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Systematic conservation planning products for land-use planning: Interpretation for implementation

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Abstract

There is an obvious need to incorporate biodiversity concerns into the policies and practices of sectors that operate outside protected areas, especially given the widespread devolution of power to local (municipal) authorities regarding land-use decision-making. Consequently, it is essential that we develop systematic (target-driven) conservation planning products that are both user-friendly and user-useful for local government officials, their consultants and the elected decision makers. Here, we describe a systematic conservation planning assessment for South Africa's Subtropical Thicket Biome that considered implementation opportunities and constraints from the outset by developing – with stakeholders – products (maps and guidelines) that could be readily used for local government land-use planning. The assessment, with concomitant stakeholder input, developed (i) Megaconservancy Networks, which are large-scale conservation corridors of multiple ownership that achieve targets principally for biodiversity processes; (ii) conservation status categories (critically endangered, endangered, vulnerable, currently not vulnerable) for all biodiversity features, identified on the basis of available extant habitat to achieve conservation targets, and (iii) a conservation priority map which integrates (i) and (ii). This map was further interpreted for municipal-level decision-makers by way of corresponding guidelines for land-use in each of the conservation status categories. To improve general awareness of the value of biodiversity and its services, a handbook was compiled, which also introduced new and impending environmental legislation. Within 18 months of the production of these products, evidence of the effective integration, or mainstreaming, of the map and its guidelines into land-use planning has been encouraging. However, more effort on increasing awareness of the value of biodiversity and its services among many stakeholder groups is still required. Nonetheless, our approach of planning for implementation by considering the needs and obligations of end users has already yielded positive outcomes. We conclude by providing suggestions for further improving our approach.

Keywords: Biodiversity persistence; Biodiversity representation; Implementation; Land-use planning; Mainstreaming; Systematic conservation planning

1. Introduction

While protected areas form the cornerstone of conservation strategies (Redford and Richter, 1999; Rodrigues et al., 2004), it is now widely accepted that strict protection will not secure the persistence of the world's biodiversity (Miller and Hobbs, 2002; Rosenzweig, 2003). The burden of conserving biodiversity will fall increasingly on sectors such as agriculture, forestry, mining and land-use planning (Burbidge and Wallace, 1995; Freemark et al., 2002; Hutton and Leader-Williams, 2003). In order for

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these sectors to play a constructive role in conservation, it is essential that biodiversity concerns be integrated or mainstreamed into their policies and practices (Cowling et al., 2002; Marzluff, 2004). Huntley et al. (in press) define mainstreaming biodiversity as the " the integration of values and goals relating to the conservation and sustainable use of biodiversity into economic sectors in order to achieve measurable conservation gains".

Over the past decade, great strides have been made in developing and refining methods of assessment for identifying priorities for conservation plans (Margules and Pressey, 2000; Groves, 2003). However, based on our collective experience in South Africa and Australia, we have come to believe that the most sophisticated methods of assessment will not achieve conservation goals if the needs of the implementing organizations and other inheritor stakeholders are not effectively considered during the planning process, and if the conservation planning products are not easily understood by these end users (Driver et al., 2003; Knight et al., in press; see also Theobald et al., 2000). This study forms part of a larger project (the Subtropical Thicket Ecosystem Planning Project) (Cowling et al., 2003) designed to overcome these two shortcomings by adopting the following approach. Firstly, those stakeholders who will ultimately inherit the plan, namely government officials associated with land-use planning, agriculture, nature conservation, water affairs and forestry, communal and freehold landowners, non-governmental organisations, tourism representatives and elected representatives, were identified (Boshoff and Wilson, 2004). Secondly, these stakeholders were invited to give input throughout the four-year development of the plan, from inception to the development of the final planning products (Knight et al., 2003). Thus, these inheritors developed a sense of ownership of the project. In this paper, we focus specifically on the products we developed to meet the needs of the land-use planning sector, a requirement widely recognised by others in the field of conservation planning (Theobald et al., 2000; Stoms, 2001; Marzluff, 2004). Agencies responsible for this sector routinely make decisions that result in the loss of irreplaceable biodiversity (Pressey, 1999; Groves, 2003). In the discipline of land-use planning (including landscape architecture) there is a long history of concern for biodiversity issues (e.g. McHarg, 1969; Steiner, 2000), though the focus has mainly been on the establishment of greenways (Fábos, 2003) and the maintenance of processes that provide services to urban and exurban communities (Beatley and Manning, 1997). Our study seeks to facilitate the integration of outcomes of systematic conservation planning into land-use planning policy and practice. These outcomes incorporate the spatial information on quantitative biodiversity targets (e.g. hectares of land classes or occurrences of species) for the long-term conservation and persistence of biodiversity features (Margules and Pressey, 2000).

In many parts of the world, land-use planning has been devolved to local government agencies that are expected to consult and involve a wide array of stakeholders from diverse sectors in identifying development options for their regions. Countries that are signatories to the Convention on Biological Diversity are compelled to adopt the principles embedded in Local Agenda 21, namely that local decision-making for integrated development planning (IDP) is democratic, and based on the goal of achieving social, economic and environmental sustainability (United Nations Conference on Environment and Development, 1992). South Africa is a signatory to the Convention, and has devolved all land-use decision making to some 284 local municipalities which encompass the entire country, and which are responsible for almost all land-use decisions. There are three major problems confronting the adoption and implementation of the environmental sustainability principle of Agenda 21: (i) among local government decision-makers there is a lack of awareness of the importance of planning specifically to protect priority areas identified through target-based conservation assessment; (ii) there is usually a disparity in objectives and, therefore, in structure and content between the scientific products generated by conservation assessments, and those required for land-use planning (Niämele, 1999; Theobald et al., 2000; Löfvenhaft et al., 2002), and (iii) many local government agencies responsible for land-use planning, especially in the developing world, lack the capacity to effectively integrate biodiversity into planning products (Wells and Brandon, 1993; Burbidge and Wallace, 1995; Infield and Adams, 1999; Groves, 2003) and would benefit from being provided with user-useful and user-friendly products (Driver et al., 2003).

Conservation biologists have made considerable progress in bridging the gap between conservation assessment and land-use planning (Saunders et al., 1995; ?, Pressey, 1998, 1999; Theobald et al., 2000; Ribaudo et al., 2001). However, systematic conservation assessment products, namely a spatially dispersed array of sites required to achieve targets (minimum sets) (e.g. Margules et al., 1988), maps of irreplaceability (e.g. Pressey, 1999), and imprecisely demarcated corridors required for the movement of specific biota (e.g. Rouget et al., 2003), are often not helpful to land-use planners who have to integrate the concerns of many sectors in a spatially explicit product. This is largely because most conservation planning assessments have neglected the instrument(s) required for the implementation process (Knight and Cowling, 2003a; Knight et al., in press), focussing instead upon the process of identifying priority areas for biodiversity. Furthermore, the use of arbitrary planning units (the spatially-explicit units used for displaying the results of conservation assessments) such as grid cells (a widespread feature of conservation assessments) makes integration even more difficult for land-use planners who usually require information for actual land management units, i.e. they work with cadasters. This paper describes a process aimed at overcoming these problems. The study is underpinned by two assumptions: (i) the conservation of biodiversity and its services forms the basis of environmental, social and economic sustainability (Orr, 2002a; Dawe and Ryan, 2003; Ekins et al., 2003), (ii) conservation priorities need to be identified using the principles of target-based representation and persistence (Margules and Pressey, 2000). Our chief contention is that the conservation priorities thus identified need to be interpreted in order to be integrated into land-use planning processes such as Integrated Development Plans (IDP) and Spatial Development Frameworks (SDFs) (Gelderblom et al., 2002; Cowling and Pressey, 2003; Marzluff, 2004).

The study was conducted in the Subtropical Thicket Biome of South Africa. Our targeted users were land-use planners and elected decision-makers in the region, which encompasses three district municipalities and 30 local municipalities. These stakeholders are responsible for all indicative planning (SDFs), hereafter referred to as forward planning, as well as reactive planning, involving decisions in response to applications from landowners for changes in land-usage. In addition to providing guidelines for these two forms of decision making, we also make recommendations regarding opportunities for sustainable development that makes optimal use of the natural environment and its biodiversity, e.g. wildlife ventures and ecotourism. We describe our approach involving the concurrent processes of systematic conservation assessment, which accounts for stakeholder needs and implementation issues, and the development of products, in particular a conservation priority map. With our initial focus on the municipal-level, we developed a Mapbook comprising a conservation priority map for each municipal area together with a set of guidelines. These guide both forward spatial planning and reactive decision making, and suggest opportunities for wise land-use. To complement the Mapbook, we compiled a Handbook for municipal decision makers aimed at enhancing understanding and awareness of the services provided by intact biodiversity, as well as relevant legislation, both existing and impending. Finally, we discuss the extent to which we have bridged the gap between conservation assessment and municipal-level land-use planning, describe the effectiveness of the interpretation for purposes of integrating this information into land-use planning, and provide a critique of our approach, so that others might learn from our experiences, especially with regard to extending the approach to other sectors.

2. A description of the planning region and planning context

2.1. Planning region

The planning region, which covers 105 454 km^2, is centred on the Subtropical Thicket Biome, and straddles the Western and Eastern Cape Provinces of South Africa (Fig. 1). Intact habitat covers 72% of the region, with 16% transformed by agriculture, urbanization, afforestation and alien invasive plants, and 12% has been severely degraded by overgrazing (Cowling et al., 2003). The principal form of land-use is the production of livestock from natural habitat on freehold farms; communal lands, where remittances from city dwellers are the major source of income, occupy less than 10% of the planning region. Approximately 7% of the planning region is included in formal (Type 1) protected areas, i.e. those underpinned by strong legislation and effective management (Cowling et al., 2003). Type 2 protected areas, i.e. those underpinned by weak or non-existent legislation, comprise 9% of the planning region. Ecotourism and wildlife ventures (principally game harvesting for venison or trophies) on freehold land, are the fastest growing enterprises that are based on the region's natural resources (Cowling et al., 2003).

