the Baviaanskloof World Heritage Area, which falls predominantly in the Eastern Cape; (4) the Groendal Nature Reserve, which lies north-west of Uitenhage in the Eastern Cape; and (5) the Addo Elephant National Park, which lies north of Kirkwood in the Eastern Cape.

The vision of E2A is to;

"*assist land managers to identify and develop a living corridor from Eden To Addo by applying sound land-use practices, encouraging a diversity of livelihoods and linking ecologically important areas, for the benefit of wildlife and the extended community*." (www.edentoaddo.co.za)

Figure 3: Eden to Addo proposed corridor; comprised of the protected areas between the red stars and the pieces of land that connect them. The study area for the specific project is demarcated by the yellow oval

E2A is a civil society conservation initiative, with limited funding and resources. Understanding the broader social context of their planning region is a prerequisite to achieving their vision. We describe a social assessment conducted in a section of the proposed conservation corridor. The specific objective of the research was to test (or: carry out trials of) a method of pragmatic rapid social assessment, which, it was hoped, would provide 1) an overview of the regional context for implementing conservation action, and 2) data suitable for identifying or mapping feasible conservation opportunities to the conservation corridor (Knight and Cowling 2007, Knight et al. 2010). The study is considered to be a preliminary approach, aimed at assisting E2A to make scientifically-informed decisions that would be likely to improve the cost-efficiency and effectiveness of their operations.

3.3 Methods

3.3.1 Study Area

The Langkloof Valley potentially connects the Baviaanskloof World Heritage Area to the Tsitsikamma National Park (Figure 3). Although much of the land has been transformed for agricultural purposes, a fair portion of the rocky, mountainous land remains in its natural state (mostly because it is too steep or rocky and is therefore not arable). The area is therefore a vital link in the corridor between the two protected areas.

The study area was not chosen for the purpose of the project; rather the study area was predefined by the goals of the E2A project when it was initiated. The Langkloof Valley lies between the Kouga-Suuranys Mountains to the north and the Outeniqua Tsitsikamma Mountains, in the south in the southern Cape of South Africa (van der Mescht 2004). Forty percent of the land in the valley is used for agriculture, whilst one percent is urbanised (Lombard and Wolf 2004). There are a number of small agricultural towns that lie on the Route 62 (R62); the road that bisects the study area horizontally. The Baviaanskloof World Heritage Area lies North of the R62, while the Tsitstikamma National Park lies South (Figure 3). Of these towns, the largest is Joubertina (23°51'23.54"E; 33°49'31.539"S) which is elevated at 4931 feet (Falling Rain Genomics 2004). Some of the area (north of the R62) falls within the domain of the proposed larger Baviaanskloof mega-reserve (Steyn pers comm. 2010). The area is renowned for the production of apples, pears and citrus fruits but other land uses do take place (van der Mesch 2004; Hart et al. 2005; van der Merwe, pers. comm. 2009). Beef grazing occupies the eastern end of the valley (van der Merwe, pers. comm. 2009).

According to Geographical Information Systems (GIS) Information sourced from the South African National Biodiversity Institute (SANBI), there are 18 vegetation types that fall within the study area (including the vegetation in both of the protected areas) (Mucina and Rutherford 2005). The area is dominated by Langkloof Fynbos and Renosterveld Mosaic (See Appendix I for a full list of vegetation types in study area). Of the 18 vegetation types that were identified, five are endangered (Albany Alluvial Vegetation, Eastern Coastal Shale Band Vegetation, Garden Route Shale Fynbos, Humansdorp Shale Renosterveld and Langkloof Shale Renosterveld). Two of the vegetation types are vulnerable (South Outeniqua Sandstone Fynbos, Tsitsikamma Sandstone Fynbos) and all except two of them include endemic species in their vegetative composition (Mucina and Rutherford 2005) (Appendix I). The Sandstone Fynbos's tend to grow on ground comprised of acidic lithosol soils derived from sandstones of the Table Mountain Group as well as the quartzite sandstones of the Witteberg Group. The Shale vegetation groups grow on land that is comprised of clay derived from shales of the Cedarberg Formation and clays and loams derived from shales of the Nardouw Subgroup of the Table Mountain Group as well as the Ceres subgroup of the Bokkeveld Group. The soil types and characteristics are illustrated in Figure 4.

3.3.2 Survey methodology

An extensive literature review that was carried out before the social assessment was initiated resulted in a pre-defined set of human and social factors (Section 2); these factors formed the foundation of the questionnaire creation process (see Table 4 for definitions of factors that should be used to measure conservation opportunity). Open-ended questions pertaining to land management, environmental and other challenges were also included in the questionnaire.

The human dimensions for willingness-to-collaborate, burnout potential and champions were not included in the internal consistency or reliability statistical tests for the following reasons; when exploring the dimension of willingness-to-collaborate, likert statements were used whereby each potential collaborative organisation was scored by each land manager; all of the questions (or organisation) therefore needed to be considered.

The burnout potential measurement matrix that was used has been utilized extensively for a number of years; each land manager is not scored on an index from zero to one, rather, a categorical low, moderate or high result for each of three burnout potential genres is achieved. These groups are 1) personal accomplishment score, 2) emotional exhaustion and 3) depersonalisation subscale score (Maslach Burnout Inventory; Maslach 1996). The champions category was measured by asking each land manager one simple question; this one question was then used to build the indices for identifying champions.

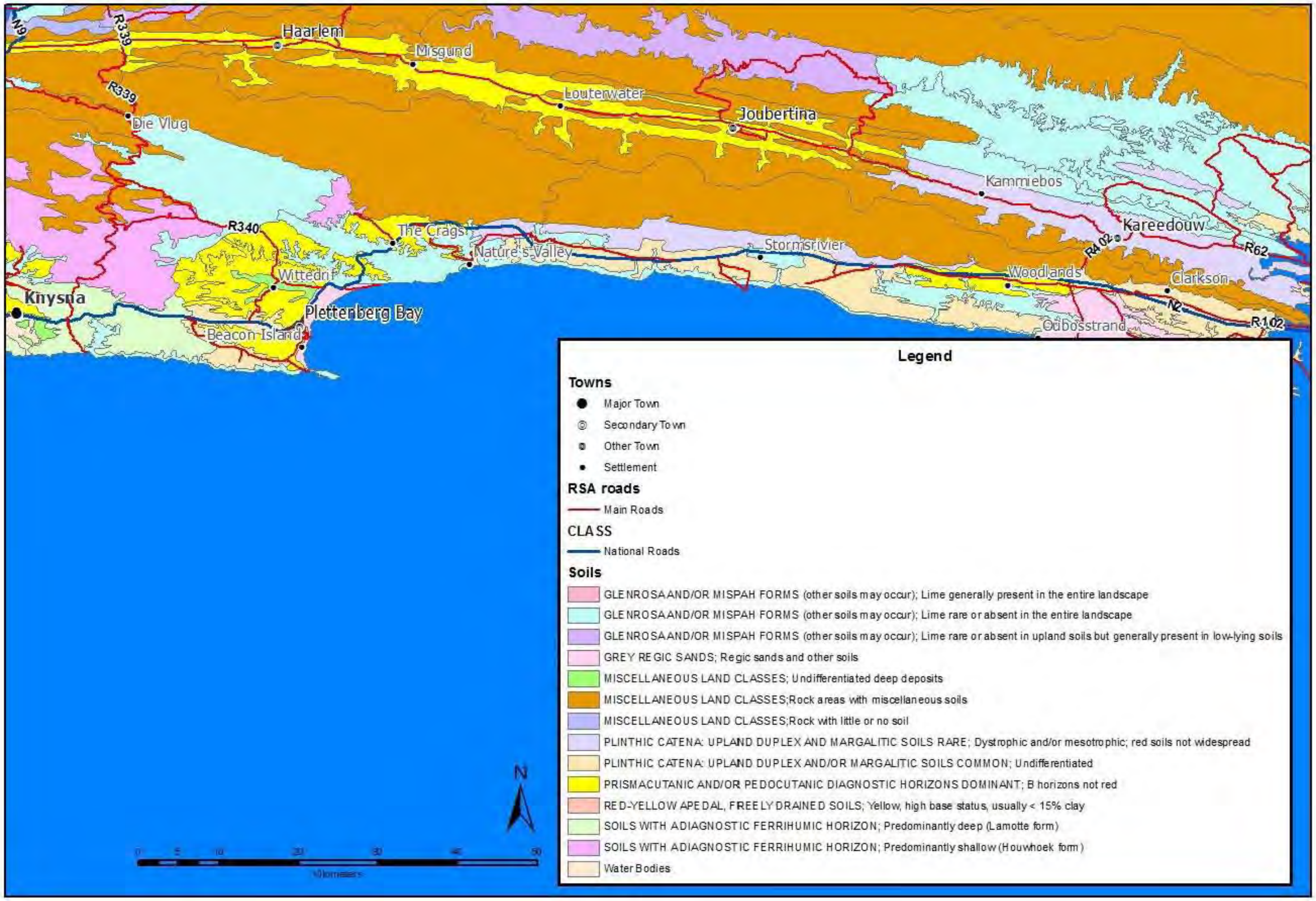


Figure 4: Soil types of the Langkloof and surrounding areas

A semi-structured questionnaire was developed to improve upon Knight et al. (2010), and was comprised of closed-ended questions (primarily Likert statements), which provided quantitative data mappable in a Geographical Information System (GIS) (ESRI 1999; ESRI 2009). Open-ended questions were also included to gather qualitative data. Draft questionnaires were revised by members of E2A, and subsequently piloted with five land managers. This version was subsequently revised, and the final questionnaire reviewed by several academics prior to conducting the final surveys. Questions regarding land managers financial concerns were deemed too sensitive, and so were avoided (*sensu* Cumming 2007; Winter et al. 2007; Knight et al. 2010).

The agricultural extension officer for the area explained that there are approximately 50 comparatively large-scale land managers in the Langkloof and created a list of 14 of the most influential individuals. Of these land managers, 12 were contactable and interviewed and a snowballing technique was used to contact a further 27 land managers. It would have been preferable to interview a larger number of land managers, but this was impossible due to time limitations and the lack of willingness of land owners to participate. The snowballing technique was semi-random; the interviewees were asked if they might know anyone else who is likely to be 'conservation-minded' or might be willing to be interviewed. Before the official interviews were carried out, a letter was sent out to introduce the interviewer to the land managers. Since the objective of the study was to perform a social assessment for the land managers in the Langkloof, it was essential that the land managers were met with in person. Homes were visited and personal characteristics, attributes and traits were recorded. Visiting the land managers was also beneficial in light of the fact that E2A are hoping to start building trusting relations with the land managers.

Each of the 39 land managers that were interviewed were visited (at their homes mostly) during August, September or October 2009. Interviews lasted 45 minutes to 2 hours, and sometimes included a tour of the property. Most of the interviews that were carried out were bilingual since many of the land managers in the Langkloof speak Afrikaans at home, but understand English.

3.3.3 Data Analysis

Quantitative data for each of the social factors measured (Table 4) were subjected to tests of internal consistency using Cronbach's ά (alpha) (Cronbach 1951), complemented by Revelle's β (beta) (Revelle 1979) and McDonald's $ώ_h$ (omega) (McDonald 1999). Although Cronbach's alpha is the most widely used measure of internal consistency, it tends to over-estimate the internal consistency of a sub-set of questions when the answers reflect multiple dimensions (Zinbarg et al. 2005). Under such conditions, Zinbarg et al. (2005) have shown that McDonald's omega is the most reliable measure of internal consistency. Using both coefficients helps to ensure that the data set chosen for analysis is robust, since equivalence between Cronbach's alpha and McDonald's omega only occurs under highly restrictive conditions (Zinbarg et al. 2005). Beta and omega values for various combinations of subsets of questions for each of the dimensions were calculated and the best combinations of questions were chosen to build indices for each factor. Acceptable thresholds of internal consistency depend on the context of the research and the proposed application of it. After reviewing the relevant literature, Knight et al. (2010) concluded that values higher than 0.60 are acceptable for omega co-efficients in applied contexts, while acceptable thresholds for alpha and beta in the same contexts is 0.80 and 0.70 respectively.

As a further guide to selecting subsets of questions (and hence answers) for further analysis, the RV-coefficient (Robert and Escoufier 1976) was used to assess how much of the informational content of the full survey-results different subsets of questions captured. Personal observation shows that different subsets of questions within acceptable ranges of reliability and internal consistency quite often capture different amounts of the original data. The value of the coefficient was therefore traded-off with the number of questions included in the subset to choose subsets of questions that included the least number of questions but that represented an acceptable level of informational content while still having an acceptable level of reliability and internal consistency. Table 5 shows a summary of the best combination of factors for each of the dimensions measured, based on this system of selection. Hence, these subsets of questions were chosen because they have the optimal measures of McDonald's omega, Revelle's beta, and Robert and Escoufier's RV coefficients.

Indices for the factors listed in Table 5 were developed following the four steps outlined by Babbie (2001) for index-construction: i) select factors (dimensions) to be measured, ii) allocate scores to the factors, iii) combine reliable factors into an index, and iv) validate the index by studying their relationships. The factors that were chosen for indexation cover those dimensions that reflect (or that are likely to reflect) the feasibility of implementing effective conservation-action in the area and opportunities for doing so (Table 4).

Statistical analyses were carried out using R (R Development Core Team 2010), supplemented by the following contributed packages; McDonald's omega coefficient was calculated using the *psych* package (Revelle 2009), whereas the RV-coefficient was calculated using the *subselect* package (Cerdiera et al. 2007). For each land manager, an index with a continuous scale ranging from 0 to 1 (Table 6) was developed for each factor. It is assumed that land managers with higher scores behave in a more "conservation-friendly" manner.

3.3.4 Index validity

Three forms of validity should be considered in order to create robust indices; Content validity, face validity and construct validity (see Winter et al. 2005). In order to ensure validity of content, extensive research was done on the possible measures of conservation opportunity, and what best defines these measures. Discussions around the topic were also carried out with academics that have had first-hand experience in measuring such dimensions. These discussions also helped to refine the level of face validity (Babbie and Mouton 2001; Winter et al. 2005) which was checked when statistical analyses were carried out (i.e. the logical relationships among the factors). The factors and dimensions that were chosen proved to establish both face and construct validity since all of the dimensions were relevant.

