Natural Forest Reserve System Identification and Protection Categorisation

Best Practice Review:
Conservation planning and target setting

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For
DWAF
Supported by
DFID

March 2003

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Executive Summary

Forests form the smallest; most widely distributed and most fragmented biome in southern Africa, covering only about 0.3% of the land surface. The contribution of forests to the national biodiversity is far greater than would be expected from their 0.3% coverage of the countries surface area. A disproportionate percentage of these species are also rare or endangered. (Geldenhuys & MacDevette,1989). Forests in South Africa have a relatively high plant species richness of 0.58 species per km^2. In this regard it is the second richest biome per unit area in South Africa[1].

Information on the actual status of conservation within individual forests is mostly outdated or non-existent, the few studies that are available and anecdotal accounts, suggest that forests are currently being over-exploited in a number of places, particularly in the Transkei coastal zones (State of forest report,1999).

Currently levels of protection offered under the National Forestry Act may be insufficient to ensure the long-term persistence of forest biodiversity[2]. This underscores the importance of the development of a prioritisation system for natural forests, where priority forest patches are identified, and where minimum area targets for each forest type are used to establish an effective and representative natural forest protected area system.

As evident from various policy directives South Africa has undertaken to integrate the principles of the Convention on Biodiversity into development policy, however South Africa has yet to commit to specific conservation targets (as required for a National Biodiversity Strategy and Action Plan). In the absence of more specific target guidelines, it would appear as if the 10 % rule has by default, been adopted (10 % being the minimum protected area target recommended by WWF and IUCN to the CBD). However, it is argued that the use of this target requires careful scrutiny, being too simplistic in that it assumes all elements of biodiversity to have the same conservation importance.

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[1] Natural forests contain 7.1% of the 20 227 vascular plant species recorded in South Africa. Forests also provide habitat to a disproportionate percentage of animals, of which 16.4% are endemic. 14% of terrestrial birds are reported from forests; while 12 frog and some reptile species are restricted to forests, as are several insect genera (State of forest report 1999) .

[2] It is evident that the 'default' level of protection offered to natural forests (demarcated as State Forests) by the National Forestry's section 3 (3)a clause may not be sufficient to ensure long term protection in the face of increased social and economic pressures. It is interesting to note that in section 3(3) a [2], the wording 'or', rather than 'and' environmental benefits has been used. This author interprets this to imply that exceptional circumstances could arise where the social and /or economic benefits of alternative land uses could override the environmental consideration of biodiversity loss associated with deforestation

Nationally agreed conservation targets are urgently needed to guide the development of a representative and effective protected area network[3].

Currently the National Forestry Act, and the associated Sustainable Forestry Management criteria and indictors list provide a useful framework to guide the development of a protected area network.

Systematic reserve selection procedures have yet to be comprehensively adopted and applied across all biomes in South Africa. The Cape Floral Kingdom, the Succulent Karoo and Subtropical Thicket biomes are currently engaged in this process (Cowling, 1999; Cowling et al 1999)

In certain respects Australia and South Africa can be considered as pioneers of systematic protected area planning. The Australian approach to reserve selection provides useful guidelines for the identification of a reserve system for South African natural forests. (In the past there has been successful collaboration between South Africa and Australia with the development and use of C-plan for the fynbos and Succulent Karoo biome). Australian forest reserve planning is particularly useful in providing a framework for the establishment of criteria for the selection of biodiversity elements and targets, and in providing tested methodologies of reserve selection (primarily based on irreplaceability and vulnerability). They also provide useful criteria for defining threatened and vulnerable ecosystems (Commonwealth of Australia, 1997).

Approaches to European forest protection considered in this review, provide little in the way of useful guidelines for the identification of a natural forest reserve system in South Africa. The focus on consumptive use in European forest protection places a different emphasis on efforts to conserve these systems. However, the reasoning behind the questioning of the applicability of the IUCN categories to European forest protected areas should be considered (Parviainen & Frank 2003).

The USA has adopted a slightly different approach, using Gap analysis and a series of computer techniques or programs (known as BioRAP), developed for the rapid assessment of biodiversity, and prediction of distributions of species or vegetation communities. The predicted distributions are then used to select priority areas for the conservation of biodiversity. Gap analysis operates at a nation-wide scale identifying the degree to which animals and communities are represented in existing conservation areas. Those species and communities not adequately represented in the existing network of conservation lands constitute conservation "gaps." These gaps then become the focus of conservation attention.

The South African Sustainable Forest Management Criteria and Indicators initiative provide a useful and powerful framework to guide the development and planning of a natural forest protected area system. It is proposed that the C&I's be used to guide the identification of the elements, and corresponding targets used in the planning of the

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[3] The National Forestry Act 84 0f 1998 (section 3(b)) refers to the need to declare a minimum area of *each* woodland type as protected (S3 (3)(b)), and that this minimum is to be based on 'best scientific advice' (section 4). Due to the scarcity of natural forest, relative to woodlands in South Africa, all natural forest are assumed to be worthy of protection, and therefore no reference has been made in this Act to minimum area requirements for each forest type.

forest reserve network. In addition it would be logical, if not essential to integrate the C&I's with the national forest reserve network planning process. This will ensure consistent approaches to the monitoring of progress towards attaining conservation goals and sustainable forest management. (Refer to table 3 of this report for a first approximation at using South Africa's SFM C&I's to guide biodiversity elements for reserve selection target setting).

The first phase of this study is primarily concerned with the biodiversity issues of reserve selection, and as such only Criteria 2 &3 are considered here. (Criteria relating to socio-economic and cultural issues of SFM will be considered in the second phase of this study).

Strawdog and way forward

Based on the assessments conducted in this document the following biodiversity elements and related targets have been proposed. These provide a framework for further deliberations by the Core Group. It is suggested that a revised version of the strawdog be sent for expert review (DWAF and selected external experts). This should be done before further stakeholder input.

Biodiversity element	Base target determination	Potential means of adjusting base target	Data availability
Pattern			
Forest types	15% adjusted on basis of species-area curve analysis	1. relative rarity (% area covered) 2. fragmentation 3. reduction of historic extent 4. resilience to species loss	1. Good 2. Good 3. Low (estimation required) 4. Low - moderate
Old-growth forest	Maximise number of selected forests with old-growth present	None	Unknown (may require estimation, e.g., period since last logging)
Forest-dependent species	4 known locations	Species rarity (as indicated by the number of known locations)	Moderate-High
Forest-associated Red Data Book or South African endemic species	4 known locations	Species rarity (as indicated by the number of known locations)	Moderate-high
Process			
Advantageous ecotonal processes	Maximise number of selected forests with favourable ecotones (habitat change index of the surrounding	None	Good

Biodiversity element	Base target determination	Potential means of adjusting base target	Data availability
	landscape)		
Connectivity (surrogate for linkage related processes, e.g , resilience to climate change, dispersal and gene flow)	Maximise number connective linkages among forests (both between patches of the same and different forest types), attention must be given to trans-boundary forests.	None	Good
Resilience to climate change	Minimum of one altitudinal gradient for each forest type where possible	None	Good

A. Introduction

Historically, most protected areas across the globe have been designated in an *ad hoc* fashion. Companion to this is the fact that the majority of the earth's protected areas are located in mountainous areas, with a resultant under protection of lowland biodiversity. The consequence of protected areas being allocated on this basis is that the so-called reserve network is not representative of biodiversity The main reason for this was that in the past, protected areas were proclaimed in marginal areas, with little agricultural potential, no known mineral resources, in mountainous areas that precluded development or in nutrient-rich savannas containing large game species. The first forest reserves were established in the Cape Colony during the colonial era in response to a realisation that natural forests in the coastal regions were being rapidly lost. The development of the Wilderness Area Concept resulted in the old forestry reserves being proclaimed as Wilderness Areas within the mountain catchments of South Africa.