2.2. Biodiversity features of the Subtropical Thicket Biome

The biodiversity features of the Subtropical Thicket Biome are described in detail in Cowling et al. (2003) and Vlok et al. (2003). The region is associated with two globally recognized centres of plant endemism, namely the Little Karoo Centre of the Succulent Karoo in the west, and the Albany Centre in the east (Van Wyk and Smith, 2001). The Subtropical Thicket Biome comprises the south-western sector of the Maputaland-Pondoland-Albany hotspot recognised as a global biodiversity priority by Conservation International (Steenkamp et al., in press).

2.3. Planning context: The Subtropical Thicket Ecosystem Planning Project

The Subtropical Thicket Ecosystem Planning (STEP) Project was a four-year initiative (July 2000–June 2004) funded by the Global Environment Facility. The overall aims of the project were: (1) to conduct a systematic conservation assessment to identify priority areas that would ensure the long-term conservation of the subtropical thicket biota, and (2) to ensure that the assessment outcomes were implemented via integrating them into the policies and practices of private and public sector agencies responsible for land-use planning and the management and use of natural resources in the planning region. Details on the project are provided by

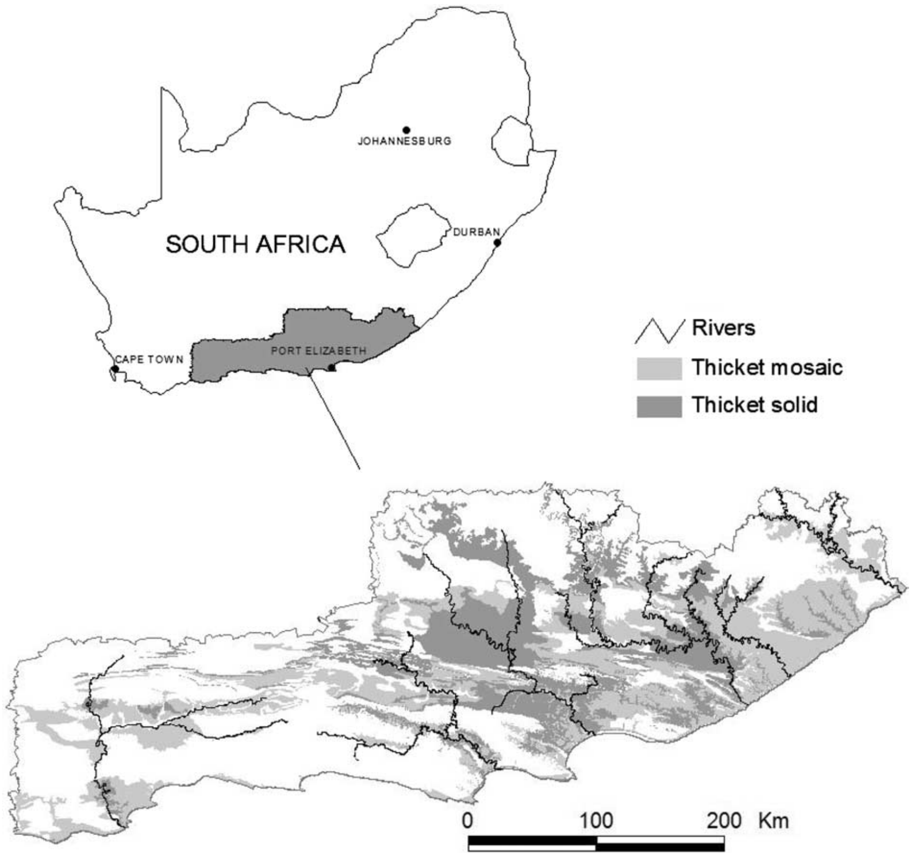

Fig. 1. The location of the Subtropical Thicket Biome and the Subtropical Thicket Ecosystem Planning (STEP) Project planning region in South Africa. Subtropical thicket vegetation is classified as "solid" and "mosaic" (see Vlok et al., 2003). Major rivers are shown.

Cowling et al. (2003), Knight et al. (2003) and Pierce (2003) (all available on http://cpu.uwc.ac.za).

2.4. Institutional and legal issues

There are two important pieces of legislation that have a bearing on the approach adopted for this study. The first is the Local Government Municipal Systems Act 32 of 2000. The spirit and deed of this act (Anon, 1998) are rooted in Local Agenda 21, a product of the 1992 Earth Summit, which identified local organizations and institutions as agents for development, and, along with social and economic issues, identified the conservation of the natural environment as a component of sustainable development. In terms of this legislation, local (municipal) government must undertake at least every five years, Integrated Development Plans and Spatial Development Frameworks. This process must be fully participatory and uphold the three foundations of social, economic and environmental sustainability. Retief and Sandham (2001) discuss how existing South African environmental legislation, geared mainly at national and provincial government, can be harnessed to ensure accommodation of environmental concerns at the local government level.

The second piece of legislation is the National Environmental Management: Biodiversity Act 10 of 2004. The aim of this act is to provide for the management and conservation of South Africa's biodiversity. Components of the act salient to this study are that (i) at the national and provincial sphere, there is provision for the listing of ecosystems that are threatened and in need of protection, and (ii) for listed ecosystems, the relevant municipalities must take into account the need for protecting such ecosystems in their Integrated Development Plans and Spatial Development Frameworks.

These pieces of legislation are progressive in: (i) recognising categories of endangerment at the ecosystem level, (ii) integrating biodiversity concerns into development planning, and (iii) the devolution of power to local-level organizations and institutions. However, at the local level, there are serious shortcomings in human capacity to implement this legislation. Prior to the 1994 democratic transition in South Africa, local government focused entirely on service delivery within urban areas, and biodiversity concerns were not their brief. Since that time, local municipalities have been newly demarcated to include various urban zones but always to encompass large areas of rural countryside that harbour much biodiversity, including many high-priority biodiversity features. Owing to the inequities of the apartheid era, all municipalities, but especially those in the racially designated former "homelands" comprising communally-owned land, have inherited a large backlog of essential services for the high number of impoverished inhabitants, operate on tight margins as a result of a small rates base, and have neither the capacity nor the resources to deal effectively with biodiversity issues. Certain products of this study, namely the guidelines associated with the maps, were designed and interpreted specifically to assist all municipal decision-makers in fulfilling their legal and moral responsibility for safeguarding biodiversity and its services, and to identify opportunities for sustainable development.

3. Conservation assessment for implementation

A STEP Project report provides a detailed description of the conservation assessment, including biodiversity features, biodiversity targets, land-use opportunities and constraints, and methods of analysis (Cowling et al., 2003). Rouget et al. (in press) provide additional information on the identification of conservation corridors as the spatial component of Megaconservancy Networks (see 3.4.1). Here, we provide a brief summary of the planning framework, methods and outcomes, highlighting how implementation considerations were integrated throughout.

3.1. Planning framework

The approach adopted for this study was guided by a conservation planning framework, developed by Knight and Cowling (2003a). This framework comprises three components, namely:

(i) empowering individuals and organizations, specifically the inheritor stakeholders and their associated implementing organizations mentioned above, through consultation about their needs and concerns, and accommodating these in the final assessment outcomes;
(ii) systematic conservation assessment;
(iii) securing conservation action through consultation with, and input from inheritor stakeholders.

Knight and Cowling (2003a) provide details on the components of the framework; here we wish to make only three points.

First, the approach to the conservation assessment was guided by the principles and practices of systematic conservation planning, as articulated in Margules and Pressey (2000).

Second, the framework added significantly to other systematic conservation planning protocols (e.g. Margules and Pressey, 2000; Groves, 2003), in that the systematic assessment was conceptually and operationally integrated into a broader planning framework focussed upon the implementation of conservation action. This increased the likelihood of establishing the prerequisite conditions essential for assessment outcomes being accepted by stakeholders and, therefore, the likelihood of successfully securing conservation action.

Third, the framework adopted the now widely endorsed ecologically sustainable land management or ecosystem approach (e.g. Bunch, 2003) to the conservation of landscapes and their component biodiversity (Knight and Cowling, 2003a). This approach aims to "keep people on the land in living landscapes", as opposed to the traditional approach of conservation, which removes people to create formal protected areas. In this way, it aims to ensure that not only are the landscapes and biodiversity of the Subtropical Thicket Biome conserved for future generations, but also that the social and economic systems of the region promote improved quality of life for its human inhabitants who are viewed as stewards for biodiversity.

3.2. Planning units

The planning region was subdivided into biogeographic divisions of the Subtropical Thicket Biome that are largely aligned with the region's major primary water catchments (Vlok et al., 2003) (Fig. 2). The units of selection for the conservation assessment, namely the planning units, were based on cadastral data, ecological and evolutionary process areas, and include Type 1 protected areas (i.e. protected areas underpinned by strong legislation and enforcement). The use of cadastres, as opposed to arbitrary planning units, enhanced implementation since these are the units that land-use planners routinely use when making land-use decisions.