Basic descriptive statistics were carried out on the qualitative data in order to identify general trends in land manager characteristics. Correlation analyses and chi^2 tests (StatSoft 2009) were also carried out to determine trends in, and correlations and relationships between, land managers thought patterns and behaviour. A holistic social database for land managers in the Langkloof was formulated.

3.4 Results

3.4.1 Index components and discarded dimensions

For five of the human dimensions, less than half of the original question count was used and for conservation behaviour, only four of the 23 original questions were required to build the index (Table 5).

3.4.2 General land Manager Characteristics

All of the land managers that were interviewed were male. The age range was between 30 and 67, but the majority of them (n = 22) were between the ages of 40 and 60. Although all of the land managers that were interviewed were white, 82% (n = 31) of them classified themselves as being of the Afrikaans race (the remainder classified themselves as English). The majority of land managers were married (n = 32) and of those who were married, 75% (n = 29) had two or more children. One third (n = 13) of the land managers that were interviewed had achieved a diploma in agriculture, whilst just over one third (n = 14) attained a full university degree (two of these land managers finished with a masters degree). The highest level of education that the remainder of the land managers had accomplished was a matric.

Table 5: Revelle's beta, McDonalds omega and RV co-efficients for human factors that define conservation opportunity

Factors	**Questions**		**Coefficients**		
			Internal Consistency		Reliability
	Question Reduction	Specific Questions	beta	omega	RV
Conservation knowledge	15 to 6	1,2,6,7,14,15	0.66	0.60	0.76
Conservation behaviour	23 to 4	9,10,17,18	0.67	0.86	0.69
Willingness to adopt conservation friendly methods	8 to 3	1,2,7	0.79	0.82	0.77
Willingness to participate in stewardship agreements	7 to 4	1,2,3,4,6	0.65	0.67	0.92
Willingness to make trade-offs for conservation	6 to 3	1,2,3	0.81	0.89	0.89
Willingness to accept incentives	8 to 4	1,2,8,5	0.70	0.82	0.85
Likelihood of selling property	3 to 2	1,2	0.86	0.69	0.87

Just under half of the land managers that were in interviewed have lived on their lands for 30 years or longer (n = 18), 72% of which have lived on their property for their whole life (n = 13). Almost half (n = 17) of the land managers belong to families that have been farming in the area (the Langkloof Valley) for four or more generations.

As illustrated in Figure 5, more than half of the land managers that were interviewed carry out fruit or crop production as their predominant form of income; of this large portion of land managers that rely on fruit/crop production, 67% (n = 14) of them are apple producers.

3.4.3 Factors of Conservation Opportunity

Land managers generally achieved higher than average scores for all of the factors of conservation opportunity, except for champions and likelihood of selling their property. These average scores for the factors suggest a high level of conservation opportunity in the Langkloof.

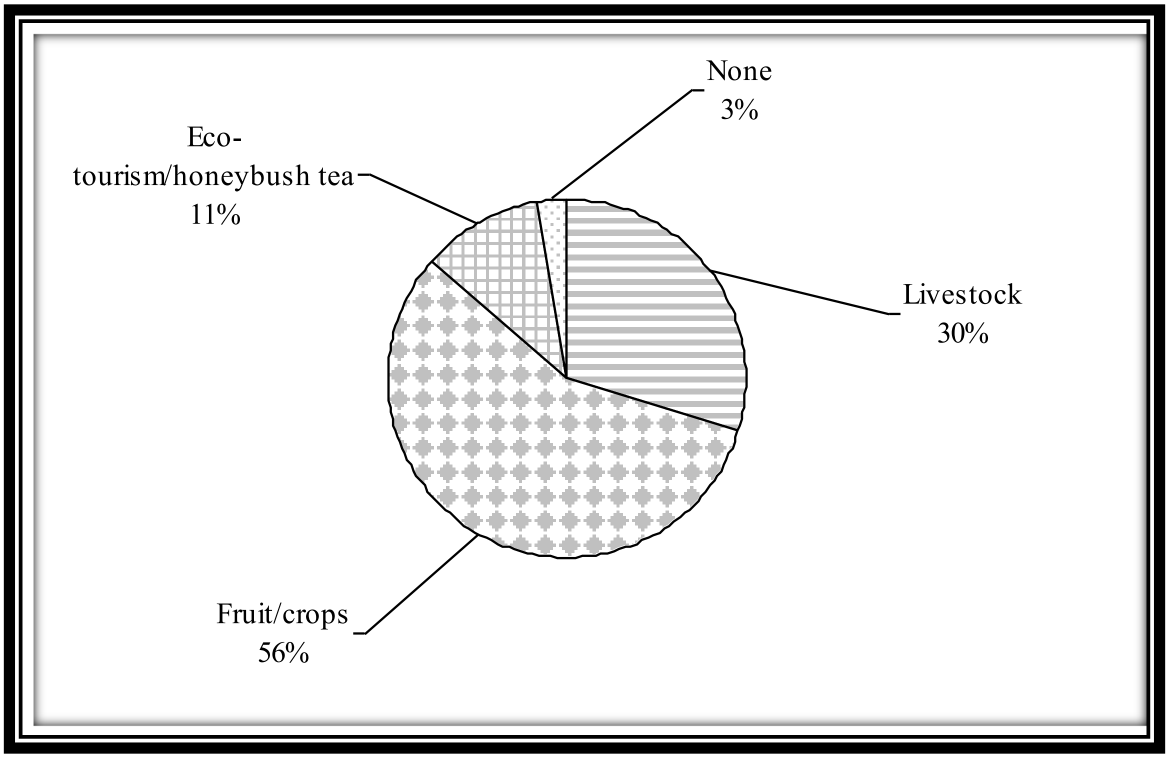


Figure 5: Pie chart showing the proportions of landowners who carry out various land uses for their predominant form of income

Table 6: Average scores achieved, minimum and maximum values and standard deviation for the human and social factors that were measured

Human / Social measure	Average score	Min. score achieved	Max. score achieved	Standard deviation
Conservation knowledge	0.587	0	1	0.317
Conservation behaviour	0.546	0	1	0.313
Willingness-to-collaborate	0.672	0.39	0.95	0.149
Willingness to adopt conservation friendly methods	0.839	0.33	1	0.146
Willingness to participate in stewardship agreements	0.789	0.44	1	0.146
Willingness to make trade-offs for conservation	0.788	0.4	1	0.15

Willingness to accept incentives	0.841	0.6	1	0.118
Likelihood of selling property	0.362	0.2	0.8	0.206
Champions score	0.146	0	1	0.229

3.4.3.1 Conservation Knowledge and Behaviour

The mean conservation knowledge score for land managers in the Langkloof is 0.587 (Table 6) but the scores achieved ranged from 0 to 1. Land managers generally knew about the local floral biomes (Fynbos) and its importance. Most of them also expressed a sound knowledge about the animals that inhabit the vegetation but their knowledge pertaining to vegetation on a larger scale (i.e. the biomes of South Africa) was lacking. 82% (n = 32) of the land managers interviewed said they were aware of alien plants that occur (or had occurred) on their property.

Although the mean score for conservation behaviour was only slightly less than that of conservation knowledge, when each of the factors was looked at individually it was clear that conservation friendly behaviour is not a priority amongst land managers. The individual scores for conservation behaviour that the land managers achieved ranged between 0 and 1. There are very few land managers in the Langkloof who are certified organic land managers, or who chose to implement organic methods. It can be deduced, after chatting to the land managers, that conservation friendly behaviour is only truly adopted willingly when there is a financial capital surplus available to do so, or if the actions benefit production and income. This is fitting with the findings of Gasson and Potter (1988) who found that land managers whose farming methods are more conservation orientated, and who are not restrained by financial capital, are most interested in conservation schemes (Beedell and Rehman 1999). 61% (n = 23) of the land managers expressed that if there were viable conservation friendly alternatives to certain farming practices, they would use them

3.4.3.2 Willingness-to-Collaborate

The mean score achieved for land manager's overall willingness-to-collaborate with government agencies, conservation agencies and academics was 0.672, with the lowest score being 0.390 and the highest being 0.950. Trends were noticed in terms of which organisations or groups of people land managers are more willing to collaborate with; district and local municipalities scored the lowest for willingness-to-collaborate (0.502), while land managers seem quite happy to collaborate with members of academic institutions (mean score = 0.782). The organisations that proved to have the most amount of respect and trust amongst the land managers, and that therefore scored very highly in terms of collaboration potential were the land managers associations (mean score = 0.847). The mean level of willingness-to-collaborate score that land managers expressed towards conservation agencies was 0.664.

3.4.3.3 Willingness to Participate

Land managers scored highly in terms of their overall willingness to adopt conservation-friendly farming practices (mean = 0.839, min = 0.330, max = 1). 87% (n = 34) of them expressed an interest in finding out how to farm in a conservation friendly way. 85% (n = 33) of the land managers said that they would prefer to use greener technologies in their farming practices if it becomes readily available and affordable. When asked about becoming involved in a conservation forum of like-minded land managers, half of the land managers expressed a keen interest to do so.

Based on what land managers stated in interviews, the Langkloof seems to be fairly opportunistic in terms of conservation with the overall average willingness of land managers to adopt conservation instruments being 0.789. The lowest overall score was 0.440 and the highest score achieved was 1 (the maximum possible). As expected, more land managers strongly agreed that they would consider becoming involved in a voluntary conservation agreement (n = 20) than those that would strongly consider a binding conservation agreement (n = 7), but overall, more than half of the land managers (n = 21) said they would consider, to some extent, becoming involved in a binding conservation agreement.

The mean score for willingness of land managers to make trade-offs for conservation is very similar to that achieved in willingness to adopt conservation instruments (0.786). More than 60% (n = 24) of the land managers agreed they would consider making various forms of trade offs for the sake of conservation.

As expected, land managers generally showed a keen interest in accepting incentives to carry out activities that benefit conservation (score = 0.841), but many of them mentioned that they didn't think the infrastructure exists in this country, or in their area, for promises relating to incentives to be delivered. The incentives are listed, and ranked, in Table 7.

Although the incentives were subject to ranking, a huge difference in the preference of various incentives was not expressed (standard deviation for scores achieved by each of the incentives is 0.007).

3.4.3.4 Champions

Two major champions in the Langkloof were identified; one of them was mentioned five times while the other was mentioned three times by other land managers

Table 7: Overall ranking of possible incentives by land managers in the Langkloof Valley

Incentive	Rank
Priority alien plant removal by Working for Water	1
Access to information regarding best management practices	2
Direct financial incentives (pay-outs)	2
Tax rebates	3
Land rates rebates	4
Access to a support network of like-minded managers	5
Extension officer support	6
Access to ecotourism infrastructure support	6

*Items in *italic* did not achieve acceptable scores for internal consistency and/or reliability (Table 5)

3.4.3.5 Burnout

An important aspect of the social assessment that was carried out was to identify land managers that display beneficial characteristics for involvement in conservation projects. It was therefore essential to attempt to measure the level of enthusiasm that land managers show for projects or their work, and how capable or ambitious they are when trying to achieve certain goals. The measure of personal accomplishment that land managers in the area expressed was not good (Figure 6) as most of the land managers interviewed articulated that they have a high level of emotional exhaustion (n = 35) and more than half of the land managers (n = 20) expressed that they feel they have a low level of personal accomplishment. Only 16.2% of the land managers (n = 6) feel that they have done well in the field of personal accomplishments. The only aspect of the burnout measurement that land managers scored better in was that of depersonalization; most of the land managers (n = 22) achieved a low depersonalization subscale score which suggests that they feel they are in control in terms of their lifestyle, management and businesses choices.

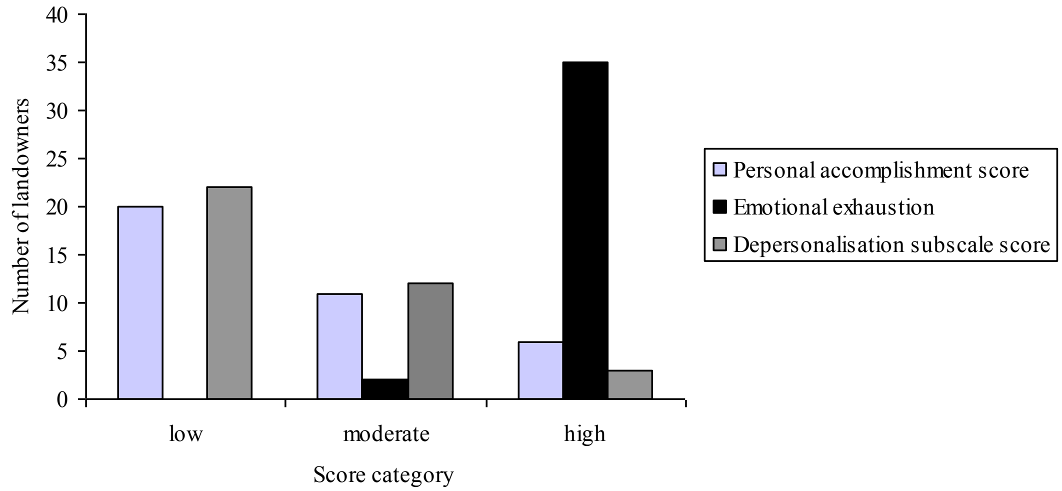


Figure 6: Summary of landowner's professional life measures

3.4.3.6 Likelihood of selling property

The likelihood of land managers to sell their properties in the Langkloof gained the lowest mean score (0.362). When asked directly whether land managers were thinking about selling their property, only 8% (n = 3) said that they were.

3.4.4 Causal relationships

Table 8 displays the correlations that were noticed in the data set; although it cannot be positively stated that a factor or characteristic leads to another factor, a number of relationships between factors were noticed, some of them highly significant.