During the last two decades, increasing importance has been attached to conserving biodiversity[4], and there was an associated growth in biodiversity research. As a result of this, the value of biodiversity to humans was realised, and it was also recognised that global biodiversity was under threat and that the world's reserve networks did not conserve a representative sample of this biodiversity. To address these problems, conservation biologists began to develop more systematic approaches to identifying prospective areas for protection, that were representative of the biodiversity of the area. However, this meant considering areas for conservation that were also needed for competing land uses, like agriculture. Therefore, more efficient use of limited conservation resources was needed.

In this brief summary, an outline of the developments within the field of reserve selection, since the early 1980's until the present, is provided. Although some of the older ideas are outdated, the sum of understanding gathered during the last two decades has resulted in the development of very effective, practicable recommendations. These recommendations need to be seriously considered by anyone wanting to design an effective reserve network. As a guide, we have provided a set of recommendations and an outline of the method to be used in this study.

B. Approaches to conservation planning

Iterative procedures

Development of conservation planning techniques began in the 1980's with the application of simple computer algorithms to the problem of identifying minimum sets of conservation sites. These algorithms became known as iterative selection procedures because they worked by iterating through a set of candidate sites. At each step, the best site was selected according to various selection rules based on specific criteria such as the representation of species richness. These algorithms evolved rapidly into a number of different types using either all species, rare, or endemic species as the basis for site selection. Algorithms vary widely in efficiency, but give some flexibility in that starting conditions or the criteria for selecting sites can be altered.

As algorithms were used more widely, so potential limitations were identified and adjustments, often to the rules for selecting sites, were made. A case in point is where

[4] In this report, we refer to the components of biodiversity as biodiversity elements. This may include parts or all of the components of biodiversity as explained by Noss (1990)

algorithms often concluded with selected sites being unevenly distributed across the study area, resulting in a widely dispersed reserve network. A widely dispersed reserve network is difficult to manage and may foreclose the desired option of linkages among reserves. Nicholls & Margules (1993), in an attempt to avoid getting widely dispersed networks as a result of an algorithm analysis, developed an amended algorithm that selected proximal rather than distal sites.

Conservation planning studies based on iterative procedures have been used quite extensively in Australia and South Africa. In South Africa, recent studies have included the Cape Action Plan for the Environment (CAPE) project, Succulent Karoo Ecosystem Planning (SKEP) project, Subtropical Thicket Ecosystem Planning (STEP) project and the Key Conservation Area Network for the City of Cape Town. Further projects using similar methods are being conducted in KwaZulu-Natal and Swaziland.

Gap Analysis Programme

Gap analysis is a US based, nation-wide scientific programme focussed at identifying the degree to which animals and communities are represented in existing conservation areas. Those species and communities not adequately represented in the existing network of conservation lands constitute conservation "gaps." These gaps then become the focus of conservation attention. The purpose of the Gap Analysis Program (GAP) is to provide broad geographic information on the status of species and their habitats to help in a broad decision-making framework.

To achieve this goal, GAP produces a number of maps that are overlain with each other in a Geographic Information System (GIS). Vegetation is mapped using remotely sensed imagery and animal ranges are mapped using specimen records in conjunction with specialist knowledge of the ranges of these animals. Essentially, the distribution of vegetation communities is linked to the habitat requirements of the vertebrates. This link is then used to improve the knowledge of the distribution of these animals. This predicted distribution is then compared with a map of ownership of conservation lands to identify where and which species fall outside these conserved lands. These overlay comparisons identify gaps in the conservation of the vertebrates which provide an objective basis of information for options in managing biological resources including showing where conservation efforts can be focused.

Because GAP provides a standardised method and format across the US, data from one state can be edge-matched with projects completed in adjacent states. This is important, as it allows for assessments at scales relevant to natural systems and not to arbitrary administrative boundaries.

GAP analysis per se has not been used in South Africa for conservation planning. However, the concept of assessing the contribution of existing reserves to conserving biodiversity is integral to the commonly applied systematic conservation planning approaches (based on iterative procedures).

BioRAP Programme: Rapid Assessment of Biodiversity

BioRAP comprises a series of computer techniques or programmes, known as tools, developed for the rapid assessment of biodiversity. Various computer programmes or tools are used to predict the distribution of species or vegetation communities. The predicted distributions are then used to select priority areas for the conservation of biodiversity.

Environmental data are the fundamental component of the rapid assessment of biodiversity particularly since terrain and climate are dominant controls on biological and agricultural activity that influence the natural environment. Data on climate, terrain, soil and vegetation are commonly used. Spatial interpolation techniques are then used to generate spatial distributions of these environmental data (often represented as grids) by calculating various biologically meaningful combinations of the environmental variables.

The BioRAP tools then use these environmental grids to predict spatial distributions of species based on known point locations. The spatial predictions (or maps) are based on identifying those regions that have the environmental conditions matching those at the point species locations. Finally, a tool is used to select priority areas based on the concentration of focal species.

C. Biodiversity elements used in conservation planning

Most of the early reserve selection work equated biodiversity and species richness – this represents a drastic oversimplification of the natural world. It has often been pointed out that resources for conservation are too limited to engage in many scattered species conservation plans. Further, individual ecological requirements for one species may be in conflict with those of another species. For example, a threatened species may require sandy habitats while another threatened species from the same area, may require flooded habitats. Separate conservation plans may lose one of these species, whereas an analysis with a broader focus would consider a region with both sandy and flooded habitats.

In the early 1990's, this concern of equating biodiversity and species richness was formally addressed by the publication of two papers by Noss (1990) and Franklin (1993). These authors stated that there are different attributes of biodiversity that operate at different hierarchical scales from the level of genes, through species to communities, ecosystems and landscapes. In essence, this meant that species, and these other biodiversity elements, were positioned within a hierarchy of biodiversity. Even more important, was the formal recognition that biodiversity elements were inexorably linked to biological processes.

This definition was both realistic and useful for the development of reserve selection methods. It was realistic because it more closely reflected current understanding of ecological reality. For example, the inclusion of higher hierarchical levels, such as vegetation communities, will relate to primary productivity, the basis of food webs. Further, according to hierarchy theory, biodiversity of lower hierarchical levels, including undescribed species, is encompassed within higher levels. Neither of these considerations was given much weight in species-only analyses.

The broader definition of biodiversity was also useful because it included the wider biophysical and ecological processes (gene flow, species turnover, species packing, minimum viable populations, predation, immigration and emigration, disturbance, natural catastrophes *etc.*) into conservation planning. For example, considering the presence of intact, natural vegetation in reserve selection methods indirectly implies the efficient functioning of natural ecological processes. Reserve selection methods in the 1990's began to reflect this broader understanding of biodiversity as proposed by Noss, with the physical and biological processes linking and operating among and between hierarchical levels being included in planning studies.

In the majority of, if not all, instances where conservation planning is undertaken, adequate databases describing the distribution of the relevant elements of biodiversity are not available. Thus, conservation planning studies often rely on using measures or indicators of an area's biodiversity, e.g. the Broad Habitat Units used in the CAPE project. It is commonly recognised that for many parts of the world the only available indicators are higher-order elements, e.g. vegetation types and broad vegetation classifications. These indicators are termed surrogates. The choice of surrogates is critical to the meaningful execution of conservation planning. Unfortunately, this choice is often dictated by the availability of data and the time and resources available for compiling new data. Rather, researchers have simply chosen available data, most often describing the distribution of vascular plants, vertebrates or butterflies. The taxonomic data sets used contain a number of fundamental flaws and biases, and assessments of surrogacy among taxonomic groups have not provided encouraging results. Higher levels in the biodiversity hierarchy have been used as surrogates, and have some advantages over the species based approach. Some of these advantages have already been discussed, with an additional one being that data describing these surrogates are more generally available for whole regions. However, no surrogate is paramount, but rather a combination of surrogates representing elements from across the biodiversity hierarchy should be used. The cause of conservation planning could be furthered by planners outlining at the outset the ideal set of elements for planning within a region. The shortcomings are thus explicit and the final results can be interpreted in the light of these.