3.3. Biodiversity features and targets

The STEP Project's conservation assessment, undertaken at the 1:100 000 scale, used as biodiversity features 169 vegetation types (of which 112 are thicket types), three wetland types, and five spatial surrogates (hereafter components) of ecological and evolutionary processes (Table 1). A model was used to determine the potential distribution and abundance of African elephant (*Loxodonta africana*) (Boshoff et al., 2001), a species used as a surrogate for the wildlife potential of the planning region (Rouget et al., in press). Conservation targets, which are central to the systematic approach to conservation planning (Margules and Pressey, 2000), were set for all biodiversity features used in this study (Table 1). Targets for vegetation types, expressed as a percentage of the type's pre-transformation area, were set using species-area data derived from phytosociological

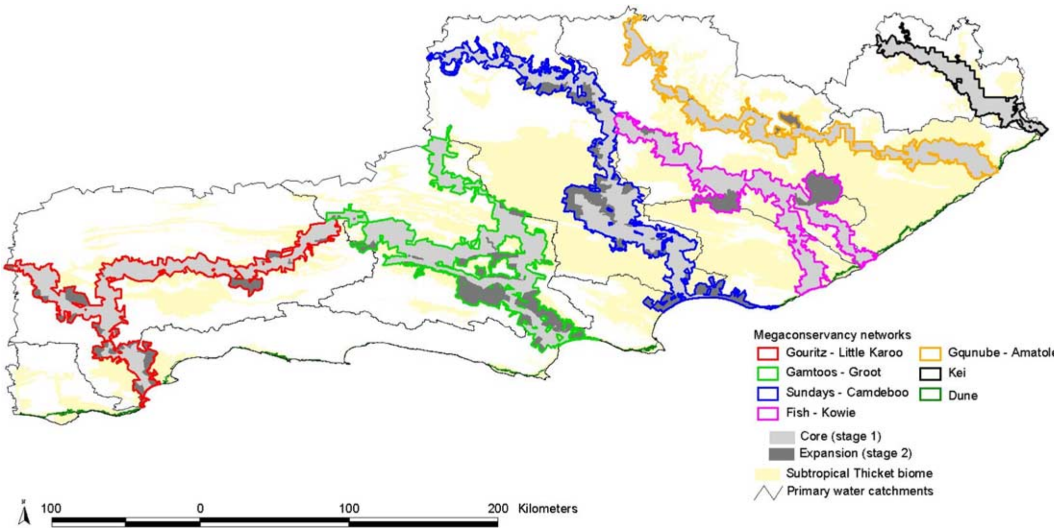

Fig. 2. Location of conservation corridors, or Megaconservancy Networks, in the STEP planning region. Each corridor represents the most suitable route for capturing upland-lowland and macroclimatic gradients within each major drainage basin, and along the dune coast. Corridors integrate biodiversity patterns and processes and incorporate protected areas, but also avoid land-use pressures. From Rouget et al. (in press).

Table 1
List of biodiversity features considered in the STEP conservation assessment

Feature	Description	Target	Additional references
Habitat types	169 vegetation and 3 wetland types mapped at 1:100 000	10–26% of original (pre-transformation) area	Desmet and Cowling (2004)
Wildlife suitability	Habitat suitability for focal species (elephant)	1000 individuals in planning region	Boshoff et al. (2002); Kerley et al. (2003)
Spatially-fixed processes	Biome interfaces, riverine corridors and sand movement corridors	100% of extant area	Rouget et al. (2003)
Spatially-flexible processes	Upland-lowland and macroclimatic gradients	At least one in each biogeographic region	

Details are provided in Cowling et al. (2003).

relevés (Desmet and Cowling, 2004), and ranged from 10% to 26% (Cowling et al., 2003). Targets for wetland and forest types were set as 100% of all remaining habitat, as required by South African legislation.

3.4. Conservation planning products

This study generated three conservation planning products, namely Megaconservancy Networks (MCNs) and conservation status categories, which were then combined into a conservation priority map for the region. The process of production is described below. Note that all products, at various stages of development, were presented for comment to a range of stakeholders, including municipal decision-makers, planners, nature conservation officials, planning and environmental consultants, and landowners at a series of workshops, where at least one of the authors was present at any given event. One-on-one interviews were held with key stakeholders in the land-use planning sector to refine the maps and guidelines. Significant time and effort was specifically invested in stakeholder collaboration for product structure, format and presentation, and this greatly improved the final utility of the product. Boshoff and Wilson (2004) provide information on the stakeholder engagement process in the workshops.

3.4.1. Conservation corridors as Megaconservancy Networks

Planning for the persistence of biodiversity (Cowling et al., 1999; Rouget et al., 2003) was a key component of the conservation assessment. We accommodated a persistence goal by identifying conservation corridors that incorporated major ecological and evolutionary processes, in particular those following major biological gradients, as well as a coastal corridor (for details, see Rouget et al., in press). The planning units used to populate the six inland and one coastal conservation corridors were selected on the basis of subtropical thicket representation, habitat transformation and degradation, wildlife suitability, irreplaceability of vegetation types (Pressey, 1999), existing protected area networks and future land-use pressures (Fig. 2). Thus, the expanded corridors accommodated implementation issues by avoiding areas already transformed and vulnerable to future transformation, and by incorporating areas that already enjoy some form of protection or are suitable for biodiversity-based tourism and wildlife ventures. These conservation corridors covered 24.9% of the planning region (ranging from 600 to 5200 km^2) and successfully achieved targets for biological processes and to a lesser extent for representation of vegetation types (Rouget et al., in press).

In order to provide an implementation mechanism for the expanded corridors, each was named as a specific Megaconservancy Network (Knight and Cowling, 2003b) (see Fig. 2). The implementation of ecologically sustainable land management in each of these would ensure simultaneously the achievement of biodiversity persistence targets, half of the biodiversity pattern (vegetation type) targets (Rouget et al., in press), and socio-economic goals (Knight and Cowling, 2003b). Hence, a Megaconservancy Network is a mechanism for achieving ecologically sustainable land management on a contiguous patchwork of properties of various tenures and land-uses, which maximizes landscape heterogeneity and the management of capital flows (e.g. natural, financial, social) (Knight and Cowling, 2003b). This can be achieved only if the component properties are managed in a co-ordinated, co-operative and integrated way.

3.4.2. Conservation status categories

The Megaconservancy Networks, together with Type 1 protected areas, do not achieve targets for all of the biodiversity features that we used in this study (Rouget et al., in press). Moreover, there is probably much undocumented and undescribed biodiversity in the 75% of the extant habitat of the planning region that falls outside of these Networks. Here, we present a procedure to deal with the areas that fall outside of both Megaconservancy Networks and existing protected areas. It was designed to ensure the retention of habitat associated with priority biodiversity features (in this case, vegetation types). In particular, it aimed to provide a region-wide categorisation of endangerment that would provide land-use decision makers with information enabling them to make decisions that would enhance instead of compromise the achievement of biodiversity targets.

Vegetation types were classified according to four categories of endangerment – critically endangered, endangered, and vulnerable ecosystems, as termed in the Biodiversity Act, as well as not currently vulnerable. The method of categorisation was purposely devised to be very simple: it was based on the area of each vegetation type required to achieve its biodiversity-based target, and the remaining area of its extant habitat, both expressed as a percentage of the original (pre-transformation) extent (Fig. 3). The conservation status of a vegetation type was determined by the difference between the target and extant habitat: where the target was ⩾ extant habitat, then the vegetation type fell into the critically endangered category; where the difference between the target and extant habitat was ⩾60% of the original extent of the vegetation type, it was categorised as currently not vulnerable. The cutoff of 60% selected those vegetation types that have a buffer of extant habitat >60% between themselves and the critically endangered category (i.e. the amount of extant habitat greatly exceeds the amount required for the target). The cutoff also selects only those vegetation types that have more than half of their habitat still extant. There is an extensive literature, mainly theory, which suggests that above a threshold of 50–70% of intact habitat, biodiversity is likely to persist, owing to the maintenance of ecosystem processes and viable populations of component species (e.g. Fahrig, 2001; Flather and Bevers, 2002; Desmet, 2004).

The other two categories (endangered and vulnerable) were determined by their positions above or below a parallel threshold line starting at 30% of extant habitat (Fig. 3). Research suggests that below a threshold of 20–40% of intact habitat remaining, biodiversity loss accelerates markedly (Andrén, 1994; Fahrig, 2001). The cutoff of 30% was half way between the two extreme categories of critically endangered, and currently not vulnerable. Vegetation types below the threshold had a buffer of less than or equal to 30% between themselves and the critically endangered category and were considered endangered, whereas vegetation types above the threshold had a buffer of between 30% and 60% between themselves and the critically endangered category and were considered vulnerable.

The results of the categorisation of the 172 vegetation types (including three wetland types) are shown in Fig. 3. Nine fell into the critically endangered category, of which seven were thus categorised because they have their targets set to all remaining extant habitat owing to national legislation: these are the three wetland types

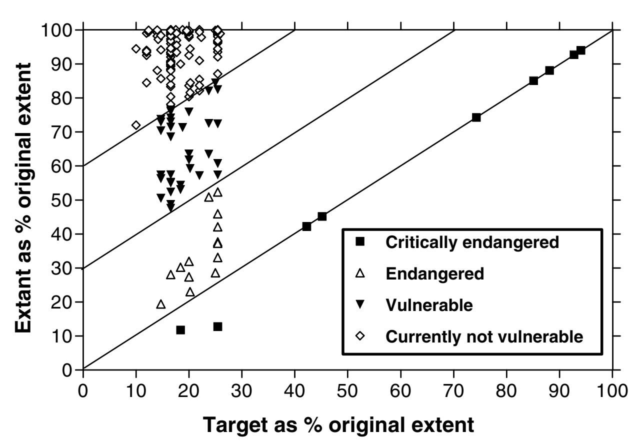

Fig. 3. Categorisation of the 169 vegetation types and three wetland types in the STEP planning region according to conservation status. The seven points on the bottom threshold line are the wetland and forest types for which targets were set at 100% of all extant habitat, as required by South African legislation.