Conservation knowledge is significantly related to conservation behaviour and willingness to adopt conservation friendly practices ($r = 0.388$; $p < 0.050$ and $r = 0.393$; $p < 0.050$ respectively). Conservation behaviour is significantly related to willingness-to-collaborate ($r = 0.385$; $p < 0.050$) and willingness to adopt conservation instruments ($r = 0.360$: $p < 0.050$), while it is very highly significantly related to willingness to adopt conservation strategies and willingness to make trade-offs for the purpose of conservation ($r = 0.533$; $p < 0.001$ and $r = 0.622$; $p < 0.001$ respectively).

Table 8: Correlations between the social factors for which indices were built

	C K	C B	W C	W P 1	W P 2	W P 3	W P 4	L S P	CH
C K	1.000								
C B	0.388*	1.000							
W C	0.090	0.385*	1.000						
W P 1	0.393*	0.533***	0.497**	1.000					
W P 2	0.280	0.360*	0.481**	0.556***	1.000				
W P 3	0.255	0.622***	0.434**	0.645***	0.531***	1.000			
W P 4	0.077	0.141	0.489**	0.648***	0.536***	0.359*	1.000		
L S P	-0.084	-0.227	-0.261	-0.177	-0.294	-0.313	-0.169	1.000	
CH	0.037	0.208	0.223	0.132	0.400*	0.355*	0.267	-0.150	1.000

(* p < 0.05 ** p < 0.01 *** p < 0.001)

* CK = Conservation Knowledge; CB = Conservation Behaviour, WC = Willingness-to-Collaborate; WP 1 = Willingness to Participate 1 (Willingness to adopt conservation friendly methods); WP 2 = Willingness to Participate 2 (Willingness to make trade-offs for the sake of conservation); WP 3 = Willingness to Participate 3 (Willingness to adopt conservation instruments); WP 4 = Willingness to Participate 4 (willigness to accept incentives that encourage participation in instruments/'conservation-friendly' behaviour); LSP = Likelihood of Selling Property; CH = Champion

Willingness-to-collaborate is highly significantly related to willingness to adopt conservation friendly practices (r = 0.497; p < 0.010), willingness to adopt conservation instruments (r = 0.481; p < 0.010), willingness to make trade-offs for conservation (r = 0.434; p < 0.010) and willingness to accept incentives for conservation (r = 0.489; p < 0.010). Willingness to adopt conservation friendly practices is very highly significantly related to willingness to adopt conservation instruments (r = 0.556; p < 0.001), willingness to make trade-offs for conservation (r = 0.645; p < 0.001) and willingness to accept incentives for conservation (r = 0.648; p < 0.001). Willingness to adopt conservation instruments is very highly significantly related to willingness to make trade-offs for conservation (r = 0.531; p < 0.001) and willingness to accept conservation incentives (r = 0.536; p < 0.001). Willingness to make trade-offs for conservation is significantly related to willingness to accept conservation incentives (r = 0.359; p < 0.050) and champion score (r = 0.355; p < 0.050).

Chi-squared tests revealed that the length of time that a land manager has been farming for has a significant relationship with conservation knowledge ($X^2 = 11.170$; $p < 0.050$) and willingness to accept incentives for conservation ($X^2 = 11.740$; $p < 0.050$) (Table 9). The most significant relationship noticed in the chi-squared test results is that between the predominant farming method that a land manager carries out and his conservation behaviour ($X^2 = 16.444$; $p < 0.001$), predominant farming method is also significantly related to willingness to make trade-offs for conservation ($X^2 = 10.468$; $p < 0.050$). A significant relationship is also noted between age and willingness-to-collaborate ($X^2 = 11.300$; $p < 0.050$).

Table 9: Results of the chi-squared tests carried out to determine whether significant relationships between the categorical and index factors exist

	C K	C B	W C	W P 1	W P 2	W P 3	W P 4	L S P	CH
Predominant farming method	4.493	16.444**	2.000	1.778	6.656	10.468*	7.647	4.232	5.420
Length of time been living on farm	11.170*	3.770	2.058	2.990	5.468	1.176	11.740*	4.447	1.942
Number of generations family has lived in the Langkloof	8.805	3.118	8.452	2.454	2.997	1.899	3.875	3.926	2.019
Age	2.309	3.211	11.300*	3.801	7.134	5.920	2.971	3.818	3.818
Culture	2.387	0.012	0.489	2.399	1.039	1.205	0.171	1.300	0.626
Highest level of education achieved	2.510	2.959	1.387	0.923	6.590	1.221	4.579	2.362	7.626

(* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$)

3.5 Discussion

3.5.1 Land Management Challenges

The most prominent challenge that was mentioned was water shortages and second was weather extremes in general. This is fitting with recent weather patterns; in 2007 floods devastated the area, while in 2009 a 50% decrease in fruit production was expected as the Eastern Cape and part of the Western Cape experienced what has been explained as the worst drought in 50 years (SABC news 2009). Only three challenges were deemed as having larger than average impacts on farming activities (water shortages, weather extremes and lack of capacity of staff). An interesting aspect that was noted was that two challenges that had almost equal scores in terms of their impact on farming were “too many fires” and “not enough frequent fires”. After chatting to the land managers it was determined that fires threaten their income if they happen in an uncontrolled manner, which happens too often and is a huge problem in the area. On the other hand, controlled burns are necessary in the area due to the dry composition of the vegetation in the winter, and the fact that the Fynbos biome is reliant on fire as a germination inducer (Ferreira 2010 pers. comm.; van Huisteen 2010 pers. comm.).

3.5.2 Conservation Opportunity in the Langkloof

Understanding the social context of a planning region is essential, not only for understanding pressures upon valued nature, but also for identifying opportunities and constraints upon implementing effective conservation action. This is particularly important in regions where prospective conservation action will be on private land. The E2A corridor will only be effectively established if land managers agree to become part of the envisaged stewardship initiative; it is therefore most feasible to design the initiative in light of the values and goals of land managers.

Many land managers knew little about, or how get involved in, conservation activities; there are few such opportunities in the Langkloof. All of the land managers that were interviewed, except one, expressed an interest in conservation, although each expressed different levels of interest. The past several years have been financially challenging for land managers due to extreme weather patterns, with several land managers battling to “make ends meet”. Financial constraints are therefore the most significant hindrance to the implementation of conservation action (which often requires financial capital). However, most land managers are more than happy to become involved in conservation initiatives if assisted with information and financial support, or if at least “met half way”. The three land managers who are most prominently and actively involved in conservation activities own property within, but do not live in, the Langkloof. Their primary income is derived off-farm, suggesting financial stability, or wealth, is associated with the adoption of conservation practices (e.g. Gasson and Potter 1988; Plieninger et al. 2004; Kabii and Horwitz 2006).

Farming method is an indicator of conservation behaviour; land managers involved in eco-friendly ventures (e.g. eco-lodges) all scored highly for conservation behaviour and land managers running livestock generally scored higher for conservation behaviour than crop or fruit producers.

Many land managers welcomed the opportunity to voice their opinions on conservation. Land managers exhibited varying levels of enthusiasm about the few conservation initiatives currently operating in the

Langkloof; some have had negative experiences in the past, leaving them questioning the benefits of becoming involved in these initiatives. Land managers frequently expressed that they feel that members of conservation agencies have not succeeded in understanding and empathising with them; conservation might be an important concept for land managers, but income is their highest priority.

When questioned about shooting pests or animals that threaten their income, many livestock land managers explained that they do not shoot animals regularly as not all of them are "problem animals", but once a "problem animal" does emerge they have no choice but to kill it to protect their stock. Initiatives have been introduced where members of a conservation NGO trans-locate problem animals. Land managers all agreed that this was their preferred option for dealing with problem predators. If conservation officials or members of conservation organisations expect land managers never to shoot predators, they need to satisfy land manager's needs by fulfilling their promises of trans-locating problem animals, or compensating for livestock that is lost. The same might apply to fruit and crop producers who have no choice but to shoot baboons or wild boer that damage or eat their produce.

The flow of information between land managers and people involved in conservation is mostly one-way; land managers feel they are instructed on how they should manage their land. Many of them have gathered very useful knowledge about the land since their families have been living in the area for a number of generations (up to ten generations). The "greenies" (conservation officials) need to take the time to genuinely listen to land managers and spend time discussing the barriers to the adoption of conservation friendly practices. Land managers should also be given the opportunity to express how they feel they can contribute to, and benefit from, conservation (Jacobson et al. 2003).

The study explained identifies the threats and needs that land managers in the Langkloof experience. It also identifies those land managers who are more likely to become involved in conservation instruments; this information can be complemented with ecological information pertaining to the area to facilitate informed opportunism (Knight and Cowling 2007; Pressey and Bottrill 2008; Knight et al. 2010).

3.5.3 An Optimal Instrument Mix

At this point land managers in the Langkloof know very little about conservation instruments or stewardship agreements, but are willing to explore them. The majority of land managers expressed that they would rather be involved in voluntary conservation agreements than binding ones but more than half (54%; n = 21) of the landowners stated that they might be willing to become involved in a binding agreement and would not require incentives.

There is a negative perception amongst the land managers regarding signing agreements that bind their property to another governing body; many of them stated that they would not like to be told what to do on their own land. The conservation instruments that are being promoted by large environmental bodies are Voluntary Agreements, Management Agreements and Contract Reserves (Botha pers. comm. 2010). An option that may be more appealing to landowners, and that E2A is piloting with interested landowners, is a Protected Environment (Provided for by The Protected Areas Act (no. 57 of 2003)) (Booth pers. comm. 2010) since landowners may draw up their own management plan in partnership with a conservation agency. There is also more flexibility in terms of the restrictions on land use and, only if the landowner wishes, are conditions of the agreement written into the title deed for the land and are binding for successors of the land (Booth pers. comm. 2010). In short, the land manager has much more control over his land in the present and the future.

A Protected Environment does have possible tax incentives, but it seems the most desirable incentive for land managers is priority clearing of alien plants by the 'Working for Water' Project. E2A should engage with government officials and those responsible for administrating the Working for Water project in order to see if they can negotiate for this incentive to materialise somehow (i.e. to explore whether those landowners who enter into agreements should be prioritised with regards to Working for Water activity)

Knowler and Bradshaw (2007) describe two basic categories of assistance that either E2A or relevant government bodies (or both) should aspire to fulfil. (1) Assistance in terms of sharing knowledge with land managers about conservation opportunities, and technical assistance; a member of E2A should try to attend land managers association meetings and engage with the land managers. (2) Financial incentives; research has already been done on the topic of 'payment for ecosystem services' (PES) for land managers living in the Baviaanskloof World Heritage Area and surroundings (Powell et al. 2009); this research should be expanded or implemented on-the-ground.

3.5.4 Recommendations for Conducting Social Assessments

Significant lessons have been learnt from this, and earlier work. It is not sufficient to just send out surveys to land managers; specific goals need to be measured against and social learning should be encouraged by meeting with and listening to the land managers. Conservation opportunity is a useful conceptual framework, but it is context specific – a land management model therefore needs to be applied (Knight et al. 2006a). Future social research should be done in the area in order to explore the perceptions that land managers hold in terms of their role in environmental management and conservation, and how it can be bettered (Davies and Hodge 2007). Table 10 lists recommendations, based on the lessons that were learnt in the field, for carrying out future social assessment's in a similar context (some apply to a variety of contexts).

Table 10: Recommendations for future social assessments

Recommendation		Rationale
1	Interviewers should try not to be biased or to express their opinions concerning conservation	Land managers may not be comfortable expressing their true opinions if they are aware of the interviewer's pro-environmental/"greenie" mind-set.
2	Interviewers should strive to inform themselves about contemporary issues that may have affected, or that may still be affecting, the land.	If the interviewer is sufficiently well informed to be able to discuss issues and events with land managers then land managers might be more inclined to trust the interviewer. Land managers are likely to feel that informed interviewers have taken a genuine interest in them and their predicaments.
3	Interviewers should enter into an interview expecting to learn from the land managers and should take an interest in the conservation/environmental opinions that the land managers have.	In some cases, land managers belong to families that have lived on the land, and have relied on its resources, for several generations. They are therefore likely to possess knowledge on local ecological conditions that is valuable, and which should not be ignored and should be carefully documented.

3.6 Conclusions

Literature has emphasised the fact that land managers play an integral role in conservation planning due to the land that they own or manage, on which important biodiversity exists. Land managers therefore need to be encouraged as active participants in conservation planning processes.

Social assessments, such as this one that was carried out for land managers in the Langkloof, are an essential pre-requisite to any conservation planning scheme since they provide an understanding of the context in which a project is to be initiated. A general environmental conscience was noticed throughout the Langkloof, but in most cases the land managers need to be better informed about how they can contribute to conservation goals; education should be the responsibility of conservation organisations.

Members of conservation organisations need to listen to, and learn from, land managers to find out what their needs or threats are and to gain local knowledge about the area from a land manager's perspective. Many land managers are restricted in terms of resources and it is therefore difficult for them to implement more conservation friendly practices. A system needs to be developed where land managers can be supported with incentives and information. Opportunities exist for establishing a conservation corridor in the Langkloof between the Tsitsikamma National Park and the Baviaanskloof World Heritage Area if a feasibility optimal instrument mix is developed. A spatial prioritisation, that includes social factors, should be conducted to identify the optimal route between these protected areas.

4 OPPORTUNITY AND CONNECTIVITY: SELECTING LAND MANAGERS FOR INVOLVEMENT IN A CONSERVATION CORRIDOR IN THE LANGKLOOF VALLEY, SOUTH AFRICA

4.1 Abstract

The integration of conservation activities on private land into broader conservation schemes has been viewed as a fundamental aspect to achieving landscape-scale conservation. Such types of conservation include conservation corridors. These corridors often traverse private and government land to link protected areas; the decisions made by land managers in terms of whether to become stakeholders or not, and their consequent actions, therefore often determines the effectiveness of corridors. The inclusion of human and social data that constitutes opportunity for conservation specifically is vital when designing a conservation corridor. In this analysis, Human data was collected for the Langkloof Valley in the Eastern and Western Cape, South Africa. It was integrated with existing ecological data to carry out systematic least-cost corridor analyses (giving the human and ecological data different weightings in three different scenarios) to link the Baviaanskloof World Heritage Area and the Tstitsikamma National Park. One dominant least-cost corridor was noticed in the Western region of the Langkloof in all of the scenarios, with the other areas of highest linkage value (least-cost) varying slightly between scenarios. Land managers were also scheduled for conservation action based on their scores for quantitative conservation opportunity data that was collected in the field, a cluster analysis that was carried out and their position in relation to the least-cost corridors identified. The conservation planning actions were part of a larger corridor initiative (the Eden To Addo Corridor Initiative).