Using this hierarchical definition of biodiversity, two major groupings of biodiversity surrogate can be recognised. The first are Biodiversity Pattern surrogates, which considers the spatial distribution of elements like species, communities, vegetation types, ecosystems and landscapes. The second grouping are Biodiversity Process surrogates (for examples see Table 1), which recognises that all biodiversity elements (pattern) are linked by and to ecological processes (such as, gene flow, predation, disturbance - fire, nutrient cycling *etc.*). The primary motivation for including process in conservation planning is to design reserve networks that allow for the persistence of biodiversity, by considering those processes that produce and maintain biodiversity. To consider ecological processes in conservation planning, it is essential that such processes can be spatially demarcated i.e., delineated on a map. This is because conservation planning is in essence a spatially explicit process using elements whose distributions can be mapped.

Table 1. Examples of forest-specific and other relevant ecological processes used in other southern African conservation planning studies.

Process	Spatial Descriptor	Study Area
Resilience against shifting vegetation distribution due to large-scale climate change.	Areas spanning primary climatic (temperature, rainfall and altitudinal) gradients.	Swaziland Cape Floristic Region
Forest transitions among escarpment, middleveld, lowveld and Lebombo forests	Forests occurring along primary altitudinal gradients from the western escarpment, through the middleveld and lowveld to the Lebomobo Mountains	Swaziland

Process	Spatial Descriptor	Study Area
Regional linking of forests between KwaZulu-Natal and Mpumalanga by Swaziland's escarpment forests.	Escarpment (height greater than 1000m a.s.l.) forests occurring along n-s axis between KwaZulu-Natal and Mpumalanga	Swaziland
Gene flow (facilitated by seed dispersers and pollinators) between forest patches.	Intact corridors of untransformed vegetation between forest patches across minimum distances of 1 km.	Swaziland
Foraging, roosting and breeding habitat area for forest dependant fauna.	Entire forest patches across the natural range of patch sizes occurring in the study area.	Swaziland KwaZulu-Natal
Seed and propagule dispersal in forest vegetation types.	Areas (10^1ha to 10^4ha) large enough to sustain viable populations of important dispersal vectors (e.g., birds, bats, primates and bushpigs *Potamochoerus porcus*).	Swaziland KwaZulu-Natal
Pollination in forest vegetation types	Areas (10^1ha to 10^3ha) large enough to sustain viable populations of important pollinators.	Swaziland Cape Floristic Region
Macroscale Dispersal – across major altitudinal gradients	E/W altitudinal linkages down interfluve.	KwaZulu-Natal
Macroscale Dispersal – across major latitude gradients	N/S linkages down tropical intrusions (Sand Forest and Dune Forest).	KwaZulu-Natal
Herbivory – by large and mega-herbivores	Areas large enough to maintain the herbivory processes associated with the full complement of herbivores.	KwaZulu-Natal Cape Floristic Region

D. Setting conservation targets

Conservation planning has the goal of identifying a network of protected areas that will conserve a representative sample of a region's biodiversity. To do this successfully, it is important that specific, quantitative conservation targets are described for each element of biodiversity being considered. Target setting is critical because it provides planners with a goal against which they can assess the current situation and then choose areas that will attain these targets.

The process of setting targets for the conservation of biodiversity elements is fraught with complications. There is unfortunately not a clear understanding of what will constitute a representative sample of biodiversity. There is also reluctance amongst conservation scientists to formalise conservation targets. This reluctance stems from uncertainty and a lack of knowledge, but also from reservations concerning ascribing the conservation of a complex phenomenon to a single figure or set of figures.

Margules and Pressey (2000) suggested a number of characteristics, which should be borne in mind when setting targets. Targets should: focus on scales finer than regions or

countries; include processes and pattern; reflect the unique requirements of the biodiversity elements being considered; and be flexible in the face of socio-economic changes. The setting of targets needs to be based on a sound ecological understanding of each biodiversity element included in the conservation planning exercise.
Conservation planning is an explicitly spatial exercise, so targets are often expressed in terms of percentage area. The most commonly used " conservation target" is the IUCN 10% rule which specifies that 10% of a vegetation type or species distribution should be set aside for conservation. Van Jaarsveld and Chown (1996) recommended that this target be adopted for South Africa. However, this target has been severely criticised as being too simplistic and not generally applicable. Higher targets have been suggested, for example 12% (Brundtland Commission; Brundtland, 1987) or 15% (agreed target for Australian forests; Pressey *et al.*, 1996), while Noss and Cooperrider (1994) suggested values between 25% and 75%. However, these uniform targets imply that all elements of biodiversity have the same conservation importance. As a result, approaches have been developed for setting targets adjusted by factors such as rarity of an element or its or vulnerability to threat. Issues like the importance of connectivity, the presence of metapopulations, and the use of multiple habitats for completion of life histories, population and habitat viability can also be considered when setting targets.

The CAPE project set graduated targets for Broad Habitat Units (BHU) by adjusting a base target value with weightings calculated using the level of threat and extent of transformation for each BHU. Rather than a single baseline percentage being used, base target values were based on geographic species turnover values determined using species-area curves. These curves showed that larger areas were required to adequately sample the species diversity in western lowland and western montane BHUs compared with those in the eastern parts of the Cape Floristic Region (CFR). This resulted in eastern BHUs have base target values of 10%, 15% (1.5 times higher) for western lowland BHUS and 25% (2.5 times higher) for western montane BHUs. A similar approach using species-area curves to determine target values has also been used in the SKEP project.
Other studies for the City of Cape Town and Swaziland have similarly used graduated targets, which were based on a base target adjusted upwards by transformation, rarity and fragmentation weightings. In KwaZulu-Natal a graduated system adjusting baseline targets using weightings based on endemism and fragmentation has been proposed for vegetation types (see Table 2).
Targets aimed at species have been set using a range of considerations, for example, a minimum of 3 viable populations, minimum of three viable populations covering at least X% of the known range, minimum number of breeding pairs/individuals, minimum extent of suitable habitat required to support viable populations, X% of a species known locations. The latter was used in a study done for the City of Cape Town, where the percentage of known locations set as targets was adjusted depending on the number of known locations. So for species with few known locations targets of up to 100% were used, with a downward sliding scale determining the target for species with progressively more known locations.
Targets for processes are most often aimed at conserving a certain number of intact examples of each process. For example in KwaZulu-Natal and Swaziland, one complete unimpeded example of a river catchment was set as a target for riverine processes associated with hydrological corridors. Similarly, the CAPE project required one example of a sand movement corridor within each of the three Broad Habitat Units associated with these corridors. Similarly, one transitional (altitudinal) gradient between highveld and lowveld forests was required as a target for a study conducted in Swaziland.

Table 2. Examples of biodiversity elements (surrogates) and conservation targets used in other conservation planning studies

Country and Region	Conservation element for targeting	Base line targets	Base value used	Modifications used	Reference
National IUCN recommendation	Major forest types (including trans-boundary forests) classified using the ecosystem approach	At least 10% under effective management	% Of current forest distribution	Not specified	IUCN, (2000)
New South Wales, Australia	Landscape types	15% of the total area of each type regardless of how much of that total had been cleared	% Of Pre-European extent of forest types	Baseline increased on the basis of factors such as natural rarity and vulnerability to threatening processes	Pressey *et. al.*, (2000) Anon., (1995); JANIS, (1997).
KwaZulu-Natal, South Africa	Forest types - based on Cooper, (1985) classification	15 % under strict protection	% Of current forest distribution	Add 5 % to target for Indian ocean coastal belt forest (higher diversity on coasts)	Goodman, (2002)
South Africa Cape Floristic Region(CFR)	Broad habitat units (BHUs)	Value dependent on species turnover. 10 % in lowland & montane units in eastern CFR, 15 % in lowland units in western, winter rainfall area, 25% in mountain	% Of Pre-European extents	Adjusted according level of threat (agriculture, urbanization % aliens) and transformation	Cowling *et. al.* (1999)

Country and Region	Conservation element for targeting	Base line targets	Base value used	Modifications used	Reference
		units in western winter rainfall areas			
Cape Town Unicity, South Africa	Vegetation types	10%, 15% & 20% - based on rarity of vegetation types.	% Of Pre-European (1652) extents	Base targets adjusted according to level of transformation	Benn *et al.* (2002)
Swaziland	Forest types	20 % (dense montane & highland), 15% (riverine), 10% dense mixed woodland)	% Of current distribution	No modifications	Emery *et. al.* (2003)

E. Irreplaceability – a measure of conservation value

Irreplaceability analysis represents one of the more significant advances in conservation planning since the development of iterative selection algorithms. Algorithms can quickly and efficiently select a set of sites to achieve a conservation goal, but no indication is given of each sites potential contribution to that goal (especially for unselected sites). It is therefore not possible to identify optional replacement sites should selected sites become unsuitable or unavailable.