Table 2
Area of extant (non-transformed[a]) habitat in categories of different conservation status in the STEP planning region

Land class	Symbol	km^2	% of planning region[b]
Type 1 protected areas		7222	8.1
Critically endangered[c]	I	17 931	20.2
Endangered	II	1388	1.6
Vulnerable	III	7388	8.3
Currently not vulnerable	IV	54 798	61.8

[a] That is, excluding areas transformed by urbanization, agriculture, afforestation and dense stands of invasive alien plants.
[b] Extant habitat only.
[c] Includes six vegetation types, three wetland types, spatially-fixed process components and the seven Megaconservancy Networks (MCNs).

and the four forest types. For the other two, targets could not be achieved owing to extensive transformation. Fourteen vegetation types fell into the endangered category. The vulnerable category included 35 vegetation types, and 114 vegetation types were categorised as currently not vulnerable.

We also categorised as critically endangered all extant habitat associated with the spatially fixed process components (Table 1) and the seven Megaconservancy Networks. The rationale for this was the need to retain all extant habitat associated with these features in order to ensure the long term persistence of biodiversity in the planning region (Cowling et al., 1999), and to contribute to targets for vegetation types through biodiversity-friendly management regimes. Overall, the critically endangered category (outside of Type 1 protected areas) comprised about 20% of the planning region (Table 2), of which 15 638 km^2 (87.5%) encompassed Megaconservancy Networks, 1206 km^2 (6.7%) the spatially fixed process components, and 1044 km^2 (5.9%) the nine vegetation types where the targets exceeded or equalled available habitat.

3.4.3. Conservation priority maps

The next challenge was to merge the Megaconservancy Networks and conservation status information into a single map that could be readily used by land-use decision-makers at all spheres of government (national, provincial and municipal), as well as by consultants, who regularly undertake work for government agencies.

Many assessments fail to be effectively implemented owing to poor or inappropriate product design (Theobald et al., 2000; Driver et al., 2003). Therefore, two of us (SMP and TW) devoted a great deal of effort, including workshop and one-on-one interactions with key stakeholders in the land-use planning sector, to identify the appropriate format and colour scheme for what we termed the "STEP conservation priority map".

Fig. 4 shows the conservation priority map for: (a) the entire planning region, and (b) a single municipality. Note that the maps include cadastral boundaries, rivers and all proclaimed roads (to facilitate site location by users), impacted or irreversibly transformed areas (to provide visual context for the endangerment categories), protected areas (Type 1 only), the location of Megaconservancy Networks (termed 'Network') and the spatial components of fixed processes (termed 'Process area'). Copies of these maps, along with the geographical information systems (GIS) data, for the entire planning region and for each of the region's 30 municipalities, can be downloaded from the website of the Conservation Planning Unit of Cape Nature, formerly the Western Cape Nature Conservation Board: http://cpu.uwc.ac.za.

3.5. Interpretation for municipal-level decision-makers

3.5.1. The STEP mapbook

We facilitated interpretation by twinning the conservation priority map with a corresponding set of guidelines designed specifically for municipal-level decision-makers (Table 3). We termed this product the STEP Mapbook, which was produced to assist municipalities in integrating biodiversity into land-use decisions (Pierce, 2003).

These guidelines provide, for each category of endangerment (Fig. 4), recommendations for reactive land-use decisions and for the forward planning required by Spatial Development Frameworks. The guidelines were developed by one of us (SMP) in wide consultation with conservation experts and key stakeholders in the land-use planning sector, by iterative refinement through one-on-one interviews and in workshops. Table 3 provides an example of the guidelines for the two extreme categories, namely currently not vulnerable and critically endangered. The complete set of guidelines can be downloaded from the website of the Conservation Planning Unit of Cape Nature: http://cpu.uwc.ac.za.

The guidelines are explicit and should ultimately be supported by regulations drafted for the Biodiversity Act. Thus, in critically endangered areas (including Megaconservancy Networks and Process areas), the recommendation is for no further loss of habitat and no impacts that would result in the loss of biodiversity (Table 3). These areas, however, also offer forward-planning opportunities, such as low-impact ecotourism. On the other hand, the guidelines recommend that high-impact activities or developments should be located in currently not vulnerable areas. Thus, the guidelines provide a basis for ensuring biodiversity-friendly development via both reactive and forward planning.

Each of the 30 local municipalities within the planning region was presented with a Mapbook, comprising a series of large-format maps (1:100 000) covering their area of jurisdiction, and a table of guidelines. The district municipalities received Mapbook compilations comprising all the local municipal areas within their domain.

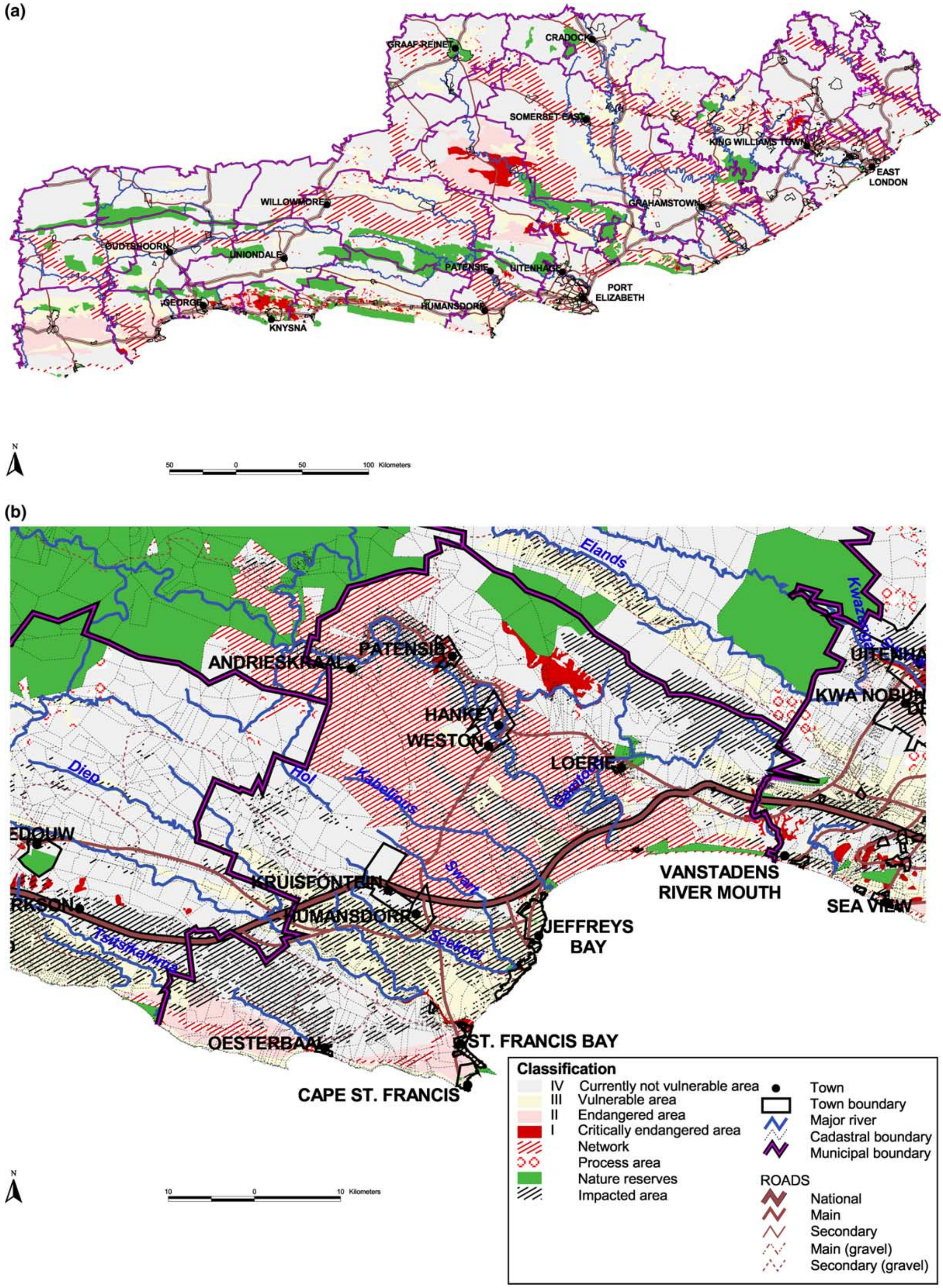

Fig. 4. Conservation priority maps of (a) the entire STEP planning region and (b) the Kouga Municipality.