Keywords: conservation opportunity, conservation planning, corridor design, implementation, least-cost path analysis, spatial prioritisation

4.2 Introduction

Integrating the management of formally protected areas and private land into conservation strategies is acknowledged as fundamental to achieving landscape-scale conservation (Polasky et al. 1997; Doremus 2003; Gallo et al. 2009). Much important biodiversity exists on private land; attempts should therefore be made to conserve it (Polasky et al. 1997; Botha 2001b; Doremus 2003). A number of landscape conservation approaches have been developed promoting the integration of diverse land-uses, including Biosphere Reserves (Kusova 2008), Natural Heritage Sites, conservation corridors (Rouget et al. 2006; Conservation International 2010) and mega-conservancy networks (Rouget et al. 2006). Under these schemes, land managers may be offered stewardship agreements (Dobbs and Pretty 2004; Winter et al. 2007) such as Biodiversity Agreements, Protected Environments and Private Nature Reserves (Botha 2001b; Botha 2004). Effective collaboration between land managers and conservation officials is fundamental to ensuring that conservation goals are achieved.

Landscape-scale conservation areas, such as Conservation International's conservation corridors or Rouget et al.'s (2006) mega-conservancy networks explicitly aim to maintain ecological and evolutionary processes by maintaining connectivity. Corridors are "linear habitats, embedded within a dissimilar matrix, that connect two or more larger blocks of habitat and that are proposed for conservation on the grounds that it will enhance or maintain the viability of specific wildlife populations in the habitat blocks" (Beier and Noss 1998). Corridors were introduced in the 1940's as a tool for game management (Chetkiewicz et al. 2006). In more recent times, they have been promoted as fulfilling conservation requirements more effectively than isolated areas since the element of connectivity is introduced at a range of spatial and temporal scales (Bennett 2003). This allows for certain large and small scale flows and processes that are imperative for biodiversity functioning to occur (Lass and Reusswig 2002; Rouget et al. 2006). Corridors also counter the effects of habitat fragmentation and habitat loss, two actions which are seen as pertinent threats to biodiversity (Chetkiewicz et al. 2006). By decreasing habitat fragmentation within the corridor area, inter-patch connectivity is promoted which is a crucial factor in the persistence of populations of animals and their migratory patterns (Ferreras 2001). Animals may depend on conservation corridors for movement between breeding and/or feeding areas when the remaining land in a particular region is not conducive to wildlife movement (Beier et al. 2008; Lagabrielle et al. 2009). Such conservation areas have also been viewed as tools that may aid fauna in adapting to climatic and other environmental changes since they include a range of environmental gradients (Beier and Noss 1998; Chetkiewicz et al. 2006; Rouget et al. 2006; Killeen et al. 2008).

Corridors often traverse, or require the inclusion of, privately owned land to link formally protected areas (Rouget et al. 2006; Whitelaw and Eagles 2007; Gurrutxaga et al. 2010). In this context, the effectiveness of conservation corridors as linkages between wildland habitats is not only highly dependent upon ecological connectedness, but also on the willingness and capacity of land managers to engage with conservation organisations and in stewardship agreements. Whilst ecological information has been widely used for designing conservation corridors (Beier and Noss 1998; Williams et al. 2005; Rouget et al. 2006), no studies have incorporated spatially-explicit information pertaining to human and social factors that define opportunities for effectively implementing conservation action in the spatial prioritisation process. Such information is essential for 1) ensuring that areas which can be feasibly implemented are identified (Lombard et al. 2010; Knight et al. 2010; Game et al. in press), and 2) avoiding the need to repeat spatial prioritisations when it is found that there is little overlap between ecologically important sites and feasible implementation sites (Knight et al. 2010; Knight et al. in press; Game et al. in press).

Mapping conservation opportunity during the design stage of conservation corridors allows for the translation of maps of important areas for achieving conservation goals, into effective conservation action (Knight et al. 2010). Conservation opportunity is context specific and looks at complex and "real-world" factors (Knight and Cowling 2007), necessitating assessment on a case-by-case basis (Knight et al. 2010, Section 3). It is defined by the social context in which a conservation initiative is situated, governance structures, existing conservation programmes, land-use, economies at various scales, culture (see Cocks 2006), and behaviour patterns of land managers, and other factors (Cowling et al. 2004). It has been hypothesized to comprise of (at least) five broad values – landscape value, vulnerability, economic costs, and human and social capital (Knight et al. 2010). Mapping conservation opportunity potentially increases the effectiveness of conservation planning initiatives, and provides an operational mechanism for bridging the research-implementation gap (Knight et al. 2008) through the inclusion of factors that define implementation effectiveness in spatial prioritizations. A map of conservation opportunity not only defines where and when a conservation initiative should be implemented, but also the specific instruments that should be implemented (Pence et al. 2003, Wilson et al. 2007). The identification of spatially-explicit conservation opportunities promotes implementation of "informed opportunism" (Noss et al. 2002; Knight & Cowling 2007; Game et al., in press), which accelerates implementation and secures deeper land manager buy-in (Knight et al. 2010).

The Eden to Addo Corridor Initiative (hereafter E2A,) is a conservation corridor initiative that aims to connect coastal areas within the Eden Municipality near Plettenberg Bay, South Africa, to the inland Addo National Elephant Park (Figure 3). We detail efforts to plan a connection through the agricultural landscapes of the Langkloof Valley in the most westerly extent of the E2A planning region, specifically between the coastal Tsitsikamma National Park and the Baviaanskloof World Heritage Area (Figure 3).

This work was designed to deliver a simple, rapid spatial prioritisation, which will direct the activities of an E2A stewardship extension officer, and the organisations strategic vision. It integrates the theory and practice of spatially-explicit corridor design (*sensu* Rouget et al. 2006) and conservation opportunity (*sensu* Knight et al. 2010).

4.3 Methods

4.3.1 Study area

The Langkloof Valley lies between the Kouga and Kamanasie mountain ranges in the southern Cape of South Africa (van der Mescht 2004). Forty percent of the land in the valley is used for agriculture, whilst one percent is urbanised (Lombard and Wolf 2004). There are a number of small agricultural towns that lie on the Route 62 (R62); the road that bisects the study area horizontally. The Baviaanskloof World Heritage Area lies north of the R62, while the Tsitstikamma National Park lies South. Of these towns, the largest is Joubertina (23°51'23.54"E; 33°49'31.539"S) which is elevated at 4931 feet (Falling Rain Genomics 2004). Some of the area (north of the R62) falls within the domain of the proposed larger Baviaanskloof mega-reserve (Steyn pers comm. 2010). The area is renowned for the production of apples, pears and citrus fruits but other land uses do take place (van der Mesch 2004; Hart et al. 2005; van der Merwe, pers. comm. 2009); beef grazing occupies the eastern end of the valley (van der Merwe, pers. comm. 2009).

According to Geographical Information Systems (GIS) Information sourced from the South African National Biodiversity Institute (SANBI), there are 18 vegetation types that fall within the study area (including the vegetation in both of the protected areas) (Mucina and Rutherford 2005) being dominated by Langkloof Fynbos and Renosterveld Mosaic (See Appendix I for a full list of vegetation types in study area). Of the 18 vegetation types identified, five are endangered (Albany Alluvial Vegetation, Eastern Coastal Shale Band Vegetation, Garden Route Shale Fynbos, Humansdorp Shale Renosterveld and Langkloof Shale Renosterveld). Two of the vegetation types are vulnerable (South Outeniqua Sandstone Fynbos and Tsitsikamma Sandstone Fynbos) and all except two of them include endemic vegetation species (Mucina and Rutherford 2005) (Appendix I).

The Sandstone Fynbos's tend to grow on ground comprised of acidic lithosol soils derived from sandstones of the Table Mountain Group as well as the quartzite sandstones of the Witteberg Group. The Shale vegetation groups grow on land that is comprised of clay derived from shales of the Cedarberg Formation and clays and loams derived from shales of the Nardouw Subgroup of the Table Mountain Group as well as the Ceres subgroup of the Bokkeveld Group.

Members from the Eastern Cape Parks Board are active in the Langkloof and members of The Landmark Foundation (www.landmarkfoundation.org) are also working in the area. Their main focus, in the Langkloof specifically, is the conservation of leopard and other predators.

4.3.2 Mapping Conservation Opportunity

A range of human, social, ecological and vulnerability data were collated and mapped, and integrated so as to assess conservation opportunity (Table 11). All data were projected in WGS 1984, UTM 34 for analysis in ArcView 3.2. (ESRI 1999) (see Appendix III for further information on data preparation).

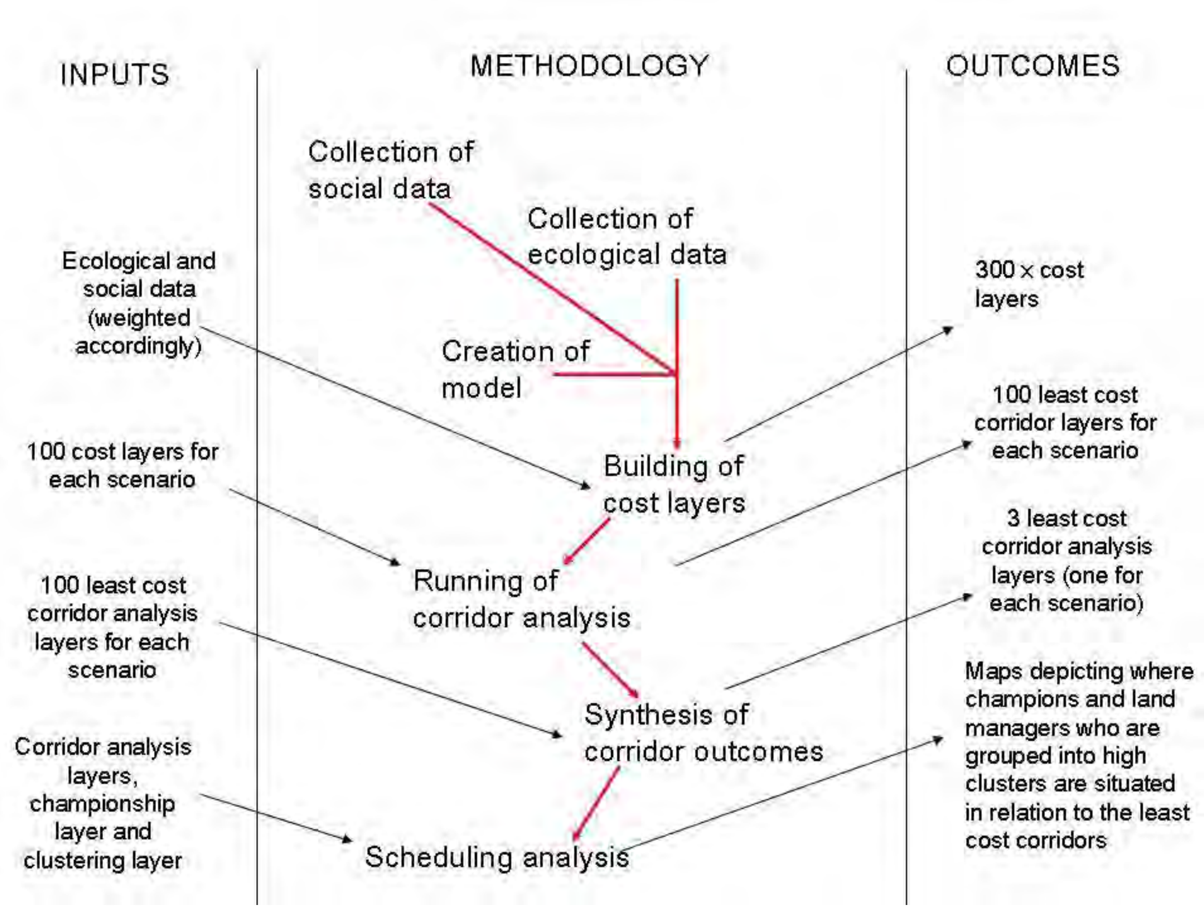


Figure 7: "Life cycle" of the least cost corridor analysis methodology

4.3.2.1 Human and social data

Factors hypothesized to be prerequisites for the effective implementation of conservation action by individual land managers were identified, based on Knight et al. (2010) (Table 4).

A semi-structured questionnaire was developed to improve upon Knight et al. (2010), and comprised of closed-ended questions (primarily Likert statements), which provided quantitative data, mappable in a Geographical Information System (GIS). Open-ended questions were also included to gather qualitative data. Draft questionnaires were revised by members of the E2A organisation, and subsequently piloted with five land managers. This version was then revised, and the final questionnaire reviewed by several academics prior to conducting the final surveys. Questions regarding land managers financial concerns were deemed too sensitive, and were therefore avoided (*sensu* Winter et al. 2007; Cumming 2007; Knight et al. 2010).

The agricultural extension officer for the area explained that there are about 50 important land managers in the Langkloof and created a list of 14 of the most pertinent individuals. Of these land managers, 12 were contactable and interviewed and a snowballing technique was used to contact a further 27 land managers. The snowballing technique was semi-random since the interviewees were asked if they might know anyone else who is likely to be 'conservation-minded' or might be willing to be interviewed.

An index was developed for each factor, based on questionnaire data. Face-to-face structured interviews were conducted with 38 land managers on their farms to gather this data (Section 3), along with contextual and qualitative data on land managers personal details.

To develop indexes, interview data for each factor was tested for its internal consistency using Cronbach's ά (alpha) (Cronbach 1951) complemented with Revelle's β (Beta), along with McDonald's $\acute{\omega}_h$ (omega) (Section 3). A smaller, more coherent set of questions was defined, their responses scored, and then indexed for values between zero and one (Section 3). Values for these factors were then linked to cadastral (i.e., land parcel) data, as these factors influence land managers decision-making, and can be systematically mapped in a Geographical Information System when linked to cadstral data (GIS) (ESRI 2009).