Irreplaceability is an index value attached to an area (e.g. a planning unit) that indicates its importance in the context of attaining the conservation targets defined for that planning domain. Irreplaceability can be defined as the likelihood that an area will be required to achieve a set of conservation targets. Alternatively, it can be viewed as the degree to which the chance of attaining these targets is reduced if the area is lost for conservation (Ferrier *et al.* 2000, Pressey *et al.*, 1994). The irreplaceability of an area is thus dependent on both the conservation targets that have been set and the occurrence of biodiversity elements within the area. Simplistically stated, irreplaceability represents the conservation value of a site under a particular conservation target scenario. Irreplaceability values can range between 100% (totally irreplaceable) and 0% (not required). Totally irreplaceable areas have to be included in the designed reserve network, if not one or more of the targets is unattainable. As irreplaceability decreases the range of possible replacement areas increases, and the effect of losing these sites on target achievement is lessened.

A map of irreplaceability is, therefore, a map of options: in areas of high irreplaceability, all (most) extant habitat is required to achieve targets; in areas of low irreplaceability, there is greater flexibility in the array of available sites required to meet a regional conservation goal. Areas with high irreplaceability should be used as the anchor points for a reserve system, around which the remaining areas can be arranged using reserve design concepts and criteria, e.g. connectivity, area size, cost of management and vulnerability to biodiversity loss.

The mathematical derivation of irreplaceability is complex, but the development of C-Plan has provided a decision-support tool that calculates irreplaceability. C-Plan is a conservation planning decision-support tool that is available as an extension to ArcView GIS (ESRI, Redlands, California). In addition to calculating irreplaceability and providing for the development and execution of minimum set algorithms, C-Plan allows for the results of a planning exercise to be rendered visually, thus facilitating interactive and collaborative decision-making and conflict resolution.

F. Vulnerability – prioritising action

The vulnerability of candidate reserve areas was not considered in early attempts at conservation planning. However, it soon became obvious that candidate reserve areas had to be prioritised (specifically for conservation action) on the basis of biodiversity value and the threat of biodiversity loss through current or future transformation processes. Areas with a high conservation value that are not faced with impending transformation should be given lower priority than areas of similar conservation value facing imminent threats. The primary sources of transformation are from human transformation of natural habitats or changes in land-use management. A number of methods have been used to determine vulnerability for inclusion in conservation prioritisations; these include, comparison of current land-use and historic (potential) vegetation or the development of predictive surfaces or indices for various land-uses.

Recent conservation planning exercises have combined the concepts of irreplaceability (or conservation value) and vulnerability to prioritise areas for inclusion in reserve systems. These approaches represent a more comprehensive and inclusive method of identifying and prioritising candidate areas for inclusion in a region's reserve system. This can guide decision-makers in the allocation of scarce resources for conservation. Scheduling conservation action is often necessary when the available resources for conservation are insufficient to adequately protect all of the natural features (e.g. species, vegetation types, ecosystems) in a region, at least in the short-term. Vulnerability is not static, but rather changes as new development opportunities arise. For example, when new crop varieties are developed, new markets for novel products develop, shifting land-use potential with changes in global climatic patterns. As a result of changing vulnerability, the distribution of priority areas will need to be flexible and be reassessed when necessary.
Graphical techniques have been used in the majority of instances to classify sites into priority classes on the basis of irreplaceability and vulnerability. The exact details of the graphical techniques applied have varied widely. For example, Sisk et al (1994) divided the graphical space into quartiles, with those sites falling in the upper quartile on both axes falling into the highest priority class. Pressey and Taffs (2001) used a diagonal line through the graphical space to identify areas of high priority (those to the right and above the line). This line was refined to a stepped diagonal using arbitrarily defined irreplaceability and vulnerability value cut-offs. Benn *et al.* (2002) and Fairbanks & Benn (2000) used a natural breaks classification method to divide the graphical space into priority zones. The natural breaks classification system identifies natural disjunctions in the data, thus allowing the data to dictate where separations should be made. This

provides a more robust method of assigning priority on the basis of a sites position in the irreplaceability-vulnerability graphical space, compared to the arbitrary methods proposed by Pressey and Taffs (2001) and Sisk et al (1994).

G. Other concepts important in conservation planning

This section describes some additional concepts and principles underpinning the majority of conservation planning studies.

Complementarity/Efficiency.

Complementarity refers to the selection of reserves that do not conserve the same species but act as complements to each other. In the milieu of reserve selection algorithms, complementarity refers to assessing what biodiversity elements are already contained in any existing reserves, and then proceeding in a stepwise fashion, selecting sites that contain biodiversity elements that are not already protected which is important when there is competition for land.

This is an important concept in conservation planning procedures as it prevents the selection of redundant sites thus ensuring efficiency in site selection. However, it can also lead to species being present in only one of the selected sites. This shortcoming can be addressed by rules specifying that more than one site has to contain a particular biodiversity element or by considering minimum viable populations and habitats. Efficient solutions to the problem of representing all biodiversity elements in an area are more defensible and minimise the risk of reaching a ceiling of acceptable reserve area before all biodiversity elements are protected.

Flexibility

The minimum set of reserves refers to the smallest number and area of sites that can be set aside for conservation of the targeted biodiversity elements. There may be only a handful of minimum sets but a wide range of potential reserve networks that are larger than the minimum. Flexibility refers to this range of potential networks. The more alternative options that are made available to a planner, the more likely they will be to find one that maximises values of design and land suitability, reduces costs, considers other competing land claims, and achieves the conservation of the desired biodiversity elements. Therefore, wherever possible reserve selection methods should indicate alternatives and options for site selection.

Defensibility

The reserve selection method that is chosen should produce a result that is defensible in the face of competing land uses. This is important given that there is usually a limited amount of land available for conservation and can be achieved by seeking specialist peer review and input from a wide spectrum of interested parties during the planning and execution phases.

H. Conservation planning and target setting for forest systems

There is no internationally agreed conservation target value that can be applied to forests. The example target values in Table 2 outline the range of values that have been suggested and/or used both locally and internationally. These range from the IUCN 10% standard to a range of target values that account for factors like rarity, transformation (area loss) or fragmentation. However, more important than a fixed percentage (e.g. 5%

or 10%) is that the final protection network should be biogeographically and ecologically representative.

The document has thus far given a broad outline of conservation planning (specifically the elements used and conservation targets set), with only incidental discussion of specific forest applications. The following section describes in detail two initiatives (in Australia and Europe) conducted to identify forest conservation networks.

1. Establishment and management of a national forest reserve system (Australia)
The Australian National Forest Policy outlines broad goals for the management of forests. These goals include ecologically sustainable development aimed at managing native forests for the conservation of biodiversity, heritage and cultural values. With respect to the conservation of forest biodiversity, the following primary objectives were elucidated:

- To maintain ecological processes and the dynamics of forest ecosystems in their landscape context;
- To maintain viable examples of forest ecosystems throughout their natural ranges;
- To maintain viable populations of native forest species throughout their natural ranges; and
- To maintain the genetic diversity of native forest species.

The primary means of attaining these goals and objectives involves the development of a comprehensive, adequate and representative (CAR) reserve system, with an emphasis on protecting old-growth forest and endangered and vulnerable species and ecosystems.

Through a process of consultation with a wide range of stakeholders, a set of principles and criteria for the development of a forest reserve system were described. These principles and criteria have implications for what elements will be considered and the conservation targets set for these. The next section describes the principles and criteria developed by the Commonwealth of Australia to develop a forest reserve system.