3.5.2. The STEP Handbook

We believed that the outcomes of the conservation assessment in the planning region needed to be supported by additional interpretive material. Furthermore, with the enactment of more stringent municipal and environmental legislation, it became apparent that land-use

Table 3
Guidelines to assist municipal decision-makers and consultants in fulfilling their legal and other obligations to the natural environment

Category	Brief description	General rule	Procedures for municipalities (Reactive decisions)	Restrictions on activities (Forward spatial planning)	Opportunities for activities (Forward spatial planning)
Currently not vulnerable	Ecosystems which cover most of their original extent and which are mostly intact, healthy and functioning	Depending on other factors, this category can withstand loss of natural habitat	1. Proposed disturbance or developments should preferably take place on impacted areas.[a] 2. In response to an application for a non-listed activity which will have severe or large-scale disturbance on a relatively undisturbed site (non-impacted), the municipality should first seek the opinion of the local conservation organization. 3. For a proposed "listed activity", EIA[b] authorisation is required by law.	1. Proposed disturbance or developments should preferably take place on portions which have already undergone disturbance or impacts[a] rather than on portions that are undisturbed. 2. In general, this category can withstand loss of or disturbance to natural areas through human activities and developments.	Depending on constraints (such as avoidance of spoiling scenery or wilderness, or infra-structure limitations), this category can withstand loss of or disturbance to natural areas. Subject to these constraints, this category may be suitable for a wide range of activities (e.g. extensive urban development, cultivation, tourist accommodation, ecotourism, game faming).
Critically endangered	Ecosystems whose original extent has been so reduced that they are under threat of collapse or disappearance. Included here are special ecosystems such as wetlands and indigenous forests	Under no circumstances can this category withstand further loss of natural habitat	1. As a rule, no further loss of natural area and no further impacts[a] should be allowed. 2. The municipality should require an on-site investigation[c] to verify the site's condition relative to impacts[a] and its categorization. 2a. If the site has been severely impacted[a], and is assessed as critically endangered, then the municipality should recommend restoration[d] of the portion of land which will remain undeveloped, and its proclamation and management as a protected area.	No further loss of natural area and no further impacts should be allowed. Any disturbance of this category should be allowed only on condition that there are net gains for the natural environment (e.g. in the portion which will remain undeveloped), restoration[d] and proclamation and management as a protected area.	This category may be suitable for eco-friendly, nature-based activities with almost no impacts[a] such as responsible ecotourism (hiking trails, etc.). In those areas which have undergone severe impacts[a], there are opportunities for Integrated Development Planning (IDP) restoration[d] projects, via poverty relief funding.

		2b. If the site is relatively undisturbed, with medium to low impacts[a], and is verified as critically endangered, then the municipality should request a Special EIA.[e] 3. For a proposed "listed activity" that by law requires EIA[b] authorisation, the municipality should recommend a special EIA.[e]

Only two sample rows are given here; omitted are rows for vulnerable, endangered, Networks (MCNs), Process areas, protected areas and impacted (transformed) areas (adapted from Pierce, 2003).

[a] Impacts may be evaluated according to: (1) type of impact (e.g. urban development, cultivation, alien invasive plants, overgrazing); (2) extent of impact (degree of fragmentation); and (3) severity of impact (e.g. density of alien invasive plants, degree of overgrazing). Category (e.g. currently not vulnerable, Network, Process area) should be considered together with evaluation of impacts in order to make appropriate recommendation.

[b] EIA = environmental impact assessment. The law requires that before municipal decision-makers may allow certain "listed activities" in their area, they must first receive the necessary EIA authorisation from the relevant government department, which has to be arranged by the applicant. See Pierce (2003) (Appendix 1, Annexure 2) for further details on EIAs and "listed activities".

[c] On-site investigation should involve firstly an evaluation of impacts[a] and then, depending on these findings, further assessment by a conservation official or specialist consultant of the site's vegetation type/s and categorisation (e.g. critically endangered, Network). This verification is recommended because of the broad-scale (1:100 000) feature mapping used in the STEP Project.

[d] Restoration can involve the permanent removal of invasive alien plants, wetland restoration, and replanting of degraded areas. See Pierce (2003) (Chapter 3, section 1.2) for financing opportunities.

[e] Special EIA here means an EIA which also takes into account: (1) a vegetation survey and categorisation of area according to the definitions of the STEP Handbook (Appendix 2); (2) evaluation of impacts[a]; (3) permission only for development appropriate to category (e.g. critically endangered, Network); (4) if area is impacted and development is allowed, then recommendations for a net gain for the ecosystem (i.e. restoration[d] of the portion of land which will not be developed, and its proclamation and management as a protected area).

decision-makers at the municipal-level needed assistance in fulfilling their legal obligations regarding biodiversity conservation and environmental sustainability.

Therefore, the STEP Handbook (Pierce, 2003) was compiled to provide further information to enable land-use decision-makers and private-sector consultants (acting on behalf of public or private sector agents) to make development decisions and recommendations, respectively, that do not violate the biodiversity conservation and environmental sustainability principles embodied in the Biodiversity and Municipal Acts.

The Handbook also provides an explanation of the conservation assessment in lay terms; information on the value of biodiversity as a prerequisite for sustainability; legal obligations regarding biodiversity and sustainability; land reform and biodiversity; a guide to environmental legislation and Environmental Impact Assessment regulations from a planning perspective; and information on the recognition of biodiversity features for specialist consultants. Information on the value of biodiversity was illustrated by case studies describing in brief the economic importance of plants and animals, the role of the indigenous pollinator fauna in sustaining the fruit export industry, water supply and quality, indigenous knowledge, ecotourism, beach sand replenishment and carbon capture, as well as socio-cultural heritage value.

The STEP Handbook can be downloaded from the website of the Conservation Planning Unit of Cape Nature: http://cpu.uwc.ac.za.

4. Response of land-use decision-makers to the STEP products

The conservation priority map has been generally well received by representatives of national, provincial and district municipal spheres, and by private consultants working for local municipalities. Owing to funding delays, the program to guide municipal decision-makers in the use of the STEP Handbook and Mapbooks has only recently been initiated (October 2004). Acceptance of the Megaconservancy Network concept has also been favourable. Below we present an anecdotal account of the extent to which the study's conservation assessment products, hereafter referred to as STEP products, have been incorporated into land-use decision-making thus far (see also Boshoff and Wilson, 2004).

4.1. National government and parastatals

The STEP products have been incorporated into the National Biodiversity and Action Plan of the national Department of Environmental Affairs and Tourism and endorsed by the South Africa National Biodiversity Institute (formerly the National Botanical Institute) which has undertaken to catalyse and facilitate the implementation of the STEP Project and its products in the Eastern Cape Province. Furthermore, the STEP products are being used by South African National Parks in the spatial planning for the expansion of the Addo Elephant and Mountain Zebra national parks; by the Department of Water Affairs and Forestry to inform their planning activities; and by the Electricity Supply Commission, South Africa's parastatal power utility company, to inform the location of a major powerline across the planning region. The Development Bank of South Africa, which provides institutional and other support to municipalities, has made compliance with the STEP Project's conservation plan mandatory for the successful disbursement of loans and grants.

4.2. Provincial governments

The STEP products have been adopted by provincial-level planners for both the Western Cape and Eastern Cape Provinces for identifying the boundaries of, and permissible impacts within, the evolving Gouritz and Baviaanskloof mega-reserves, two of the Megaconservancy Networks identified by the assessment (Fig. 2). Cape Nature, the conservation organisation for the Western Cape Province, has endorsed the use of the STEP products and has made compliance with these a default in the compilation of their Spatial Development Frameworks for district and local municipalities within the planning region. The Department of Economic Affairs, Environment and Tourism: Eastern Cape Province, the organisation responsible for conservation outside of Type 1 protected areas, has used the STEP products in compiling the provincial conservation plan, which will ultimately inform the forthcoming Provincial Growth and Development Plan; this plan will, in turn, provide a spatially-explicit development guidelines for all government sectors in that part of the planning region that falls within the province. The products were incorporated into the Eastern Cape Province's Strategic Assessment of Biodiversity of 2003 and its State of the Environment report of 2004.

Little success, however, has been achieved in engaging the formal agriculture sector, especially at provincial government level, despite involvement of relevant officials in the process. However, rural landowners have viewed the Megaconservancy Network concept with interest and enthusiasm.

4.3. Local government

The planning region includes a metropolitan municipality (the Nelson Mandela Metro comprising three large urban centres) and three district municipalities, each of which includes a number of local municipal areas. Officials, planners and their consultants are using the STEP products to inform their spatial planning, but to varying degrees. Two district municipalities of the Eastern Cape have formally requested their local municipalities to comply with the planning guidelines in the compilation of their Spatial Development Frameworks. Stewart et al. (2004) produced a fine-scale (1:10 000) assessment for the Nelson Mandela Metro that used the STEP Project's approach to produce a conservation priority map and the same associated guidelines. This product has been integrated into land-use decision-making for the metro.

STEP products are also being integrated into planning for the municipality of the region's second largest city. Several of the smaller municipalities are using the products, although this is happening not through the involvement of municipal officials, but instead via consultants who are employed by municipalities to prepare their Spatial Development Frameworks. Feedback from these consultants has been very positive and all regard the products as user-useful and user-friendly. We know of at least two cases where frameworks that used the STEP products, have directed development away from priority areas.

At this stage, an evaluation of the extent to which of the products have been effectively integrated or mainstreamed into municipal decision-making is premature, and must await the completion of the recently initiated capacity building and training project based on the Handbook and Mapbook.

5. General discussion

Here, we first evaluate the conservation assessment approach and its products, next we assess the extent to which we have been successful in making these products useful, and finally we provide a general critique of our study and make suggestions for improving future initiatives.

5.1. Evaluation of the conservation assessment for implementation

The implementation of conservation action is a normative process, guided by human values and the consequent choices that people make (Callicott et al., 1999; Freyfogle and Newton, 2002). Therefore, in order to influence conservation decisions, conservation biologists need to confront and comprehend the messy world of institutions, policies and politics (Meffe, 1998), and reach beyond the biological sciences into economics, sociology, education and law (Robertson and Hull, 2001; Orr, 2002b; Mascia et al., 2003). The discipline of "conservation planning" is a case in point: overwhelming effort has been devoted to refining the scientific and technological aspects of the systematic assessment component of what is, overall, a complex social planning process (Knight et al., in press). Equal effort is now required in designing products for implementers, illustrated by, for example, the development of the conservation priority map, the Handbook and Mapbook (Pierce, 2003), as well as developing an implementation strategy. The development of the implementation strategy (Knight et al., 2003) took the same amount of time as the systematic assessment, and was fraught with greater challenges.