Table 11: Data used in the least cost corridor analysis

Dimension		Data	Measure
Human	1	Conservation knowledge	Knowledge of issues relating to endangered species, environmental legislation and general conservation issues.
	2	Conservation behaviour	‘Conservation friendly' behaviour of land managers in their everyday lifestyle and in their farming methods
	3	Willingness-to-collaborate	The extent to which landowners are willing to collaborate with conservation agencies, government officials or other potential stakeholders, and which of these stakeholders are more favourable as collaborating bodies.
	4	Willingness to participate	The extent to which landowners are willing to participate in conservation related activities, specifically their willingness to 1) adopt conservation friendly methods, 2) make trade-offs for the sake of conservation, 3) adopt conservation instruments and 4) accept incentives that encourage participation in instruments/'conservation-friendly' behaviour.
Social	5	Champions	To what extent a land manager is deemed as successful or influential by his/her peers.
Ecological	6	Land coverage	Areas of natural vegetation, urbanised areas, water bodies and agricultural areas
	7	Vegetation types	Vegetation types within the study area (endemicity factor embedded in the vegetation layer)
	8	Vegetation degradation status	Condition of vegetation within the study area
	9	Spatially fixed processes (soil and biome interface)	Areas of inland movement of marine sands and associated development, areas of untransformed habitat between solid thicket and an adjacent biome
	10	Status of rivers in South Africa	Condition of rivers within the study area

	11	Conservation priority status of land units	Conservation priority status of land units within the study area
	12	Endemicity	Endemicity status of vegetation types within the study area (high/medium/low – embedded in the vegetation layer)
Contextual	13	Roads and towns	Extent and spatial position of roads and towns
	14	Cadastres and protected areas	Land manager units (all human and social factors are embedded in the cadastral layer)

* Although recognised as highly important, vulnerability data was not included in the least-cost corridor analysis since, after extensive talks with local government officials and land managers, it was established that those areas that had the potential to be farmed or urbanised have already been transformed – most of the natural areas that are left are too mountainous or rocky For example, 60% of the land owned by the du Toit apple producing group cannot be used for apple production since it is too mountainous and rocky.

Due to time and resource restraints, not all of the land managers in the Langkloof were interviewed. Empty cadastres were allocated values for human and social factors through extrapolation. Frequency curves of factor values were generated in Microsoft Excel (Microsoft Office Excel 2003), and these values were randomly distributed across empty cadastres. This process was carried out 100 times, with the values re-randomized (i.e. linked to a different cadastre) to create 100 different shapefiles.

The "burnout potential" data (included in the social assessment) was excluded since it is a negative measure and for all of the other indexes land managers are scored on an index from 0 – 1 (a positive index).

4.3.2.2 Ecological data

Vegetation cover, vegetation degradation status, ecological and evolutionary processes (including river flows) and conservation priority status data layers were included in the least-cost corridor analyses (Table 11)

4.3.3 Designing the least-cost corridor

4.3.3.1 Weighting opportunity factors

The relative importance of the different types of data in designing a conservation corridor can be variously argued. Whilst ecological data have historically been used for spatial conservation prioritisation (Beier and Noss 1998; Williams et al. 2005; Rouget et al. 2006, see section 2), human and social data have recently been proposed as being of higher significance, in certain conditions (Perhans et al. 2008, Cowling et al. 2010). Weighting of individual data layers was conducted by three experts during a small workshop, generally applying the approach of Rouget et al. (2006). The outcome of the discussions was a coefficient for each of the dimensions of (i.e., categories within) each datum (Table 5). The scenarios were developed for combining datum into thee cost layers, where human/social and ecological/vulnerability data were weighted differentially, to test the influence of different data (Table 12).

Table 12: Weightings that the two dimensions were given, according to the three different scenarios in which the least cost corridor analyses were carried out

	Weighting	
Scenario	**Ecological Data**	**Human Data**
a	70%	30%

b	50%	50%
c	30%	70%

4.3.3.2 Building the cost layers

ArcView 3.2's Model Builder (ESRI 1999) was used to create raster cost layers from the ecological, human, social and vulnerability data. 100 cost layers were produced for each of the three scenarios (data weighted differentially) (Table 12). Cost layers were created by overlaying and summing all of the separate data layers to produce a single datum where each raster cell of the cost layer had a unique cost value.

4.3.3.3 Least-cost corridor analysis

A least-cost corridor analysis (Gallo 2007) was run for the 100 different cost layers for each of the three scenarios using the least-cost path corridor analysis toolbox (LDST Factory, part of LandscapeDST_v1_011) applied through Spatial Analyst in ArcGIS 9.3 (ESRI 2009). The results from the 100 runs were summed (average score per unit) to form a single robust corridor map.

4.3.3.4 Scheduling Conservation Opportunity

The human and social data were subject to a cluster analysis, grouping land managers with similar attitudes and behaviours; it was assumed that land managers that exhibit similar characteristics require similar instruments, incentives and institutions to implement effective conservation action (Knight et al. 2010). Agglomerative hierarchical clustering with aggregation by Ward's method was used, applying the Squared-Euclidean index distance metric (Legendre and Legendre 1998).

Individual clusters were ranked by experts in preferred implementation order for rolling-out a private land stewardship initiative (sensu Knight et al. 2010), based on the principal factors dominating individual clusters (Knight et al. 2010). Clustering applied the stats-package and the ade4-package (Chessel et al. 2004; Dray and Dufour 2007) for the R statistical environment (R Development Core Team 2010). Clusters were mapped in GIS, by allocating cluster rank values to cadastres according to the relevant land manager cluster scores.

Finally, cadastres were scheduled for conservation action by overlaying three layers: 1) the least-cost corridor layer, 2) champions, as identified by their peers and 3) the cluster rank of land managers. The spatial location of land managers was considered on a primary level since the least-cost corridor layer provides data on both ecological connectivity and conservation opportunity. The champion layer was considered next as it identifies land managers who potentially improve opportunity, as they are influential within the community and potentially act as an example that other land managers may follow should they join the initiative (Knight et al. 2010; see section 3). The cluster rank identifies the specific locations of interviewed land managers and their 'conservation characteristics'; it was therefore used as a tertiary ranking tool.

4.4 Results

4.4.1 Corridor Design

The results from the three scenarios were similar (Figure 8). With all scenarios the most prominent least-cost corridor (C1) (the darkest blue area in Figure 8) is wide and located within the Western region of the Langkloof Valley. It runs along a north-northeast to south-southwest axis. As social data is given more weighting in the analyses, the axis rotates slightly clockwise, the southern tip of C1 moving westward while the northern tip remains in the same location.

The results from scenario a (Figure 8a) show another corridor of equally high linkage value to C1, but much narrower, that falls West of C1. In contrast, in the results from scenario b (Figure 8b), the West corridor takes a lower linkage value while two very narrow corridors of high linkage value fall East of C1. The one corridor is situated just east of C1 while the other is situated nearer the middle of the Langkloof Valley. The results from scenario c (Figure 8c), in which the human data is given the highest weighting, show C1; a corridor of very high linkage and a corridor of fairly high linkage value are evident in the Eastern side of the Langkloof.

4.4.2 Cluster Analysis

Six clusters were identified for the purpose of the study (Figure 9). Clusters are numbered from one to six with cluster 1 including land managers that display the most favourable characteristics representing conservation opportunities (Table 13) and land managers in cluster 6 requiring the biggest investment to realise conservation opportunities. Conservation knowledge, conservation behaviour, willingness-to-participate (in conservation) and willingness-to-make-trade-offs were described as key variables in the clustering process.

4.4.3 Scheduling Analysis

There is one highly significant land manager who should be prioritised for conservation action when looking at the cluster data layer overlaid onto the third scenario outcome for the least-cost corridor (Figure 10); this is LM17. LM17 has his property completely within C1, is grouped into cluster one and is the only land manager to achieve a champion score of 1.

Table 13 lists the land managers (by LM number) that were interviewed and their overall priority ranking to be targeted for conservation action. The top 10 land managers fall within areas of high linkage value (ranging from light blue to dark blue) and are therefore distinct priorities for conservation action.

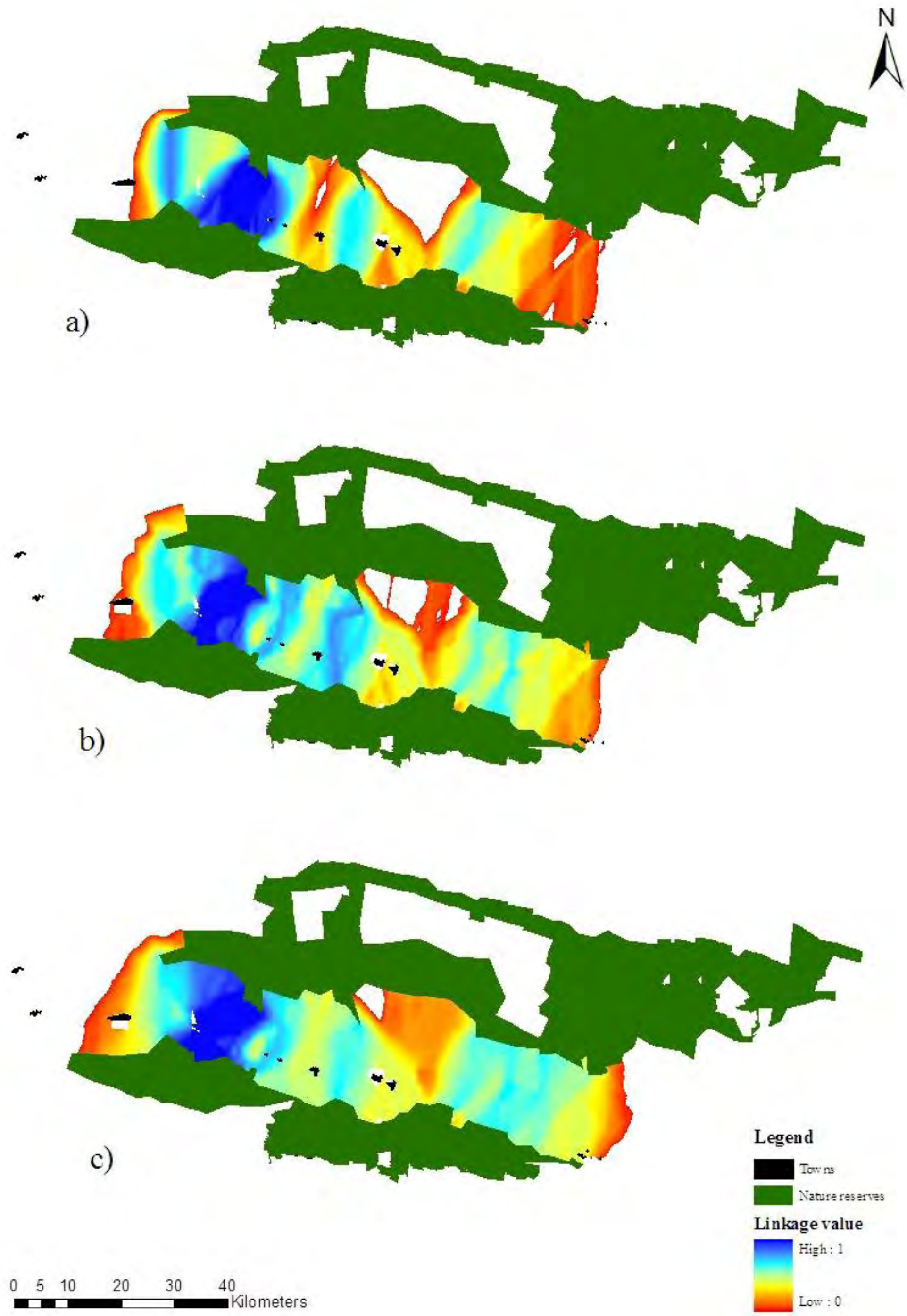


Figure 8: Results from the least cost corridor analysis

a) human data weighted 30%, ecological data weighted 70%
b) human data weighted 50%, ecological data weighted 50%
c) human data weighted 70%, ecological data weighted 30%

As the scheduling list continues, land managers that were not evidently situated in priority spatial positions (in relation to the linkage value) and were therefore prioritised based on the cluster into which they were grouped (i.e. their conservation opportunity characteristics). Those land managers that did not fall within the top 10% linkage value were prioritised into the last two groups (Table 13).

4.5 Discussion and Conclusions

4.5.1 Linking connectivity with opportunity

Much has been written about corridor design, but little has included opportunity (Section 2). Making spatial prioritisation effective for informing the implementation of conservation action on private land requires the integration of a diverse range of data (O'Connor et al. 2003; Moffett et al. 2005; Knight et al. 2006a; Moffett and Sarkar 2006; Wallace et al. 2008; Knight et al. 2010), as these initiatives inevitably confront "wicked problems" (Brown et al. 2010). Solutions must address a diversity of integrated factors not readily untangled. Mapping conservation opportunity integrates a diverse range of data that identifies areas of conservation importance, whilst ensuring that conservation activities can be feasibly implemented (Knight and Cowling 2007; Knight et al. 2010). This study advances spatial prioritisation methods by integrating spatially-explicit corridor design (Beier and Noss 1998; *sensu* Rouget et al. 2006) with human and social data that define the likelihood of effectively implementing the corridor (Cowling and Wilhelm-Rechmann 2007; Knight and Cowling 2007; Knight et al. 2010). Conservation opportunity represents a theory and a methodology, that was implemented, for integrating data to bridge the research-implementation gap (Knight et al. 2008), by providing practitioners with pragmatic direction to improve their decision-making process.