<u>a. Principles for reserve system development</u>
Principle 1: Comprehensiveness
Description
Comprehensiveness requires that the full range of forest communities, recognised by an agreed national scientific classification at appropriate hierarchical levels, be sampled in the reserve system.
Forest ecosystems, forest types and forest vegetation communities, together with their environmental descriptors, are commonly used as surrogates for biodiversity and as a basis for planning a comprehensive reserve system. Unfortunately, they do not have a national classification system, with different systems and definitions being used in different regions. Rather than develop a national system, they approached these differences in defining surrogates by determining the reserve system on a regional basis.

Conservation planning implications
Forest ecosystem/type classifications were used as pattern surrogates for forest biodiversity. However, due to regional differences the actual surrogates used were determined on a regional basis. Unfortunately, this means that the protection status of

forest systems at a national scale cannot be assessed, as the surrogates used will differ across Australia.

Principle 2: Adequacy

Description

Adequacy requires the maintenance of the ecological viability and integrity of populations, species and communities.

Adequacy introduces the difficult concept of reservation extent – what level of reservation will ensure viability and integrity of populations, species and communities? There are numerous methods of assessing required extents, ranging from best-guess estimates for poorly defined ecosystems, to very accurate calculations for endangered or specific populations of animals and plants. In instances where detailed information on population viability is available, this should be used to ensure reserve system adequacy.

Conservation planning implications

This principle deals specifically with the setting of conservation targets. For example, what percentage of each forest type must be conserved to ensure ecological viability and integrity, or what number of individuals is required to ensure population viability? In addition, this also considers replication across the range of geographic, environmental and biotic domains – how many separate viable populations or occurrences of a forest type are required?

No precise basis exists for determining adequacy. However this project applied the general rule that the chances of long-term survival increases with increased extent of populations or forest systems protected and appropriately managed. The degree of risk varies with different species (or groups of species) and with the degree of modification of the native forest outside reserves. The majority of estimates indicate that the risk of loss is highest where only a small percentage of the distribution of the community or species is reserved and adjoining unreserved forest is cleared or significantly modified.

Replication provides insurance against the loss of species, populations or systems due to stochastic events (such as fire), which may dramatically reset successional processes and reduce or entirely remove key habitats. Implicit in the maintenance of biodiversity is the requirement to sustain ecological processes and functions and provide for the maintenance of natural patterns of speciation and extinction. This requires that the adequacy of a reserve system be considered in a landscape context. The nature of surrounding areas and the options for provision of corridors to provide linkages are important in the development of integrated nature conservation strategies. In addition, this stresses the importance of including processes in the reserve system planning process.

Factors operating within the surrounding landscape that are particularly relevant to determining the adequacy of the reserve system are threatening processes (e.g., land clearing and disease), and the conservation strategies adopted in forests outside those areas reserved specifically for conservation. This shows the importance of including an assessment of vulnerability (threats) in the conservation planning procedure.

Principle 3: Representativeness

Description

Representativeness requires that those sample areas selected for inclusion in reserves should reflect the biotic diversity of the communities they contain.

This principle aims at ensuring that the diversity within each forest system is sampled within the reserve system.

Conservation planning implications
Many species, particularly animals, may have distributions that are not easily predicted by surrogates such as forest ecosystems. This implies that where possible, data on the distribution of species (particularly forest-dependent and rare, endangered or endemic species) should also be used to assess reserve system representativeness. This principle emphasises the importance of adequately protecting known species and genotypes with the aim of maximizing viability. This principle also promotes the concept of using a range of elements of biodiversity (including processes) to develop reserve systems, for example forest types, forest-dependent and Red Data Book species and, ecological forest processes.
This study emphasised the importance of being practical, by using available or readily acquirable data, depending on its type, quality, and resolution.

b. Criteria for reserve system development
This study proposed a set of national criteria for the conservation of forest biodiversity, old-growth forests and wilderness. The criteria considered the uncertainties regarding forest values and their conservation status, the differences between regions in the nature of their forests and the different levels of data available in the various Australian States and Territories.
In deriving these criteria recognition has been given to current world practice, a review of practical models (Woinarski and Norton 1993), the Caracas Action Plan (1992) developed by the Commission for National Parks and Protected Areas which identifies that "a minimum of 10% of each biome" should be preserved, and the Commonwealth's proposed criterion (Commonwealth 1995) of 15% of the pre-1750 distribution of each forest ecosystem. The criteria were divided into categories, with two of these, namely the biodiversity and old-growth forest criteria being applicable. In addition, a set of criteria for reserve design and management were also developed.

Biodiversity Criterion 1
Description
15% of the pre-1750 distribution of each forest ecosystem should be protected in the reserve system with flexibility considerations applied according to regional circumstances, and recognising that as far as possible and practicable, the proportion of Dedicated Reserves (IUCN categories 1to 4) should be maximised.

Conservation planning implications
The priority for reservation of a forest ecosystem is related to how much remains relative to its initial distribution and its vulnerability to threatening processes. In consideration of the above, 15% of pre-European distribution is seen as a desirable objective; however, some flexibility is both acceptable and desirable. For instance, where socio-economic impacts are not acceptable, or where biodiversity conservation objectives can be demonstrably achieved, such as for forests ecosystems, which are extensive, a lower level of reservation (e.g., 10%) may prove adequate. Fifteen percent thus represents a base target value for reservation, which is adjusted on the basis of factors like vulnerability and socio-economic issues. Inherent in this criterion is that systems that are most severely depleted are conserved to a greater extent. Further adjustment of the base target value is provided for in Criteria 2 and 3, which focus specifically on vulnerable and rare/endangered forest systems.

Biodiversity Criterion 2

Description

Where forest ecosystems are recognised as vulnerable, then at least 60% of their remaining extent should be reserved.

(A system is considered vulnerable when approaching a reduction in areal extent of 70% within a bioregional context and which remains subject to threatening processes; or which is not depleted but subject to continuing and significant threatening processes that may reduce its extent.)

Conservation planning implications

This criterion represents a specific adjustment of the 15% conservation target value outline in Criterion 1. Vulnerable forest ecosystems include those where threatening processes have caused significant changes in species composition, loss or significant decline in species that play a major role within the ecosystem, or significant alteration to ecosystem processes.

Biodiversity Criterion 3

Description

All remaining occurrences of rare and endangered forest ecosystems should be reserved or protected by other means as far as is practicable.

A rare ecosystem is one where its geographic distribution involves a total range of less than 10,000ha, a total area of generally less than 1,000ha or patch sizes of generally less than 100ha,where such patches do not aggregate to significant areas. This criterion is to be applied within a bioregional context having cognisance of distribution in adjoining bioregions. It should be noted that rarity is a naturally phenomenon and does not necessarily indicate that the system is under threat. An endangered ecosystem is one where its distribution has reduced to less than 10% of its former range or where 90% of its area is in small patches (small is not defined) which are subject to threatening processes and unlikely to persist.

Conservation planning implications

This criterion represents a specific adjustment of the 15% target value, aiming at increasing the required protection of rare and endangered systems. This recognises the uniqueness of these rare systems, and the vulnerability of those which have been extensively transformed and fragmented.

Other biodiversity criteria

- Reserved areas should be replicated across the geographic range of the forest ecosystem to decrease the likelihood that chance events such as wildfire or disease will cause the forest ecosystem to decline. This requires that the areal target values are met by the protection of more than one reserve for each system type, bearing in mind the requirement for system viability.
- The reserve system should seek to maximise the area of high quality habitat for all known elements of biodiversity wherever practicable, but with particular reference to:
  - the special needs of rare, vulnerable or endangered species;
  - special groups of organisms, for example species with complex habitat requirements, or migratory or mobile species;
  - areas of high species diversity, natural refugia for flora and fauna, and centres of endemism; and

- those species whose distributions and habitat requirements are not well correlated with any particular forest ecosystem.