The approach adopted for the assessment is significantly different from the approach used for most other systematic conservation assessments. Notably, we considered implementation issues from the outset. Of particular importance were the lessons that we learnt from participating in the assessment for the Cape Action Plan for the Environment Project (Cowling and Pressey, 2003), namely: (i) municipal-level decision-makers are a key stakeholder group since it is they who are empowered to make far-reaching decisions regarding biodiversity, and (ii) assessment products must be both user-friendly and user-useful: products based on arbitrary planning units and dynamic and often cryptic biodiversity values (e.g. maps of irreplaceability) are not comprehensible to most stakeholders working in the land-use planning sector (Driver et al., 2003).

Other factors that influenced our approach for this assessment and developing its products were the promulgation of the Municipal and Biodiversity Acts. These two pieces of legislation provide the principal instruments for ensuring that our assessment products are being integrated into municipal-level decision-making. They dictate the sphere of governance that we targeted and underpin the conservation status categories that were identified for different land classes. Another influence on our approach is the growing armoury of municipal-level incentives for conservation on private land, currently being developed to facilitate the retention of natural habitat in priority areas (Botha, 2001). Finally, successfully implementing ecologically sustainable land management on freehold land requires an optimal mix of complementary conservation and land-use instruments (Young et al., 1996). This led us to formulate an explicit land management model, namely the Megaconservancy Network concept (Knight and Cowling, 2003a).

5.2. Evaluation of conservation status categories

While there have been other attempts to allocate land class features to categories of endangerment (e.g. Noss et al., 1995; Reyers et al., 2001), this study is the first attempt to use, in addition to habitat loss, an explicit and defensible biodiversity target in identifying these categories. Obvious problems with the method are the somewhat arbitrary cutoffs between categories and lack of consideration of habitat fragmentation status of extant features. Thus, a feature in the currently not vulnerable category could have a high level of anthropogenic habitat fragmentation and might better be located in the vulnerable category. However, similar overall levels and configurations of habitat fragmentation may affect different components of the biota differently (Collinge, 2001). Until a clearer picture has emerged on the impacts of different habitat fragmentation patterns on different biodiversity components, we believe it would be unwise to change this system. We do note, however, that any amount of fine-tuning is unlikely to change the status of critically endangered and endangered features (unpublished data), these being the ones where habitat retention is most critical. These thresholds can be reviewed periodically, as provided for by the Biodiversity Act.

5.3. Evaluation of the conservation priority map

A major advantage of the conservation priority map is that it provides information on the priority status of features (i.e. vegetation types and ecological and evolutionary process surrogates), as opposed to individual planning units (e.g. grid squares), for the entire planning region. Furthermore, the endangerment status categories are relatively stable over time, unlike in the case of minimum set analyses (Margules et al., 1994). The latter deliver spatially dispersed arrays of priority planning units that achieve biodiversity targets but provide no information on the remainder of the planning region. Moreover, any given minimum set solution is only one of a host of different spatial options for target achievement (Balmford, 1998); land-use planners would require the appropriate data and software in order to assess the likely impacts of habitat loss on biodiversity conservation. While maps of irreplaceability do have the advantage of providing region-wide information on conservation value (Pressey, 1999), their information is provided for planning units and relatively small changes in the status of particular planning units may result in quite large changes in the irreplaceability patterns. As is the case of minimum set analysis, irreplaceability analysis is dynamic and requires capacitated personnel to effectively use these tools for land-use planning. Our experience from earlier conservation assessments such as the Cape Action Plan for the Environment Project (Cowling and Pressey, 2003) indicates land-use planners and other stakeholders had great difficulties in comprehending dynamic products (Driver et al., 2003).

5.4. Bridging the gap

While many have made the plea for improved integration of systematic conservation assessment and land-use planning approaches and products (Niämele, 1999; Pressey, 1999; Theobald et al., 2000; Stoms, 2001; Löfvenhaft et al., 2002; Groves, 2003; Marzluff, 2004), we know of no published examples that have sought, explicitly, to bridge the gap between these two sectors. This gap is symptomatic of the pervasive gap that exists between the production of scientific information and its provision in forms useful to those who need it for implementation (Hulse et al., 2004). Clearly, if this gap is to be bridged at a much wider scale, the current academic focus upon systematic assessment methodologies must be re-focussed upon implementation issues (Knight et al., in press).

This study has connected the outcomes of a systematic conservation assessment with the needs of land-use planners, resulting in the products that have been endorsed by planning officials and consultants working in this sector. In particular, they have appreciated the region-wide depiction of conservation values, the stability of the products (at least over the five-year planning processes required by the Municipal Act), and the lack of requirement for GIS and other software capacity for routine use. We are quite confident that our products have achieved simultaneously the goals of systematic conservation planning (representation and persistence) in a format that is comprehensible and useful for municipal-level decision-making. However, additional training support will be required in poorly capacitated municipalities.

5.5. Adoption of the products

In just eighteen months since their publication, the products have been surprisingly well integrated or mainstreamed into land-use decision-making across the planning region, but especially in those organizations that fulfil the prerequisites of adequate organizational and institutional capacity, effective non-governmental organisation involvement, and awareness of the significance of biodiversity (Cowling et al., 2002). Thus, the adoption of the products has been most effective in the Nelson Mandela Metro (Stewart et al., 2004), in the municipality of the region's second largest city (Buffalo City), and in the better-capacitated district municipalities (especially in the Western Cape Province), in national and provincial organizations, and amongst consultants.

The major constraints for effective adoption at the municipal level are a lack of awareness of the significance of biodiversity for social and economic sustainability, and poor governance and capacity in municipal organizations. Because of the high levels of poverty and unemployment in our planning region, much greater emphasis is given to the social and economic pillars of sustainability; generally, biodiversity and the natural environment concerns are associated with the wealthy elite (see Turpie, 2003) and not regarded as a priority. Envisaging a healthy biosphere as the foundation for economic and social well being (Orr, 2002a; Dawe and Ryan, 2003), or even as one of the three equally important pillars of sustainability, is certainly not a widely held view amongst municipal officials in the planning region. However, when expressed in terms of clean water, sufficient forage for livestock, and a supply of wild plants for food and medicine, biodiversity and the environment have much more meaning for the rural poor, as revealed in meetings between one of us (SMP) and officials and councillors from impoverished and poorly capacitated municipalities. More effort is required to clarify the significance of biodiversity to human well-being in these municipalities.

Along with a lack of awareness of biodiversity issues, a lack of capacity and poor governance in many municipalities in the planning region, there are a number of characteristics which are also hindrances to effective integration or mainstreaming of biodiversity concerns into land-use planning (Smith et al., 2003). The amalgamation of small neighbouring urban municipalities, a skills exodus, large backlogs for social delivery to the very poor, and the additional burden of servicing expanded rural areas, have placed a huge strain on the new municipal structures (Retief and Sandham, 2001). In most municipalities, ecosystem services are poorly understood, under supported and not co-ordinated, and capacity for environmental conservation is mostly non-existent. A weak non-governmental organization sector (at least in conservation) greatly hinders opportunities for effective partnerships for achieving environmental sustainability (Wells and Brandon, 1993; Steiner et al., 2003).

In order for widespread adoption of the products to occur throughout the planning region, much more attention needs to be given to creating more effective and accountable governmental and non-governmental organizations and institutions at the local scale (Burbidge and Wallace, 1995; Brunckhorst, 1998). Hopefully, an increasing awareness and appreciation of the value of biodiversity to material and spiritual well being (Orr, 2002b) will be achieved by the capacity building project for training municipal officials and councilors in the use of the STEP Handbook and Mapbook. The project also intends to expand the guidelines to incorporate all provincial and national government sectors that influence land-use decision-making.

5.6. General critique and suggestions for improvement

The overall approach we have adopted for this study has many shortcomings. Fortunately, planning is an ongoing activity and Spatial Development Frameworks must, by law, be repeated every five years. Therefore, there are many opportunities to improve the conservation assessment products to enable stronger integration into municipal land-use planning. Below we provide some suggestions.

While the Handbook was aimed at increasing awareness of the value of biodiversity for the range of services it provides, our conservation planning assessment used biodiversity features that emphasized existence rather than use values. Nonetheless, many of the features that we have targeted are of great value to other sectors with which alliances should be formed (Johns, 2003), namely tourism (e.g. sand movement corridors for beach replenishment, natural scenery and wildlife), water (mountain catchments, riverine corridors and wetlands) and agriculture (habitat for pollinators, grazing resources, cut flowers). The conservation of priority natural habitat adjacent to urban areas involves high opportunity costs. However, the retention of such areas provides an opportunity to re-connect the urban poor to biodiversity (Pyle, 2003) and maintain unbroken the heritage of indigenous knowledge and biodiversity-based tradition that exists amongst rural migrants who now live in urban centres (e.g. Cocks and Wiersum, 2003).

The features that support the services described above can be envisaged as critical natural capital, defined by Ekins et al. (2003) as "natural capital which is responsible for important environmental functions and which cannot be substituted in the provision of these functions by manufactured capital". We propose that stakeholders be involved in identifying and mapping different forms of critical natural capital, and also in communicating its importance for sustainability to government and civil society. While economic assessments of the value of this capital would be welcome, we believe that impassioned narratives (Johns, 2003), fierce lobbying, effective social marketing and other normative actions are likely to be more effective than often dubious monetary values (Chiesura and De Groot, 2003) in integrating the conservation of these features into land-use planning. Once the features associated with critical natural capital have been mapped, it will be possible to assess the extent to which they have achieved the biodiversity-based conservation targets. Assuming the establishment of effective lobby groups to protect the natural capital features, the responsibilities of the conservation sector may shrink significantly as a greater slice of the citizenry is marshalled to protect biodiversity. Moreover, a greater overall portion of intact habitat may be included in the protection sphere, since the maintenance of some services may require habitat for which biodiversity targets have already been achieved.