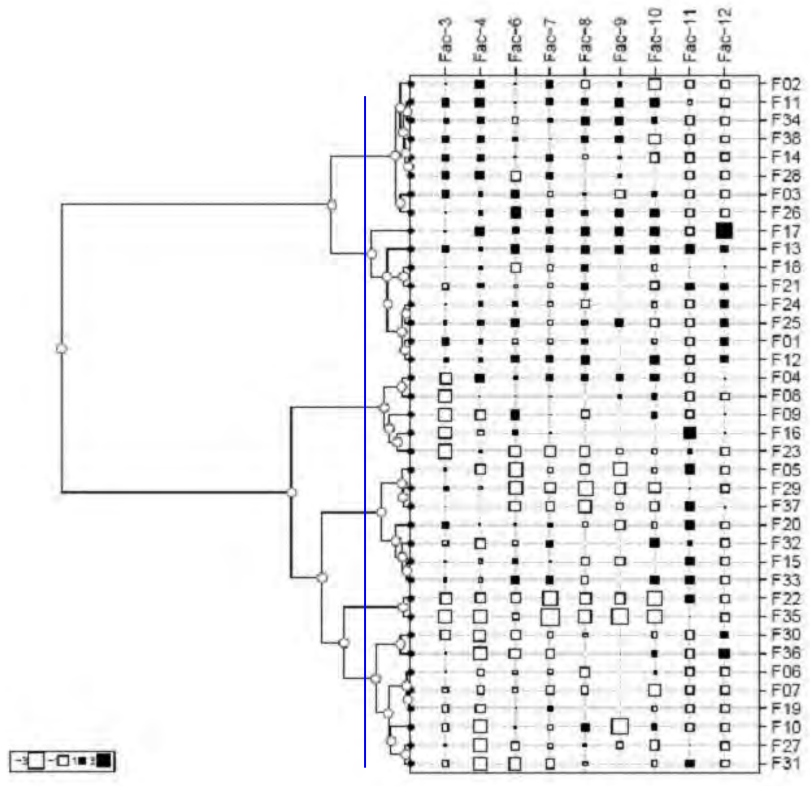
4.5.2 Corridor Scenarios

Scenario b (Figure 8) was anticipated to present optimum results for the purpose of this study since human and ecological data was weighted equally. Corridor C1 is identified as the least-cost area, and the top priority land manager (most influential and grouped into the highest cluster) is located within this corridor, and so represents the most potentially effective beginning for land manager collaboration.

Table 13: Land manager prioritisation for conservation action ranking based on their spatial characteristics, whether they are champions and the cluster into which they were grouped

Land Managers	Conservation Knowledge	Conservation Behaviour	Willingness-to-collaborate	Willingness to participate (conservation)	Willingness to participate (instruments)	Willingness to participate (trade-offs)	Willingness to participate (incentives)	Likelihood of selling property	Champion	**Cluster**	**Rank**
	Factors of Conservation Opportunity										
LM17	0.58	1	0.82	1	1	1	1	0.2	Yes	1	**1**
LM26	0.67	0.75	0.95	1	0.92	1	1	0.2	No	2	**2**
LM36	0.67	0	0.5	0.73	0.8	0.8	0.95	0.2	Yes	4	**3**
LM16	0.08	0.44	0.77	0.87	0.8	0.8	0.85	0.8	No	3	**4**
LM09	0	0.25	0.9	0.87	0.68	0.8	0.95	0.2	No	3	**5**
LM30	0.25	0.125	0.53	0.8	0.76	0.8	0.8	0.2	No	4	**6**
LM32	0.5	0.25	0.63	1	0.8	0.8	1	0.5	No	5	**7**
LM08	0.042	0.63	0.69	0.87	0.8	0.87	0.95	0.2	No	3	**8**
LM31	0.5	0.06	0.47	0.73	0.76	0.8	0.8	0.6	No	4	**9**
LM10	0.42	0	0.72	0.8	1	0.4	0.95	0.2	No	4	**10**
LM01	1	0.75	0.65	0.8	0.92	0.8	0.8	0.2	No	1	11
LM12	0.83	0.75	0.84	1	1	0.8	1	0.2	No	1	11
LM13	1	0.75	0.89	1	1	1	1	0.7	No	1	11
LM24	0.67	0.75	0.78	0.8	0.68	0.8	0.8	0.2	No	1	11
LM02	0.67	1	0.71	1	0.68	0.87	0.7	0.2	No	2	12
LM03	1	0.75	0.87	0.8	0.84	0.67	0.95	0.2	No	2	12
LM14	0.92	0.88	0.67	1	0.76	0.87	0.75	0.2	No	2	12
LM38	1	0.88	0.77	0.87	0.92	1	0.7	0.2	No	2	12

LM04	0.17	1	0.74	1	0.92	0.93	1	0.2	No	3	13
LM23	0	0.69	0.49	0.67	0.64	0.73	0.8	0.5	No	3	13
LM07	0.5	0.38	0.63	0.73	0.72	0.8	0.7	0.2	No	4	14
LM19	0.42	0.31	0.69	0.93	0.8	0.8	0.8	0.2	No	4	14
LM27	0.75	0.06	0.57	0.8	0.84	0.73	0.75	0.4	No	4	14
LM05	0.75	0.25	0.39	0.8	0.64	0.53	0.8	0.7	No	5	15
LM15	0.58	0.5	0.75	0.87	0.68	0.67	0.85	0.6	No	5	15
LM20	1	0.63	0.67	0.93	0.76	0.67	0.8	0.7	No	5	15
LM29	0.83	0.5	0.41	0.67	0.44	0.6	0.7	0.4	No	5	15
LM33	0.75	0.5	0.87	1	0.72	0.8	1	0.6	No	5	15
LM37	0.67	0.56	0.48	0.73	0.56	0.73	0.75	0.7	No	5	15
LM18	0.67	0.69	0.53	0.8	0.96	0.8	0.8	0.4	No	1	16
LM21	0.42	0.81	0.66	0.8	0.92	0.8	0.75	0.6	No	1	16
LM25	0.75	0.81	0.9	0.8	0.92	1	0.75	0.2	No	1	16
LM22	0.17	0.25	0.52	0.53	0.6	0.6	0.6	0.6	No	6	16
LM35	0	0.06	0.61	0.33	0.52	0.4	0.6	0.4	No	6	16
LM28	1	1	0.53	1	0.8	0.87	0.85	0.2	No	2	17
LM34	0.83	0.81	0.62	0.93	1	1	0.95	0.2	No	2	17
LM06	0.67	0.38	0.65	0.8	0.64	0.8	0.9	0.2	No	4	17



Legend

Fac-3 : Conservation knowledge

Fac-4 : Conservation behaviour

Fac-6 : Willingness to collaborate

Fac-7 : Willingness to participate (conservation)

Fac-8 : Willingness to participate (instruments)

Fac-9 : Willingness to participate (trade-offs)

Fac-10 : Willingness to participate (incentives)

Fac-11 : Likelihood of selling property

Fac-12 : Champion

Figure 9: Cluster diagram showing the results of the cluster analysis. A shaded square represents a positive deviation from the average while a white square indicates the negative (no square indicates an average). The size of the square indicates the extent of the deviation.

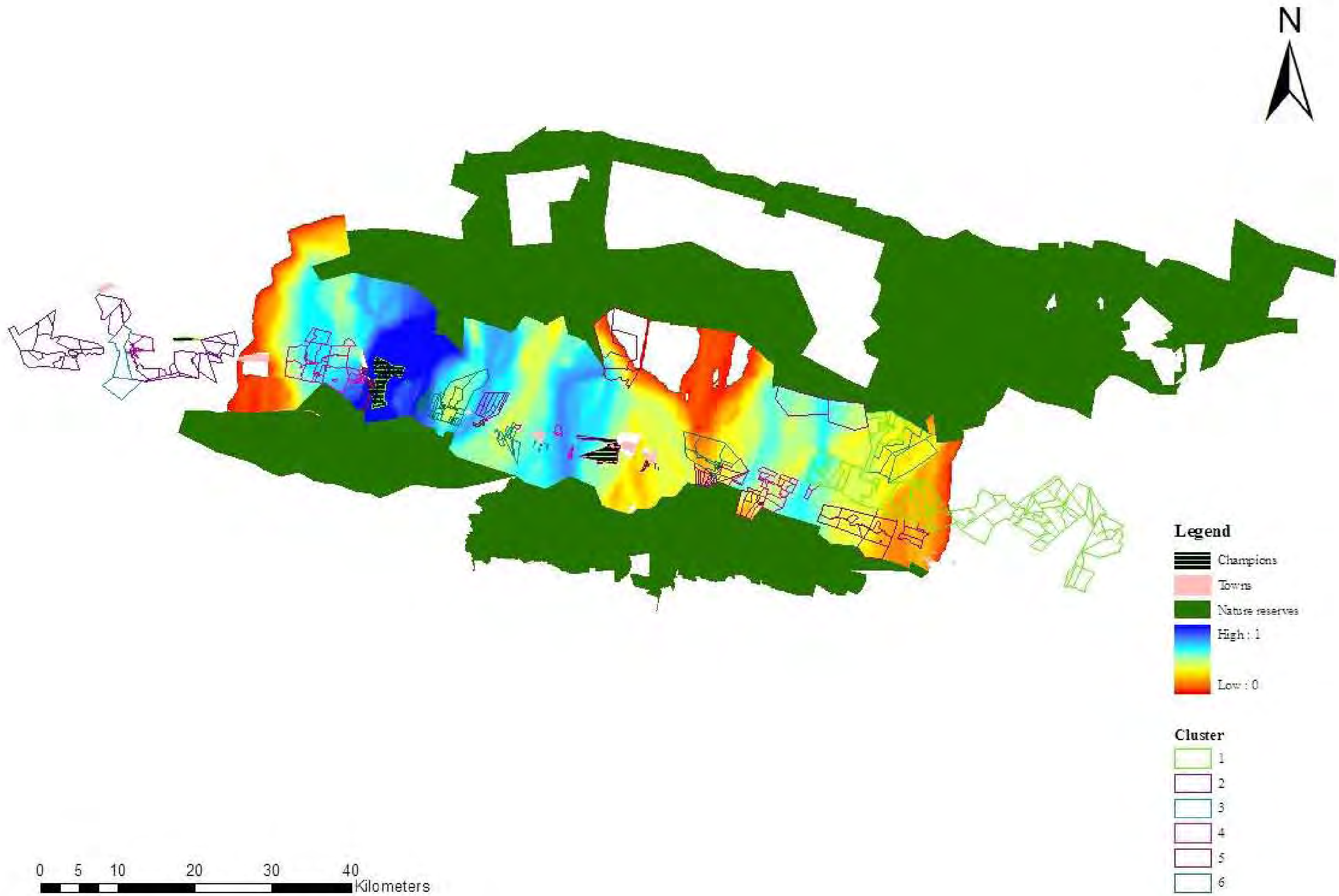


Figure 10: Champion and cluster analysis data overlaid on the results from scenario b of the least cost corridor analysis

However, the importance of social data is noted when looking at the other land managers that manage areas within the corridor; LM32 and LM35 manage land within this area but are grouped into clusters 5 and 6 respectively which indicates poor conservation opportunity. As the human data is given more weighing, there is more opportunity to implement conservation in other areas, especially in the Eastern side of the Langkloof. The land managers in this region are generally a more 'conservation-minded' group (based on one-on-one interaction with the land managers in this region during the interview phase, and because they are predominantly livestock land managers) but the land that they manage did not score highly in terms of endemicity of vegetation type (which was weighted highly). The Eastern side represents the 'path-of-least-resistance' for implementing conservation action based on conservation opportunity (see conservation opportunity scores in Table 6: LM13, LM01, LM12, LM24, LM21, LM18 and LM25 all manage land in this region).

All three corridor scenarios were surprisingly similar (Figure 8) regardless of the different data and weightings applied; the widest and most intact least-cost corridor occurs in the Western part of the Langkloof Valley (C1; Figure 8). This is potentially explained a number of ways. This may be a positive outcome since there may already be some correlation between the human aspects (the data gathered in the area) and the ecological data; i.e. land managers who are more "conservation minded", and who therefore scored higher for the human factors measured, are those who live on/manage properties that have more favourable ecological aspects on their land.

4.5.3 Data distribution and decisions

The similarities in results do, however, raise questions around the most appropriate data for mapping corridors of conservation opportunity. If patterns of attitudinal and behavioural characteristics (and consequently social and human cost) of land managers were distributed rather evenly across the cadastres, it was the ecological data that more strongly determined the preferred corridor paths. Again, this may be an artefact of the extrapolation. Interestingly though, this hypothesis highlights that if the degree of variation between the social and human traits that characterise land managers is low between cadastres across a given landscape, then ecological data (those data with the most variation) will likely be the prominent factor in this type of corridor design (Perhans et al. 2008). If this is the case then some social and human data sets could possibly act as surrogates for others; this finding necessitates further research to investigate the relationships between human and social data that identifies areas of conservation opportunity.

In some cases areas of ecological integrity and conservation opportunity do not overlap completely and trade-offs need to be made; such investigations introduce a variety of alternatives - possibly suitable corridor options that would not be identified using ecological data alone. Perhaps one of the most important positive outcomes of this study is the hypothesis that if one considers a more holistic environment and a number of corridor options based on more than one type of data, critical, open-minded and adaptable thinking and planning is encouraged. Corridor options in both the Western and Eastern sides of the Langkloof are introduced when human data is included in the spatial prioritisation process.

4.5.4 Opportunities for implementing a conservation corridor

The conservation corridor map presents a testable hypothesis of the best return-on-investment for implementation (Knight et al. 2010). E2A has secured funding for a stewardship officer, who began work in February 2011. This person's job is to use the research and outcomes described in this study as a foundation, and to build on it by approaching land mangers that are located within the identified least-cost corridors, or who are ranked in a favourable cluster. By targeting areas that incorporate conservation opportunity data and are therefore more feasible, it is hypothesised that time, efforts and monetary resources will be saved. This hypothesis is already proving to be defensible since the results from the corridor analyses have been shared with the members of E2A and it turned out that their expected corridor (prior to assessing the results) did not fall at all into any of the high linkage value areas. By taking into account the results from the analyses, the members of E2A can reassess their target areas for corridor implementation and make informed decisions.

In order to implement conservation/stewardship action in collaboration with land managers in the landscape who have been prioritised, an optimal instrument matrix should be adopted (Section 3).