- Reserves should be large enough to sustain the viability, quality and integrity of populations. This will require that the areas set aside for reservation fulfill a minimum size criterion, with size dependent on viability considerations, and possibly also the requirements for effective management.
- To ensure representativeness, the reserve system should, as far as possible, sample the full range of biological variation within each forest ecosystem, by sampling the range of environmental variation typical of its geographic range and sampling its range of successional stages. Forest ecosystems are often distributed across a variety of physical environments, and their species composition can vary along environmental gradients and among the microenvironments within the ecosystem. This approach will maximise the likelihood that the samples included in the reserve system will protect the full range of genetic variability and successional stages associated with each species, and particularly those species with restricted or disjunct distributions. This requires that forests are described on the basis of their position along primary environmental gradients (climatic, altitudinal, geological etc), and areas spanning the gradients included in the reserve system. Using known species distributions will also assist in ensuring that the full range of biological variation is sampled in the reserve system.

Old-growth forest criteria

Old-growth forest was defined as ecologically mature forest that has been subjected to negligible unnatural disturbance such as logging, road building and clearing. The definition focuses on forest in which the upper stratum or overstorey is in the late mature to over mature growth phases.
Criteria focused at old-growth protection where approached in a flexible manner, dependent on specific regional considerations. This was especially critical in regions with relatively widespread, large areas of remaining old-growth. This study incorrectly distinguished between old-growth and biodiversity criteria. Old-growth is an important component of forest biodiversity, providing specific habitat and micro-habitat conditions necessary for the maintenance of species diversity. However, for the purpose of this review the distinction is retained.

The following old-growth criteria were developed:

- Where old-growth forest is rare or depleted (generally less than 10% of the extant distribution remains) within a forest ecosystem, all viable examples should be protected, wherever possible. In practice, this meant that the majority of rare of depleted old-growth is protected. This requires that almost 100% of old-growth forest complying with these requirements be conserved.
- For other forest ecosystems, 60% of the old-growth forest identified at the time of assessment should be protected. This percentage is increased on the basis of the following considerations:
    - The representation of old-growth forest across the geographic range of the forest ecosystem;
    - the protection of high quality habitat for species identified under the biodiversity criterion;
    - Appropriate reserve design;
    - Protection of the largest and least fragmented areas of old-growth;

- Specific community needs for recreation and tourism.

Reserve design and management criteria

Based on the premise that the way in which a reserve is designed can influence the effective and efficient protection of biodiversity, a set of criteria for forest reserve design and management were developed.

- Boundaries should be set in a landscape context with strong ecological integrity, such as catchments.
- Large reserved areas are preferable to small reserved areas, though a range of reserve sizes may be appropriate to adequately sample conservation values. The value of larger areas is substantiated by research in Ghanaian forests, which showed that larger fragments supported a greater diversity of tree species (Hill & Curran, 2001). The analysis of species-area curves is generally conducted by considering species as equal units, without regard to rarity, habitat requirements etc. However, the Ghanaian study analysed rare species separately and found a similar relationship between species number and fragment area. Considering species number alone, it appears that forests can be substantially reduced without the loss of many species, however an examination of the identity of the lost species shows that they are often the rarest. This indicates that rare species are particularly susceptible to forest area reduction, and need large forest fragments to ensure persistence.
- Boundary-area ratios should be minimised and linear reserves should be avoided where possible except for riverine systems and corridors identified as having significant value for nature conservation. Again, research in Ghana confirms the need to minimise boundary-area ratios, especially for evergreen and shade-tolerating species (Hill and Curran, 2001).
- Reserves should be developed across the major environmental gradients if feasible, but only if these gradients incorporate key conservation attributes which should be incorporated in the reserve system.
- Each reserve should contribute to satisfying as many reserve criteria as possible;
- Reserve design should aim to minimise the impact of threatening processes, particularly from adjoining areas.
- Reserves should be linked through a variety of mechanisms, wherever practicable, across the landscape.

Summary

This Australian example provides useful guidelines for the identification of a reserve system for South African natural forests. It particularly provides guidance on the selection of biodiversity elements for inclusion in a conservation planning study. The emphasis however seems to have been on biodiversity pattern (forest types and species), with less useful guidance provided on the selection of process elements. However, two key process-related considerations that were emphasised was diversity along environmental gradients and connectivity through the identification of linkages between forests.

Furthermore, it provides guidance on the setting of conservation targets, and criteria to be applied in designing a reserve system, as well as the importance of considering vulnerability in setting individual conservation targets.

2. Europe forest protected area selection criteria

Comparison of forest protection between regions in Europe is extremely difficult, because there is such wide variation of strategies, procedures and constraints; the way forests have been used historically and their present closeness to nature also varies, and furthermore so does the definition of what constitutes a forest. According to historical forest use and data on the present forest structure, multifunctional production forests in Continental Europe are mainly altered or cultivated, whereas in the Nordic countries they are semi-natural.

Long-term practical experience and research have proved that appropriate silvicultural management of multifunctional production forests can assure conservation of different species of organisms. Consequently, the focus of debate in Europe appears to shift from total protection in segregated areas to 'precision protection' and to combining protection and timber production in the holistic, integrated concept of modern management of forest areas. (Parviainen & Frank. 2003)

In the European Union, the protection network for all ecosystems is the Natura 2000 network. The aim of the Natura 2000 network is to ensure the preservation of biodiversity in the area of European Union.

A network of areas is being formed in the Member States according to the EU Habitats and Birds Directives (Habitats Directive 92/43/EEC and Birds Directive 79/409/EEC), with the aim of preserving the most important habitats, natural habitat types and species.

In Europe, forest protection includes forest areas where use is limited to a varying degree. Protected areas are often small, located in majority on land owned by the State, local authorities or other bodies and their management and upkeep is linked with the aims of multiple forest use (Parviainen & Frank, 2003).

The usefulness of the application of IUCN classification system to European forests has been questioned by EU on the grounds that, forests are often only a part of larger protection areas and the degree of naturalness or the differences in the historical development of a forest are not taken into account. It was felt that the IUCN classification works when applied describing protection in vast, untouched, continuous forest areas, so its usefulness for Europe is questionable. (Parviainen & Frank, 2003).

A working group established by the Ministerial Conference on the Protection of Forests in Europe (MCPFE) has developed in 1999–2002 a new classification system for forest protection in Europe. The classification consists of three categories with different management objectives: protected forests safeguarding biodiversity, protected landscapes and specific natural features, and protective functions (for soil, water, and against natural hazards).

In Europe voluntary forest certification has sometimes been seen as an overall umbrella to guide sustainability and to increase forest protection. However, this should be viewed only as one tool for promoting sustainable forest management. After 10 years of implementation, it is evident that the original intention to save tropical biodiversity through certification has largely failed to date. Most of certified areas are in the temperate and boreal zone, with Europe as the most important region. Only around ten per cent is located in tropical countries. (Rametsteiner & Simula, 2003).

Summary
This example provides little in the way of useful guidelines for the identification of an natural forest reserve system in South Africa. The focus on consumptive use in European forest protection places a different emphasis on efforts to conserve these systems. However, the questioning of the applicability of the IUCN categories to forest protected areas should be considered. An assessment of the applicability of these categories to forest reserves in South Africa should be undertaken, especially in the light of the new Protected Areas bill.

I. Review of policy to guide conservation planning for natural forests
Three levels of policy, (international, regional and national), were reviewed for their implications regarding the conservation planning of natural forests. Specific emphasis was placed on policy relevant to the selection of conservation goals and the establishment of biodiversity planning elements and targets. This information has also been summarized in a table in annex 1

International conservation obligations
As party to the 1992 International Convention on Biological Diversity, South Africa is committed to the following objectives of the convention:

- Conservation of biodiversity.
- Sustainable use of ecosystems, species and genetic resources.
- The equitable sharing of any benefits arising from the use of its genetic resources.

The convention calls for the contracting parties to develop national strategies, plans and programs for the conservation and sustainable use of biological diversity (Article 6, UNEP 1992).

While the CBD does not make specific reference to conservation targets, recommendations of the Fifth Meeting of the Subsidiary Body on Scientific, Technical and Technological Advice (WWF and IUCN recommendations to COP5), that forest protected areas should cover at least 10% of each of the remaining major forest types, and that parties should establish and effectively manage ecologically representative networks of forest protected areas (Fifth Meeting of the SBSTA, January 2000)

Box 1 provides further detail to the origins and use of the 10 % rule.