This brings us to the second major shortcoming of our approach. Other than the Megaconservancy Networks where connectivity for the maintenance of ecological processes is central, in cases where spatial options still exist, our approach is very silent on exactly where natural habitat should be retained. We recommend (Table 3) that down to a certain threshold, loss of habitat can be tolerated in areas categorized as currently not vulnerable. Two problems arise. Firstly, this contradicts the land-use planners' perception towards avoiding development in currently "wild" areas; secondly, we are mute regarding the configuration of habitat loss and the impacts of progressive habitat fragmentation on the persistence of biodiversity (Theobald et al., 1997; Fahrig, 2001; Flather and Bevers, 2002; Desmet, 2004; see Section 5.2). These problems are overcome to a certain extent by mapping the spatial components of processes required for the maintenance of biodiversity. Mapping of critical natural capital may also ensure the retention of tracts of landscape that are larger than areas required by the biodiversity targets alone. However, in a perpetual growth economy, development and, hence, habitat fragmentation, have to occur somewhere. Our recommendation is to locate new development in areas where considerable options remain to achieve targets. We do acknowledge that more attention must be given to the configuration of habitat required for target achievement and biodiversity persistence.

Finally, the process of uptake and application of these products by land-use planners requires monitoring. No such programme is yet in place, although this will form part of the training project discussed above. We support the assertion of Theobald et al. (2000) that the ability of implementers to describe the goals of programmes such as the STEP Project, is an (at least) equally important measure of success of conservation programmes as are measures of biodiversity features under conservation management. People are, after all, not only the cause of the need for conservation efforts, but also the solution.

Ours is a tentative step to bridge the gap between systematic conservation assessment and land-use planning, and to ensure the integration of our products into land-use decision-making. It is much too early to say whether we have been successful, although the products are already being used as inputs for land-use planning. Given that ongoing habitat loss is the greatest pressure facing biodiversity, our approach represents an attempt to turn the tide by persuading land-use planners to focus development away from the areas most in need of conservation. The land-use guidelines given in the Mapbook enable biologically informed decisions to be made regarding retention of habitat and its loss to development, and highlight opportunities for biodiversity-friendly development in priority areas. Thus, they embody a less conflict-ridden and crisis-centred approach to conservation than is commonly the case (Redford and Sanjayan, 2003). It is still early in the day, but we believe this will be good news not only for biodiversity conservation, but also for the people who depend upon it.

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References

Andrén, H., 1994. Effects of habitat fragmentation on birds and mammals in landscapes with different proportions of suitable habitat: a review. Oikos 71, 355–366.

Anon., 1998. Local Government Information Series: A short guide to the White Paper on Local Government. Department of Constitutional Development, Pretoria.

Balmford, A., 1998. On hotspots and the use of indicators for reserve selection. Trends in Ecology and Evolution 13, 409.

Beatley, T., Manning, K., 1997. The Ecology of Place. Planning for Environment, Economy and Community. Island Press, Washington, DC.

Boshoff, A., Wilson, S., 2004. The STEP stakeholder participation programme: summary, comments and some lessons learned. Terrestrial Ecology Research Unit Report No. 50, University of Port Elizabeth, South Africa.

Boshoff, A.F., Kerley, G.I.H., Cowling, R.M., 2001. A pragmatic approach to estimating the distributions and spatial requirements of the medium- to large-sized mammals in the Cape Floristic Region. Diversity and Distributions 7, 29–44.

Boshoff, A.F., Kerley, G.I.H., Cowling, R.M., 2002. Estimated spatial requirements of the medium- to large-sized mammals, according to broad habitat units, in the Cape Floristic Region. African Journal of Range and Forage Science 19, 29–44.

Botha, M.A., 2001. Conservation options for farmers and private landowners. The Botanical Society of South Africa, Cape Conservation Unit, Report 01/2001.

Brunckhorst, D.J., 1998. Guest editorial. Creating institutions to ensure sustainable use of resources. Habitat International 22, 347–354.

Bunch, M.J., 2003. Soft systems methodology and the ecosystem approach: a system study of the Cooum River and environs in Chennai, India. Environmental Management 31, 182–197.

Burbidge, A.A., Wallace, K.J., 1995. Practical methods of conserving biodiversity. In: Bradstock, R.A., Auld, T.D., Keith, D.A., Kingsford, R.T., Lunney, D., Sivertsen, D.P. (Eds.), Conserving Biodiversity: Threats and Solutions. Surrey Beatty & Sons, Sydney, pp. 11–26.

Callicott, J.B., Crowder, L.B., Mumford, K., 1999. Current normative concepts in conservation. Conservation Biology 13, 22–35.

Chiesura, A., De Groot, R., 2003. Critical natural capital: a socio-cultural perspective. Ecological Economics 44, 219–231.

Cocks, M.L., Wiersum, K.F., 2003. The significance of plant diversity to rural households in Eastern Cape Province of South Africa. Forests, Trees and Livelihoods 13, 39–58.

Collinge, S., 2001. Spatial ecology and biological conservation. Biological Conservation 100, 1–2.

Cowling, R.M., Pressey, R.L., 2003. Introduction to systematic conservation planning in the Cape Floristic Region. Biological Conservation 122, 1–13.

Cowling, R.M., Pressey, R.L., Lombard, A.T., Desmet, P.G., Ellis, A.G., 1999. From representation to persistence: requirements for a sustainable system of conservation areas in the species rich mediterranean-climate desert of southern Africa. Diversity and Distributions 5, 51–71.

Cowling, R.M., Pierce, S.M., Sandwith, T., 2002. Conclusions: the fundamentals of mainstreaming biodiversity. In: Pierce, S.M., Cowling, R.M., Sandwith, T., MacKinnon, K. (Eds.), Mainstreaming Biodiversity in Development: Case Studies from South Africa. World Bank, Washington, DC, pp. 143–153.

Cowling, R.M., Lombard, A.T., Rouget, M., Kerley, G.I.H., Wolf, T., Sims-Castley, R., Knight, A.T., Vlok, J.H., Pierce, S.M., Boshoff, A.F., Wilson, S.L., 2003. A conservation assessment for the Subtropical Thicket Biome. Terrestrial Ecology Research Unit Report No. 43, University of Port Elizabeth, South Africa. Available from: http://cpu.uwc.ac.za.

Dawe, N.K., Ryan, K.I., 2003. The faulty three-legged-stool model of sustainable development. Conservation Biology 17, 1458–1460.

Desmet, P.G., 2004. Application of systematic conservation planning in the Succulent Karoo Biome of South Africa. Ph.D. thesis, University of Cape Town.

Desmet, P.G., Cowling, R.M., 2004. Using the species-area relationship to set baseline targets for conservation. Conservation and Society 9, 11. http://www.ecologyandsociety.org/vol9/iss2/art11.

Driver, A., Cowling, R.M., Maze, K., 2003. Planning for living landscapes: perspectives and lessons from South Africa. Center for Applied Biodiversity Science at Conservation International and the Botanical Society of South Africa, Washington, DC and Cape Town.

Ekins, P., Simon, S., Deutsch, L., Folke, C., De Groot, R., 2003. A framework for the practical application of the concepts of critical natural capital and strong sustainability. Ecological Economics 44, 165–185.

Fábos, J.G., 2003. Greenway planning in the United States: its origins and recent case studies. Landscape and Urban Planning 68, 321–342.

Fahrig, L., 2001. How much habitat is enough?. Biological Conservation 100, 65–74.

Freemark, K.E., Boutin, C., Keddy, C.J., 2002. Importance of farmland habitats for conservation of plant species. Conservation Biology 16, 399–412.

Flather, C.H., Bevers, M., 2002. Patchy reaction-diffusion and population abundance: The relative importance of habitat amount and arrangement. American Naturalist 159, 40–56.

Freyfogle, E.T., Newton, J.L., 2002. Putting science into place. Conservation Biology 16, 863–873.

Gelderblom, C.M., Kruger, D., Cedras, L., Sandwith, T., Audouin, M., 2002. Incorporating conservation priorities into planning guidelines for the Western Cape. In: Pierce, S.M., Cowling, R.M., Sandwith, T., MacKinnon, K. (Eds.), Mainstreaming Biodiversity in Development: Case Studies from South Africa. World Bank, Washington, DC, pp. 129–142.

Groves, C., 2003. Drafting a Conservation Blueprint. A Practitioner's Guide to Planning for Biodiversity. Island Press, Washington, DC.

Hulse, D.W., Branscombe, A., Payne, S.G., 2004. Envisioning alternatives: using citizen guidance to map future land and water use. Ecological Applications 14, 325–341.

Huntley, B.J., Peterson, C., Cowling, R.M., Frazee, S., Maze, K., Sandwith, T., Sekhran, N., in press. Introduction. In: Peterson, C., Huntley, B.J. (Eds.), Mainstreaming biodiversity in production sectors and landscapes. South African National Biodiversity Institute, Cape Town.

Hutton, J.M., Leader-Williams, N., 2003. Sustainable use and incentive-driven conservation: realigning human and conservation interests. Oryx 37, 215–226.

Infield, M., Adams, W.A., 1999. Institutional sustainability and community conservation: a case study from Uganda. Journal of International Development 11, 305–315.

Johns, D.M., 2003. Growth, conservation, and the necessity of new alliances. Conservation Biology 17, 1229–1237.