4.5.5 Lessons learnt and recommendations

In order to further improve studies of this nature the following questions need to be answered or actions should be carried out. Firstly, from a technical viewpoint, planners need to continually learn from and improve methods that have been used; the study that has been explained is highly technical and fairly time consuming. It is suggested that a quicker and more robust method to populate the empty cells is used. Ideally, all of the land managers in the study area would be visited but in a world where perfect research methods need to be balanced with practicalities and implementation, there is usually not enough time to do so. Further investigation needs to be done on why the three scenarios are so similar. Although possible explanations for these similarities have been proposed; a more thorough study needs to endorse these reasons. Data on the movement of keystone species within a planning area would probably add substantially to least-cost corridor analysis and conservation corridor planners should attempt to incorporate it in their prioritisation methods.

To further promote the feasibility of the least cost-corridor analysis, it should be complemented with a specific and contextual implementation strategy (time permitting) and linked with an active adaptive management plan. E2A is attempting to initiate a similar project in another landscape where they hope to link two existing protected areas (Knight pers. comm. 2010). Preliminary social assessment studies have been carried out and if the project is to use a similar method with an aim to improve on it, then the considerations, lessons learnt and recommendations need to be reviewed carefully.

Since the approach that was used was novel, it was necessary to document the pitfalls of the study, those areas that can be improved on and the lessons learnt from the overall experience in order to support the call for developing a "safe-fail" culture; a conservation planning environment in which academics and practitioners share what they have learnt from their mistakes and failures in order to better the conservation planning process (Redford and Taber 2000). Table 14 summarises these findings. The lessons learnt from liaising with the land managers are explained in Table 10.

Table 14 Lessons learnt from the least-cost path corridor analysis

Lesson learnt	**Rationale**
Consider study area size	• If linkages are too narrow, the resources aimed at carrying out a least cost corridor analysis may be unnecessary – visiting the area to survey the vegetation, chatting to land managers and carrying out a few analyses on human data may be sufficient to implement extension officer stewardship activities. • The vegetation may be fairly homogenous in reality and assigning weights to ecological aspects may over-emphasise differences in vegetation characteristics.
Aim to implement repeatable, simple and robust methods	• It is easy and sometimes encouraged, as a scientist, to utilise complex statistical studies to acquire results for a study or steps of a study. Although the significance of these analyses are recognised, when dealing with inter-disciplinary processes such as conservation planning, it might be better to focus on developing methods that can be understood and utilised by land managers and conservation practitioners alike
Balance the research against the implementation process and timeline	• Ideally the technical/planning steps of conservation initiatives would be 100% accurate before the plans are implemented but in reality, trade-offs need to be made between technical perfection and implementation. Spatial prioritisations should not be rushed but scientists must accept that in some cases ideas need to be implemented to "get the ball rolling" that may not be flawless or that may not have undergone a serious of statistical analyses to certify that they are perfect. • It is important to remember that the conservation planning

	process is an adaptive social learning experience (Knight et al. 2006a). Imperfect conservation plans are more likely to be improved through practical 'hands-on' experience instead of statistical/arithmetic refinements. A simple plan is better than no plan at all (Knight et al. 2006b).

5 SYNTHESIS

Spatial prioritisation techniques are regarded specifically and systematic conservation planning as a discipline more generally, as having the potential to contribute usefully to effective, real-world conservation action. Conservation planners have historically had an academic focus and a reticence to engage techniques for securing data (human and social data) which determine the feasibility of implementation activities.

This body of work and research illustrates the lack of human and social data that has been used in conservation planning, although its importance to conservation planning is evident in the literature. In contrast, it also demonstrates the exciting potential utility of spatial prioritisations that incorporate human and social data. The spatial prioritisation process that was carried out for E2A has already supported the initiative in making more effective decisions. Each of the three research papers included in this thesis aimed to improve conservation planning.

The literature review (Section 2) demonstrated that factors defining conservation opportunity (i.e., feasibility) are rarely included in spatial prioritisation studies, despite recognition of the importance of these factors for translating maps of areas important for achieving conservation goals into effective conservation action. This paper serves as a call for recognising the importance of designing spatial prioritisations that bridge the 'research-implementation' gap, by ensuring that their technical design facilitates feasible and effective conservation action. The results from the review were startling, as only one out of the 167 peer reviewed articles systematically included human or social data in their spatial prioritisation process. This finding confirms the hypothesis that such data is rarely used in spatial prioritisation analyses. This will hopefully lead conservation planners to the realisation that the human and social data that are so often mentioned as being important for conservation planning in the theoretical literature are not being included in spatial prioritisation.

Social assessments rarely precede spatial prioritisations (although recommended by Cowling & Pressey 2003; Knight 2006a) – Section 3 trialled an approach for undertaking a social assessment to provide benchmark data to guide the design of ways in which E2A should approach private land managers. The process followed on from the literature review that was conducted (Section 2); the review therefore aided in defining a set of important social characteristics that should be used in systematic conservation planning. The social assessment questionnaire was informed and influenced by the literature review stage of the study. Most of the land managers were willing to engage conservation activities and collaborate with relevant organisations, but they do not have the financial capacity to adopt 'conservation-friendly' methods.

The social assessment stage proved very interesting, surprising, highly informative and beneficial in terms of its methodology. Meeting the land managers face-to-face, mostly at their homes, allowed for information sharing to take place in an environment where they were comfortable, and provided for opportunistic social learning experiences to occur between the land managers and the interviewer. As both a member of the E2A team and an affiliate of Rhodes University, the interviewer was able to seem less biased in terms of how or what conservation should be done – it was emphasised that, since it was an investigative study, the interviewer was interested in the land managers opinions, ideas, needs and wants. The interaction that took place between the interviewer and the interviewees was, however, seen as the initial communication between the land managers and E2A (for most of the land managers) and it was evident that the land managers appreciated the perspective with which the interviews were carried out. It is hoped that a level of trust was built between the land managers and E2A as an organisation.

The quantitative results from the social assessment were not only essential to move forward and carry out the least cost-corridor analyses, but also provided insight into how land managers think and the overall social context of the Langkloof Valley. This is an essential aspect in any type of conservation planning project that requires land manager co-operation or interaction.

Corridors are widely employed in conservation planning, but typically use only ecological data in their design. The corridor design method of Rouget et al. (2006) was fused with the conservation opportunity mapping approach of Knight et al. (2010) to schedule conservation activities for E2A that have a high likelihood of being feasible (Section 4). Two corridors were identified within the Langkloof Valley; a major corridor in the western region of the valley and another secondary corridor further east. Since proactive human and social information has never been included in a least-cost corridor analysis, the three scenarios to which the human, social and ecological data were subjected, allowed the team to review the impact of including such data in the analysis. The study also represented the first time that the LandscapeDST_v011_01 software was used for a real-world conservation initiative (J. Gallo, pers. comm.). As a result, this body of research represents a substantial advance in conservation corridor design.

The results from all three of the scenarios were presented to E2A and discussed during a meeting in the beginning of November 2010. The effect of giving the human and social data more weighting was considered with most of the E2A team and it was decided that the organisation should strive to establish, or at this stage initiate, two possible corridors that will potentially connect the Baviaanskloof World Heritage Area and the Tsitsikamma National Park through the Langkloof Valley. The primary corridor is that in the western region and is illustrated clearly in the results of the least cost corridor analysis, and the secondary corridor is in the eastern region which is most evident when the human and social data is given a higher weighting.

These decision support suggestions were reinforced by the scheduling stage. Scheduling was based on face-to-face interaction with the land managers, scores that each one achieved during the conservation opportunity assessment, the clustering activity, and their position in relation to the least-cost corridor results. Land managers were therefore ranked in terms of priority stakeholders or role players in stewardship agreements, and conservation activities more generally.

The approach with which the objective of this thesis was achieved proved to be both effective and operational in its methodology and for translation into action. E2A is sending a stewardship officer into the Langkloof Valley in early 2011 based on the results from this study which were presented to them. The team now has a clear idea about which land managers to target in order to maximise project efficiency and minimise resource waste. Their progress will be monitored and it is hoped that this innovative project proves to be effective and that the methodology described can be refined wherever needed and applied in a number of conservation planning contexts.

It was a privilege to be part of a project in which the research from this thesis can be translated effectively into conservation action by including ‘real-world’ problems and considerations in the design of conservation priority areas. A great deal was learnt by the researcher from the experiences as a conservation planner and interest were sparked in terms of integrating the practicalities of the real-world as an implementation domain into the planning stages of conservation in the future. It was realised that the science of conservation planning is of limited use without input from land managers who are potential stakeholders in the conservation plan. The needs and threats of these land managers must be taken seriously, not just to achieve conservation goals, but also to create effective partnerships between land managers and conservationists. By working towards common goals, there is opportunity for trust to be built between the two parties which will improve the efficiency of conservation planning greatly in the future.

Spatial prioritisation methods are useful tools for conservation planning but there is a need for them to be developed with implementation in mind; they should therefore include aspects of feasibility (i.e. human and social factors) in their design. It is, of course, imperative that protected area designs are robust, but conservation planners would probably learn a lot more about how to implement a successful protected area if they reflected upon and learnt from their own, and others, experience. As a result it is felt that an important part of any conservation design is documenting failures, lessons learnt and recommendations for future plans.

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7 APPENDICES

7.1 Vegetation types of the study area (including the Baviaanskloof Natural Heritage Area and the Tsitsikamma National Park)

Vegetation type	**IUCN status**	**Endemic species**
Albany Alluvial Vegetation	Endangered	
Baviaanskloof Shale Renosterveld	Least threatened	*
Eastern Coastal Shale Band Vegetation	Endangered	
Eastern Inland Shale Band Vegetation	Least threatened	*
Eastern Little Karoo	Least Threatened	*
Gamtoos Thicket	Least Threatened	*
Garden Route Shale Fynbos	Endangered	*
Groot Thicket	Least threatened	*
Humansdorp Shale Renosterveld	Endangered	*
Kouga Grassy Sandstone Fynbos	Least threatened	*
Kouga Sandstone Fynbos	Least threatened	*
Langkloof Shale Renosterveld	Endangered	*
North Outeniqua Sandstone Fynbos	Least threatened	*
South Kammanassie Sandstone Fynbos	Least threatened	*
South Outeniqua Sandstone Fynbos	Vulnerable	*
Southern Afrotemperate Forest	Least threatened	*
Tsitsikamma Sandstone Fynbos	Vulnerable	*
Uniondale Shale Renosterveld	Least threatened	*

7.2 Interview questionnaire

INTERVIEW QUESTIONNAIRE

Interviewee(s): ____________________________ Interview date / time: ________________

Interview location: __________________________

1. **BACKGROUND INFO**

What do you farm?

1.01	*Agricultural product(s)*	Yes/no	Proportion contributes to income
	Apple		
	Pear		
	Apricot		
	Plums		
	Peach		
	Beef		
	Dairy		
	Sheep		
	Honeybush		
	Potatoes		
	Tomatoes		
	Grapes		
	Other #1		
	Other #2		

Please point out the position of your farm on the cadastral map

For how many years have you lived on this farm?…………………………………..

For how many years have you been farming yourself?………………………………..

For how long has this farm been in your family?………………………..

For how many generations has your family farmed in this region?…………………..

2. CONTEXT

2.01 What did nature do for you, or provide you, today?

………
………
………
………
………
…………………………

2.02 What are the major challenges you face working on the land, or that concern you about land management, generally, in South Africa?

………
………
………
………
………
……………………

2.02 Challenges	Impact of challenges on farming				
	Very low	Low	Moderate	High	Very high
Water shortages					
Weather extremes					
Insect pest problems					
Animal pest problems					
Frequent fires					
Lack of regular fires					
Legislation restrictions					
Lack of capacity of staff					
Lack of financial capital					

Market instability					
Land reform and restitution					
Climate change					
Other:					
Other:					
Other:					

CONSERVATION KNOWLEDGE

Conservation Knowledge		No	Yes	Sort of
3.01	Do you know how many vegetation biomes occur in South Africa?	0	2	1
3.02	Do you know how many vegetation biomes occur in the Langkloof?	0	2	1
3.03	Were you aware, before this interview, that Fynbos makes up one of the worlds 'biodiversity hotspots'?	0	2	1
3.04	Are you aware if any alien plants occur in the Langkloof?	0	2	1
3.05	Were you aware that landowners in South Africa have a legal obligation to clear aliens from their land?	0	2	1
3.06	Are you aware if any rare animals occur in the Fynbos?	0	2	1
3.07	Are you aware if any rare plants occur in the Fynbos?	0	2	1
3.08	Are you aware of any farming activities that change the land and therefore require a permit to be carried out?	0	2	1
3.09	Do you know if there are any conservation agencies that are active in your area	0	2	1
3.10	Are you aware of the different environmental stewardship programmes that are available?	0	2	1
3.11	Do you know if there are any national parks or other reserves in the Langkloof?	0	2	1
3.12	Do you know what the responsibility of the Eastern Cape Parks Board / Cape Nature is?	0	2	1

3.13	Do you know of any conservation projects that are going on in the area?	0	2	1
3.14	Are you aware if any rare plants occur on your property?	0	2	1
3.15	Are you aware if any alien plants occur on your property?	0	2	1

CONSERVATION BEHAVIOUR

Conservation behaviour		Never	Not sure	Sometimes	Usually	Always
4.01	I implement measures to try and prevent soil erosion	0	1	2	3	4
4.02	I attend meetings of an environmental organisation (note which one)	0	1	2	3	4
4.03	I monitor the veld condition	0	1	2	3	4
4.04	I use a chemical insecticide to kill insects in my house.*	0	1	2	3	4
4.05	I make donations to environmental organizations.	0	1	2	3	4
4.06	I monitor wildlife	0	1	2	3	4
4.07	I conduct ecotourism activities on my farm	0	1	2	3	4
4.08	I recycle paper that I have used	0	1	2	3	4
4.09	I farm using organic methods	0	1	2	3	4
4.10	I use a chemical fertilizer*	0	1	2	3	4
4.11	I take empty bottles to a recycling bin	0	1	2	3	4
4.12	I use a chemical pesticide in my farming methods*	0	1	2	3	4
4.13	In the winter, I keep the heat on so that I do not have to wear a jersey.*	0	1	2	3	4
4.14	I take my own bags when I do the shopping so that I do not use plastic bags	0	1	2	3	4
4.15	I prefer to shower rather than to take a bath	0	1	2	3	4

4.16	I talk with friends about problems related to the environment.	0	1	2	3	4
4.17	I use holistic management practices when farming	0	1	2	3	4
4.18	If there is a conservation friendly alternative to a certain farming practice I will use it	0	1	2	3	4
4.19	I buy organic products	0	1	2	3	4
4.20	I usually drive on freeways at speeds under 120 k.p.h	0	1	2	3	4
4.21	We wait until we have a full load before doing laundry.	0	1	2	3	4
4.22	I poison or shoot vermin when they impact on my farming operations*	0	1	2	3	4
4.23	I point out to people when their behaviour is not ecologically friendly	0	1	2	3	4

PROFESSIONAL LIFE

How Often:	0	1	2	3	4	5	6
	Never	A few times a year or less	Once a month or less	A few times a month	Once a week	A few times a week	Every day

	How Often: 0-6	Statements
5.01		I feel emotionally drained from my work.
5.02		I feel used up at the end of the work day.
5.03		I feel fatigued when I get up in the morning and have to face another day working.
5.04		I can easily understand how the people I work with feel about things.
5.05		I feel I treat some people I work with as if they were impersonal objects.
5.06		Working with people all day is really a strain for me.