Box 1 Background and use of the 10 % rule

In 1992 the Caracas Action Plan of the World Parks Congress adopted a 10 % minimum goal for each of the worlds major biomes (World resources Institute 1994). This was based on an earlier recommendation made by Diamond (1976) who justified the apparently arbitrary figure on island biogeography theory that 10 % of a contiguous area should protect about 50 % of its species.

The degree to which the ten percent minimum for protected area coverage has been met by various countries depends on how these countries have defined 'protected areas". Of the five countries in southern Africa, two have achieved the goal of protecting an overall 10 % of their vegetation. Botswana (17.9%) and Namibia (12.6 %). South Africa is halfway to achieve this goal at 5.1 %, whereas Swaziland (3.2%) and Lesotho (0,2%) are well below the international levels (5.9 %) or for the African continent at 4.6 %, for 1994 (World Resources Institute 1994)

Three of the seven southern African biomes have more than 10 % of there area conserved. The desert, fynbos and savanna biomes, with the forest biome approaching 9%. In contrast the Nama-karoo, grassland and succulent karoo biomes have less than 3% of the area conserved (the greater part of these two biomes falls largely within

The 10% rule has also been used as a target for the Proposed Global Strategy for Plant Conservation (UNEP/CBD/SBSTTA/7/10). Under conserving plant diversity, the following target has been used: '10% of each of the world's ecological regions and 50% of the world's threatened species effectively conserved in situ' by 2010.

It is important to understand that the 10% rule derived from Island biogeographic theory (10 % of an area will contain 50 % of the species) assumes that the conserved area is contiguous. With conservation areas being highly fragmented, it is likely that 10 % will be insufficient to conserve even 50 % of a habitats species, it should therefore be considered only as a base minimum for each habitat type. It would be more scientifically defensible that minimum area requirements be determined using species /area curves (see for example Hill & Curran 2001).

Southern African Development Community Forest Protocol

At the regional scale the Southern African Development Community Forest Protocol has underscored State Parties commitment to 'take all necessary legislative, administrative and enforcement measures to address natural and human-induced threats to forests, particularly those that may have trans-boundary impacts'. No procedural detail or conservation targets are mentioned.

National Acts

The new Nation Forestry act, the Protected Areas Draft Bill and the Biodiversity Draft Bill are particularly relevant to this review.

The National Forestry Act 84 Of 1998

This is currently the most important legislation that will underpin this study. Sections 3 and 4 are relevant to conservation of natural forests and are discussed below.

Section 3(3)(a)) of the act provides that 'natural forests in South Africa must not be destroyed save in exceptional circumstances" and section 3(3)(b)) that 'a minimum area of each woodland type is protected.' From this it apparent that the act acknowledges that, relative scarcity of forest to woodlands, as all natural forests deserve 'protection', whereas woodlands being far more extensive, only a certain minimum area for each woodland type would enjoy protection. (See Box 3 for section 3(3) of the NFA)

With regard to setting conservation targets for woodlands, section 4 of the act provides that 'The Minister must determine the minimum area of each woodland type to be conserved in terms of subsection (3)(b) on the basis of scientific advice."

Section 3 (C) i refers to the conservation of natural forest pattern (species, habitat and genetic diversity), while section 3 (c) iv, 'to promote natural forest health and vitality' could be interpreted as the conservation of natural forest ecosystem processes and integrity. See Box 2 Below.

It is evident that the 'default' level of protect offered to (state) natural forest by the S3 (3) a clause 'natural forests must not be destroyed save in exceptional circumstances where, in the opinion of the Minister, a proposed new land use is preferable in terms of its economic, social or environmental benefits' may not be sufficient to ensure it's full long term protection in the face of increased social and economic pressures. (It is interesting to note that the wording 'or' is used specifically rather than 'and' environmental benefits.).

The Act does however make provision for three types of specially protected areas (that would hopefully enjoy more entrenched protection status, than that of state forest). These include forest nature reserve, forest wilderness area and...."Any type of protected area which is recognized in international law or practice " (section 8 (1))

> Box 2: Section 3 of NFA
>
> (3) The principles are that—
> (a) natural forests must not be destroyed save in exceptional circumstances where, in the opinion of the Minister, a proposed new land use is preferable in terms of its economic, social or environmental benefits;
> (b) a minimum area of each woodland type should be conserved; and
> (c) forests must be developed and managed so as to—
> (i) conserve biological diversity, ecosystems and habitats;
> (ii) sustain the potential yield of their economic, social and environmental benefits;
> (iii) promote the fair distribution of their economic, social, health and environmental benefits;
> (iv) promote their health and vitality;
> (v) conserve natural resources, especially soil and water;
> (vi) conserve heritage resources and promote aesthetic, cultural and spiritual values; and
> (vii) advance persons or categories of persons disadvantaged by unfair

Biodiversity Bill

In it current form (draft 9) the bill does not provide much in the way of conservation goals or targets, however section 47 (1) stipulates that 'the Minister must designate monitoring mechanisms, and set indicators, to determine (a) the conservation status of various components of South Africa's biodiversity; and any negative and positive trends affecting the conservation status of the various components'.

While this fall far short of setting targets, the need to develop indicators of conservation status of biodiversity components could be used as elements for targets. For example a classic indicator used for biodiversity conservation is the % of country/biome/vegetation type under protection, which is also a protected area selection target.

Section 38(2) of the Bill refers to the need for a 'biodiversity framework that may determine norms and standards for provincial and municipal conservation plans'. It is not clear if this will include conservation targets.

Recent proposed amendments to the Biodiversity Bill regarding the listing of endangered ecosystems has implications for reserve selection criteria (refer to box 2 for details).

Box 3: Proposed amendments to Biodiversity Bill and implication for target setting

The Botanical Society of South Africa has recently suggested amendments to the bill that are particularly pertinent to this study (Amana Driver pers. comm. 4 March 2003). It has been proposed that the Bill should include provisions for the Minister to identify and list *threatened or protected ecosystems*. (The Bill already includes provisions for the Minister to list threatened or protected species.)Three categories of threatened ecosystems suggested are: critically endangered, endangered, and vulnerable. The regulations would specify the threshold needed to conserve the majority of species associated with the ecosystem, based on best available scientific advice. This threshold will vary from ecosystem to ecosystem. Currently pattern threshold (the minimum area needed to conserve most the species) is best defined using a species-area curve. Using this method, the threshold for most ecosystems is likely to fall between 15% and 30% of the original geographic extent of the ecosystem; the thresholds will be higher in species-rich ecosystems. Threshold needed to maintain ecosystem functioning (process) are likely to be higher, available literature suggests on average that this threshold, although variable between ecosystems, is approximately 60% of the original geographic extent (Amanda Driver, Botanical Society of South Africa, pers. comm.) These regulations would need to address the issue of minimum viable areas size and habitat fragmentation.

The implications of this proposed policy to reserve selection targets are important. If vegetation types (surrogates for ecosystem types) were classified according to there endangered status (using degree of transformation and /or extent of remaining area relative to minimum area calculations based on species –area curves) then these criteria used for ecosystem status classification would effectively dictate conservation targets for protected area selection. For example an endangered ecosystem may be defined as any ecosystem in which habitat loss has reduced the geographic extent of that ecosystem below the threshold needed to maintain ecosystem functioning (60 %), while a critically endangered ecosystem one in which the area has dropped below 15 % of its original, a. The regulations then, would need to specify what the threshold needed to maintain ecosystem functioning would be. Available literature suggests on average that this threshold, although variable between ecosystems, is approximately 60% of the original geographic extent (Mandy Driver pers. comm.). This could be used to imply that a) an effective protected area network that conserves both pattern and process, you would need to include at least 60 % of the original ecosystem area, and b) your priority areas would be those ecosystems that have lost more than 60 % of there original habitat.

Protected Areas Draft Bill

Section 38 of the Bill provides clear definitions for the purpose of protected areas and provides criteria for the classification of protected areas.

Section 38 of the Bill: The purpose of the declaration of areas as protected areas is –
(a) to select ecologically viable areas representative of South Africa's biological diversity;

No specific mention is made of conservation goals and targets.