Kerley, G.I.H., Pressey, R.L., Cowling, R.M., Boshoff, A.F., Sims-Castley, R., 2003. Options for the conservation of large- and medium-sized mammals in the Cape Floristic Region, South Africa. Biological Conservation 112, 169–190.

Knight, A.T., Cowling, R.M., 2003. Conserving South Africa's "lost" biome. A framework for securing effective bioregional conservation planning in the Subtropical Thicket Biome. Terrestrial Ecology Research Unit Report No. 44, University of Port Elizabeth, South Africa. Available from: http://cpu.uwc.ac.za.

Knight, A.T., Cowling, R.M., 2003. The Megaconservancy Network concept: "Keeping people on the land in living landscapes". Terrestrial Ecology Research Unit Report No. 45, University of Port Elizabeth, South Africa. Available from: http://cpu.uwc.ac.za.

Knight, A.T., Boshoff, A.F., Cowling, R.M., Wilson, S.L., 2003. Keeping people on the land in living landscapes: a co-operative strategy for conserving landscapes and enhancing livelihoods in the Subtropical Thicket Biome. Terrestrial Ecology Research Unit Report No. 46, University of Port Elizabeth, South Africa. Available from: http://cpu.uwc.ac.za.

Knight, A.T., Cowling, R.M., Campbell, B.M., in press. Planning for implementation: an operational framework for conservation planning in production landscapes. Conservation Biology.

Löfvenhaft, K., Björn, C., Ihse, M., 2002. Biotope patterns in urban areas: a conceptual model integrating biodiversity issues in spatial planning. Landscape and Urban Planning 58, 223–240.

Margules, C.R., Pressey, R.L., 2000. Systematic conservation planning. Nature 405, 243–253.

Margules, C.R., Nicholls, A.O., Pressey, R.L., 1988. Selecting networks of reserves to maximise biological diversity. Biological Conservation 43, 63–76.

Margules, C.R., Nicholls, A.O., M.B, 1994. Apparent species turnover, probability of extinction and the selection of nature reserves: a case study of the Ingleborough limestone pavements. Conservation Biology 8, 398–409.

Marzluff, J.M., 2004. Fringe conservation: call to action. Conservation Biology 16, 1175–1176.

Mascia, M.B., Brosius, J.P., Dobson, T.A., Forbes, B.C., McKean, M.A., Turner, N.J., 2003. Conservation and the social sciences. Conservation Biology 17, 649–650.

McHarg, I.L., 1969. Design with Nature. The Natural History Press, New York.

Meffe, G.K., 1998. Conservation biology: into the millennium. Conservation Biology 10, 916–917.

Miller, J.R., Hobbs, R.J., 2002. Conservation where people live and work. Conservation Biology 16, 330–337.

Niämele, J., 1999. Ecology and urban planning. Biodiversity and Conservation 8, 119–131.

Noss, R.F., LaRoe III, E.T., Scott, J.M., 1995. Endangered ecosystems in the United States: a preliminary assessment of loss and degradation. Biological report 28, National Biological Service. US Department Interior, Washington, DC.

Orr, D.W., 2002a. Four challenges to sustainability. Conservation Biology 16, 1457–1460.

Orr, D.W., 2002b. The Nature of Design. Ecology, Culture and Human Intention. Oxford University Press, New York.

Pierce, S.M., 2003. The STEP Handbook and Mapbook: integrating the natural environment into land-use decisions at the municipal level: towards sustainable development. Terrestrial Ecology Research Unit Report No. 47, University of Port Elizabeth, South Africa. Available from: http://cpu.uwc.ac.za.

Pressey, R.L., 1998. Algorithms, politics and timber: an example of the role of science in a public, political negotiation process over new conservation areas in production forests. In: Wills, R.T., Hobbs, R.J., Fox, M.D. (Eds.), Ecology for Everyone: Communicating Ecology to Scientists, the Public and the Politicians. Surrey Beatty and Sons, Chipping Norton, Australia, pp. 73–87.

Pressey, R.L., 1999. Applications of irreplaceability analysis to planning and management problems. Parks 9 (1), 42–51.

Pyle, R.M., 2003. Nature matrix: reconnecting people and nature. Oryx 37, 206–214.

Redford, K.H., Richter, B.D., 1999. Conservation of biodiversity in a world of use. Conservation Biology 13, 1246–1256.

Redford, K., Sanjayan, M.A., 2003. Retiring Cassandra. Conservation Biology 17, 1473–1474.

Retief, F.P., Sandham, L.A., 2001. Implementation of integrated environmental management (IEM) as part of integrated development planning (IDP). South African Journal of Environmental Law and Policy 8, 77–94.

Reyers, B., Fairbanks, D.H.K., van Jaarsveld, A.S., Thompson, M., 2001. South African vegetation priority conservation areas: a coarse filter approach. Diversity and Distributions 7, 79–95.

Ribaudo, M.O., Hoag, D.L., Smith, M.E., Heimlich, R., 2001. Environmental indices and the politics of the Conservation Reserve Program. Ecological Indicators 1, 11–20.

Robertson, D.P., Hull, R.B., 2001. Beyond biology: toward a more public ecology for conservation. Conservation Biology 15, 970–979.

Rodrigues, A.S.L., Andelman, S.J., Bakarr, M.I., Biotani, L., Brooks, T.M., Cowling, R.M., Fishpool, L.D.C., da Fonseca, G.A.B., Gaston, K.J., Hoffmann, M., Long, J.S., Marquet, P.A., Pilgrim, J.D., Pressey, R.L., Schipper, J., Sechrest, W., Stuart, S.N., Underhill, L.G., Waller, R.W., Watts, M.E.J., Yan, X.l., 2004. Effectiveness of the global protected area network in representing species. Nature 428, 640–643.

Rosenzweig, M.L., 2003. Reconciliation ecology and the future of species diversity. Oryx 37, 194–205.

Rouget, M., Cowling, R.M., Pressey, R.L., Richardson, D.M., 2003. Identifying spatial components of ecological and evolutionary processes for regional conservation planning in the Cape Floristic Region, South Africa. Diversity and Distributions 9, 191–210.

Rouget, M., Cowling, R.M., Lombard, A.T., Knight, A.T., Kerley, G.I.H., in press. Designing large-scale conservation corridors for pattern and process. Conservation Biology.

Saunders, D.A., Craig, J.L., Mattiske, E.M. (Eds.), 1995. Nature Conservation 4: the Role of Networks. Surrey Beatty & Sons, Chipping Norton, Australia.

Smith, R.J., Muir, R.D.J., Walpole, M.J., Balmford, A., Leader-Williams, N., 2003. Governance and the loss of biodiversity. Nature 426, 67–70.

Steenkamp, Y., Van Wyk, A.E., Victor, J.E., Hoare, D.B., Dold, A.P., Cowling, R.M., Smith, G.F., in press. Maputaland-Pondoland-Albany. In: Mittermeier, R.A., Hoffmann, M., Pilgrim, J.D., Brooks, T.B., Mittermeier, C.G., Lamoreux, J.L., Fonseca, G. (Eds.), Hotspots revisited: Earth's biologically richest and most endangered ecoregions. Cemex, Mexico City.

Steiner, F., 2000. The Living Landscape. An Ecological Approach to Landscape Planning. McGraw-Hill, New York.

Steiner, A., Kimball, L.A., Scanton, J., 2003. Global governance for the environment and the role of Multilateral Environmental Agreements in conservation. Oryx 37, 227–237.

Stewart, W.I., Cowling, R.M., Martin, A.P., du Preez, D.R., Lombard, A.T., 2004. A biodiversity conservation assessment and framework for the open space system for the Nelson Mandela Metropole, Cape Floristic Region, South Africa. Biodiversity Conservation Unit, Wildlife and Environment Society, Port Elizabeth.

Stoms, D.M., 2001. Integrating biodiversity into land-use planning. National Planning Conference of the American Planning Association, March 2001, New Orleans, USA.

Theobald, D.M., Mills, J.R., Hobbs, N.T., 1997. Estimating the cumulative effects of development on wildlife habitat. Landscape and Urban Planning 39, 25–36.

Theobald, D.M., Hobbs, N.T., Bearly, T., Zack, J.A., Shenk, T., Riebsame, W.E., 2000. Incorporating biological information in local land-use decision-making: designing a system for conservation planning. Landscape Ecology 15, 35–45.

Turpie, J.K., 2003. The existence value of biodiversity in South Africa: How interest, experience, knowledge, income and perceived level of threat influence local willingness to pay. Ecological Economics 46, 199–216.

United Nations Conference on Environment and Development, 1992. Convention on biological diversity. In: Proceedings of the United Nations Conference on Environment and Development, Rio de Janeiro, Brazil, June 1992. Department of Public Information, United Nations, New York.

Van Wyk, A.E., Smith, G.F., 2001. Regions of Floristic Endemism in Southern Africa. A Review with Emphasis on Succulents. Umdaus Press, Hatfield, South Africa.

Vlok, J.H.J., Euston-Brown, D.I.W., Cowling, R.M., 2003. Acocks' Valley Bushveld 50 years on: new perspectives on the delimitation, characterisation and origin of thicket vegetation. South African Journal of Botany 69, 27–51.

Wells, M.P., Brandon, K.E., 1993. The principles and practice of buffer zones and local participation in biodiversity conservation. Ambio 22, 157–162.

Young, M.D., Gunningham, N., Elix, J., Lambert, J., Howard, B., Grabosky, P., McCrone, E., 1996. Reimbursing the future: an evaluation of motivational voluntary, price-based, property-right, and regulatory incentives for the conservation of biodiversity, Part 1. Biodiversity Series, Paper No. 9. Department of the Environment Sport and Territories, Canberra, Australia.