5.07		I deal very effectively with the problems of the people I work with.
5.08		I feel burnt out from my work.
5.09		I feel I'm positively influencing other people's lives through my work.
5.10		I've become more callous toward people since I took this job.
5.11		I worry that this job is hardening me emotionally.
5.12		I feel very energetic.
5.13		I feel frustrated by my job.
5.14		I feel I'm working too hard on my job.
5.15		I don't really care what happens to some of the people I work with.
5.16		Working with people directly puts too much stress on me.
5.17		I can easily create a relaxed atmosphere with the people I work with.
5.18		I feel exhilarated after working closely with the people I work with.
5.19		I have accomplished many worthwhile things in this job.
5.20		I feel like I'm at the end of my rope.
5.21		In my work, I deal with emotional problems very calmly.
5.22		I feel some of the people I work with blame me for some of their problems.

WILLINGNESS TO COLLABORATE

	Agency	Willingness to work with them				
		Very low	Low	Moderate	High	Very High
6.01	Department of Agriculture					
6.02	Department of Water Affairs and Forestry					
6.03	Department of Land Affairs					
6.04	South African National Parks					
6.05	South African National Biodiversity Institute (SANBI)					

6.06	South African Police Service					
6.07	Working for Water					
6.08	Landcare					
6.09	Dept of Agriculture (E.C./W.C)					
6.10	Local Government and Traditional Affairs (E.C.)					
6.11	Dept of Economic Affairs and Tourism (W.C.)					
6.12	Dept of Environmental Affairs and Development Planning (W.C.)					
6.13	Eastern Cape Parks Board					
6.14	Your District Municipality					
6.15	Your Local Municipality					
6.16	CapeNature					
6.17	Landmark Foundation					
6.18	Wilderness Foundation					
6.19	Eden to Addo Initiative					
6.20	Wildlife & Environment Society of South Africa					
6.21	World Wildlife Fund (WWF)					
6.22	Endangered Wildlife Trust (EWT)					
6.23	University of Cape Town					
6.24	Stellenbosch University					
6.25	Rhodes University					
6.26	Skul de krans					

6.27	Your conservancy					
6.28	Your farmers association					
6.29	Your co-operative or industry group					
6.30	Private consultant					
6.31	Other (specify)					

WILLINGNESS TO PARTICIPATE

Willingness to participate – Conservation		Strongly disagree	Disagree	Neutral/ unsure	Agree	Strongly Agree
7.01	I would be interested in finding out how to farm in a conservation friendly way	1	2	3	4	5
7.02	I would not be interested in becoming part of a conservation forum of like-minded landowners *	5	4	3	2	1
7.03	I think that conservation and agriculture can happen simultaneously, with the support of agencies and the government	1	2	3	4	5
7.04	There is too much hype about conservation in this area*	5	4	3	2	1
7.05	I would be willing to drive up to half an hour to attend an environmental meeting	1	2	3	4	5
7.06	I would be willing to drive up to an hour to attend an environmental meeting	1	2	3	4	5
7.07	I would prefer to make use of green technology (i.e. organic pesticides) if it becomes available	1	2	3	4	5
7.08	I am willing to further explore environmental agreements that may protect some of the vegetation on my property	1	2	3	4	5

Are there any existing incentives for you to carry out conservation friendly farming practices? If so please explain.

……
……
……

………
……………………

Willingness to Participate – Instruments		Strongly disagree	Disagree	Neutral/ unsure	Agree	Strongly Agree
8.01	I would be interested in becoming a partner in a **voluntary conservation agreement** for my property, and would not require incentives	1	2	3	4	5
8.02	I would be interested in becoming a partner in a **voluntary conservation agreement** for my property, but only if my production remains unaffected	1	2	3	4	5
8.03	I would be interested in becoming a partner in a **binding conservation agreement** for my property, and would not require incentives	1	2	3	4	5
8.04	I would be interested in becoming a partner in a **binding conservation agreement** for my property, but only if my production remains unaffected	1	2	3	4	5
8.07	I would consider setting-aside farmable land for conservation	1	2	3	4	5
8.08	I would prefer to cull caracal, jackal and leopard than to adopt alternative non-lethal approaches to managing them	5	4	3	2	1
8.09	I would be happy to conserve my entire property if my livelihoods are secured	1	2	3	4	5

Willingness to make trade-offs *(make it clear that the farmer would bear the costs)*		Strongly disagree	Disagree	Neutral/ unsure	Agree	Strongly agree
8.16	I would consider changing the type of pesticides/herbicides I use in order to meet conservation goals	1	2	3	4	5
8.17	I would consider changing the type of fertilizer I use in order to meet conservation goals	1	2	3	4	5
8.18	I would consider changing my fencing in order to meet conservation goals	1	2	3	4	5
8.19	I would consider leaving some areas of vegetation natural in	1	2	3	4	5

	order to meet conservation goals					
8.2	I would consider adopting new approaches to my farming in order to make them more environmentally-friendly, even if they reduced my production, without receiving any compensation	1	2	3	4	5
8.21	I would only reduce my yield to meet conservation goals if I were compensated	1	2	3	4	5

*Willingness to participate - Incentive**s***							
	How interested would you be to receive each incentive?	Rank best incentive for you	No interest	Partial interest	Neutral or Unsure	Interested	Very interested
8.08	Tax rebate		1	2	3	4	5
8.09	Rates rebate		1	2	3	4	5
8.10	Financial payment (direct payment)		1	2	3	4	5
8.11	Priority alien plant removal by WfW		1	2	3	4	5
8.12	Access to information regarding best management practices (maps/plans etc.)		1	2	3	4	5
8.13	Extension officer support		1	2	3	4	5
8.14	Access to eco-tourism support		1	2	3	4	5
8.15	Access to a support network of like-minded landowners		1	2	3	4	5

LIKELIHOOD OF SELLING PROPERTY

Likelihood of selling property		Strongly disagree	Disagree	Neutral/ unsure	Agree	Strongly agree
9.01	I am thinking about selling my property	1	2	3	4	5
9.02	I will not sell my property but will pass it on to my children	5	4	3	2	1

9.03	I would prefer to sell my property to a conservation organisation than to a private buyer	1	2	3	4	5

SOCIAL NETWORKING (CHAMPIONS)

10.01	*Please identify people who you feel are respected and influential in your community*	*Why is he/she influential?*	*Contact details*
1			
2			
3			

SOCIAL NETWORKING (CHAMPIONS)

10.02	*The general quality of the relationship with my neighbour is…*	Very poor	Poor	Neutral/ unsure	Good	Very good
	# 1	1	2	3	4	5
	# 2	1	2	3	4	5
	# 3	1	2	3	4	5
	# 4	1	2	3	4	5
	# 5	1	2	3	4	5

11.01 ***Interviewee Personal Information***

E-mail: ………………………………………… Tel:……………………….

Landowner gender: Female / Male Year born: ………………………..

Farm name and property number/s:……………………………………………………………………….

Landowner race:

(White) English	(White) Afrikaans	Xhosa	Coloured	Other

What language do you primarily use at home?

English	Afrikaans	Xhosa	Zulu	Other

What language is primarily used with farm staff?

English	Afrikaans	Xhosa	Zulu	Other

Marital status:

Single	Married	Divorced	Widowed	Other (please specify)

Gender and ages of children:

……………………………………………….. …………………………………………………

……………………………………………….. …………………………………………………

……………………………………………….. …………………………………………………

Level of education completed:

Junior school	High school	Diploma	Did some University	Full degree	MSc degree	PhD degree	Other (please specify)

7.3 Metadata

7.3.1 Ecological Data

- An endemism field was added to the STEP vegetation data that was used in the analysis; two vegetation layers were used in order to determine the "level of endemism" for vegetation types that occurred in the Langkloof. Both the Subtropical Thicket Ecosystems Project (STEP) and the Vegmap data were surveyed (South African National Biodiversity Institute); although the STEP data seemed to be at a finer scale, it only covered the STEP study region and is therefore unsuitable to work out what percentage of a vegetation type that occurs in Southern Africa, occurs in the Langkloof. We therefore identified the vegetation types on the VegMap data layer that occurred within the Langkloof, and calculated what percentage of the vegetation group is found in the Langkloof in relation to the Rest of South Africa. Once this was done Idetermined which vegetation groups (from the VegMap data) the vegetation types (from the STEP) data, fell predominantly in. Fortunately, because the data is quite similar, the STEP vegetation types could be sorted quite neatly into the VegMap groups. The endemism scores of the VegMap groups were used as a surrogate for the endemism score of each STEP vegetation type. We placed the vegetation types into 3 categories of "high endemism" (over 60 percent of the vegetation type falls within the Langkloof), "moderate endemism" (between 31 and 59 percent of the vegetation falls within the Langkloof) and low endemism" (30 percent or less of the vegetation falls within the Langkloof). These categories were decided on after academics in the botanical field were consulted.

- Buffer layers were created to be incorporated in the cost layers around roads and towns. The breadth of the research area, and other factors, were taken into consideration; buffers of 300 m around roads, and 1000 m around towns were created. It was acknowledged that the research area is bisected by a main road (part of the Route 62), but it was decided that the buffering effect could reduce the chances of a possible corridor being within the proximity of a road (i.e. parallel) for an area that is larger than is needed.

- The inclusion of a habitat suitability layer was considered and discussed extensively. The STEP habitat suitability layer considered environments that could support a population of elephant, as an umbrella or keystone species (Rouget et al. 2006). It was decided that the extent of the natural vegetation in the Langkloof is not enough to sustain a natural population of large herbivores that can be used as umbrella species (such as elephant or rhino), and since it is a comparatively small section of the corridor, it would ideally serve the purpose of linking two large and established protected areas (the Tsitsikamma National Park and the Baviaanskloof Natural Heritage Area) in order to ensure the movement of genetic material over a range of gradients. The larger, established protected areas would serve the purpose of maintaining viable populations of larger mammals. The International Union for the Conservation of Nature (IUCN) statuses of the animals that inhabit the area was also considered. A separate habitat suitability layer was therefore not included in the analysis, it was decided that this ecological aspect would be included in the degradation component which was included in the analysis; i.e. areas of intact habitat (Fynbos or Thicket) are more suitable for natural faunal species. The weightings that were given to the various land categories were ranked according to the transformation and condition classes for the land cover data as utilized by Rouget et al. (2006); they were ranked as either transformed, moderate or good.

- It seemed necessary, in the beginning of the study, that a vulnerability layer also be included in the study, but after chatting to landowners and active academics in the region, it was discovered that nearly all of the land that can potentially be used for agriculture is already being utilized (de Wit 2010, Koetze 2010 pers. comm.). The land that is defined as natural land is, most often, situated on rocky slopes that are unfavourable for agriculture and thus, the element of vulnerability is redundant.

Data Layers Used in the Least Cost Corridor Analysis

No	Data layer	Description	Manipulated	Field added?	Field description	By who?
1	clip1_Vegm_2006_roads	vegetation (and other) coverage of Southern Africa created by SANBI, roads coverage used in the analysis	projected in WSG_UTM 34, clipped to study area			
2	clip1_STEP_veg_UTM34	vegetation coverage of the STEP planning region created by members of the Subtropic Ecosystem Thicket Project	projected in WSG_UTM 34, clipped to study area	endemism	the Veg_map and STEP_veg data layers were used to create an endemism layer. Three endemism categories were created based on the % of each specific vegetation type that occurs in the planning region compared to the rest of Southern Africa	McClure, A. and Payet, K.
3	cads_pa_UTM34	cadastres and protected areas that fall into the study area provided by Steven Holness	projected in WSG_UTM 34, clipped to study area, protected areas merged into single polygons, the cadastres of land owners that were interviewed were identified and the relevant information was included in the attribute table	will_col, cons_behav, champ, cons_know, wp_con, wp_ins, wp_trad, wp_inc	lan_col: landowner willingness to collaborate, lan_part: landowner willingess to participate, cons_behav: conservation behaviour of landowners, cons_know: conservation knowledge of landowners	Payet, K., McClure, A.
4	clip_step_vegtrans2_utm_proj	vegetation degradation status in the STEP planning region, created by members of the Subtropic Ecosystem Thicket Project	projected in WSG_UTM 34, clipped to study area			
5	clip_step_process_utm34	fixed processes (soil, river and biome interface) data for the STEP planning region created by members of the Subtropical Ecosystem Thicket Project	projected in WSG_UTM 34, clipped to study area			
6	clip_riv_cons_statutm34	conservation status of rivers in South Africa	projected in WSG_UTM 34,			

		created by ?	clipped to study area
7	clip_res1_utm34	conservation priority status of land units in the STEP planning region created by members of the Subtropic Ecosystem Thicket Project	projected in WSG_UTM 34, clipped to study area