National policies

National Biodiversity Strategy and action plan (NBSAPS)
As a signatory to the CBD, South Africa is obliged to develop a national planning processes leading towards development and implementation of CBD and Agenda 21. This document is still under development (Geoff Cowen DEAT, pers. comm.).
It would seem to be a requirement of this document to set specific conservation targets. As regional comparisons, Swaziland and Namibia have commitment to set aside at least

10 % and 15 % respectively of all vegetation types.(NBSAPS Swaziland , NBSABS Namibia)

National Forestry Action plan
The National Forestry Action Programme (NFAP) is essentially a programme for implementing the new forestry policy as set out in the White Paper. Paragraphs 12.34 to 12.55 set out the principles and requirements for developing SFM Criteria & Indicators. The National Forestry Action Plan also refers to the need to address the issue of determining the extent and current condition of forests and woodlands and the current value of this resource. No reference is made to conservation targets.

White Paper on Sustainable Forest Development in South Africa
This document recognizes the special value of natural forests and woodlands and describes them as a "national asset". It acknowledges our obligation to the global community to adequately protect the forests and biodiversity of the world. No conservation targets mentioned.

White Paper on Biodiversity
Goal 1 of the biodiversity white paper is to conserve the diversity of landscapes, ecosystems, habitats, communities, populations, species and genes in South Africa

Policy objective 1.3 specifies the need to establish and manage efficiently a representative and effective system of protected areas.

No specific commitment to conservation targets are mentioned

National Criteria and Indicators
C&I aim to provide a rational framework for monitoring and evaluation. Because protected area planning should be an interactive exercise, monitoring results of C&I should feedback and inform the Minister if obligations regarding conservation of forest biodiversity (principles 1, 2 & 3) are being met

Criteria and indicators form a useful platform to guide the selection of biodiversity elements that are to be included into target setting. Table x translates the relevant national criteria and indicators into spatial planning biodiversity target elements.

Conclusion
The various pieces of legislation and policy discussed, point out in varying degrees of detail, the government's commitment to the conservation of biodiversity in all its forms, and the need to establish a protected area network that is both effective and representative of South Africa's biodiversity.

South Africa has yet to commit its self to specific conservation targets as required for a Nation Biodiversity Strategy and Action Plan. As is evident in the various policy documents discussed, South Africa has aligned its conservation policies with the principles and objectives of the Convention on Biodiversity, and in the absence of more specific targets directives, it would appear as if the 10 % rule has by default, become operational (10 % being the recommended minimum protected area targets by WWF and IUCN to the CBD). It is interesting to note that the Department of Environmental Affairs and Tourism have undertaken to increase the national percentage of protected area coverage from it current levels of around 5 % to 8 % by the year 2010 (DEAT 2002)

Nationally agreed conservation targets are urgently needed to guide the development of a representative and effective protected area network. Suggestions to include a listing of threaten ecosystems within the Biodiversity Bill would assist in developing priorities and minimum area targets requirements.

The National Forestry Act 84 Of 1998 (section 3(b)) refers to the need to declare a minimum area of *each* woodland type as protected (S3 (3)(b)), and that this minimum is to be based on 'best scientific advice' (section 4). Due to the scarcity of natural forest, relative to woodlands in South Africa, all natural forest are assumed to be worthy of protection, and therefore no reference has been made in this Act to minimum area requirements for each forest type.

It is evident that the 'default' level of protect offered to (state) natural forest by the National Forestry's section 3 (3) a clause may not be sufficient to ensure it's full long term protection in the face of increased social and economic pressures. It is interesting to note that in section 3(3) a [5], the wording 'or', rather than 'and' environmental benefits has been used. This author interprets this to imply that exceptional circumstances could arise where the social and /or economic benefits of alternative land uses could override the environmental consideration of biodiversity loss associated with deforestation.

This underscores the importance of the development of a prioritisation system for natural forests, where priority forest patches can be identified, and where minimum area targets for each forest type are used to establish an effective and representative natural forest protected area system.

Currently the National Forestry Act, and the associated Sustainable Forestry Management criteria and indictors list provide a useful framework to guide the development of a protected area network.

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[5] NFA S3(3)a: natural forests must not be destroyed save in exceptional circumstances where, in the opinion of the Minister, a proposed new land use is preferable in terms of its economic, social or environmental benefits';

J. Using Sustainable Forest Management (SFM) Criteria & Indicators (C&I) to guide selection of biodiversity elements and conservation targets

Today, it is internationally accepted that Sustainable Forest Management (SFM) is about more than sustained yield. It includes all forest values: social, environmental, cultural and spiritual. To date, about 150 countries worldwide are engaged in one or more international processes to develop national level criteria and indicators for SFM. Of the nine international Criteria & Indicator (C&I) processes that currently exist, only a few are actually continuously working as a group. The existing regional and national C&I sets for SFM have been developed from the policy point of view and their main purpose is to identify relevant aspects to be covered at national and/or forest management unit (FMU) levels. They thereby attempt to define SFM operationally. The purpose has been to provide a tool for monitoring progress towards the goal of SFM and, more importantly, to allow governments and international bodies to monitor and report on the status of SFM in a country or region.

The conceptual framework behind national-level C&I sets developed by governmental bodies are in many cases not primarily dominated by systematic approaches. Most are issue-based frameworks that mirror the concerns on forests in the early 1990s and most express, through SFM criteria, broadly set political goals. Common to practically all is that they are not structured according to cause-effect-response based frameworks, which are not well suited to the multifaceted nature of ecosystem management.

It is no surprise that also a range of similar indicators can be found in the C&I sets of the different processes. While no consensus view has to date emerged about how many indicators are actually compatible or comparably covered by different processes, more than ten indicators can be considered to be largely identical.

Criteria and indicators for SFM and forest certification share some similarities but there are also considerable differences between these two concepts. Both tools are voluntary and promote SFM. They incorporate key elements of sustainability as defined internationally.
Also the purpose is different. While C&I sets are elaborated to describe the status of SFM, forest certification is essentially based on prescriptive standards. C&I contain no targets or performance expectations, while certification is an assessment against performance standards.
The elaboration of C&I sets is often led by governmental and semi-governmental bodies and used for information sharing and reporting. Private bodies for marketing purposes often set up forest certification standards and systems.

C&I's for sustainable management of plantations and natural forests in South Africa have recently been developed. These C&I's were developed in compliance with the requirements of the National Forests Act, and the principles of sustainable management contained in that Act.
The C&I's focus on four key aspects of sustainable forest management: environmental, social, economic, and policy. The C&I's have been designed to capture information on forest conditions and management activities at national, provincial, landscape and local scales and to monitor trends in forest condition and thus guide sustainable management. The C&I's include standards or goals as benchmarks towards which forest management should strive. The standards identified are prescribed in current legislation as minimum

requirements, while a number of non-regulatory aspirational goals have also been identified. These goals can act as guidelines towards improving sustainable forest management. It would be beneficial to integrate the C&I's with the national forest reserve network, to ensure a consistent principles and approaches to forest management in South Africa. It is therefore proposed that the C&I's be used to guide the identification of the elements, and corresponding targets which should be used in the conservation planning study aimed at identifying a representative forest reserve network. The integration of these two processes will also facilitate monitoring progress towards attaining conservation goals and sustainable forest management. Table 3 provides an initial assessment of the C&I's developed for South Africa with relevance to identifying elements and the setting of targets and selection criteria for forest reserves. This table is not definitive but rather provides a starting position for discussion around the identification of elements, target setting and selection criteria. In addition, this table only lists those C&I's considered relevant in an initial analysis, others may need to be included. Furthermore, elements and targets not covered in the C&I's may also need to be considered. Some of these are suggested by similar studies that have been conducted in South Africa and other parts of the world A comprehensive set of elements (pattern and process) and corresponding targets, guided by the C&I's and other studies, will then need to be developed in consultation with internal DWAF scientists and external experts.

The C&I's also provide guidance on the identification of threatening processes and socio-economic issues concerning forests. The C&I's should thus also be used when deliberation around these issues is initiated.

Table 3. Using South African sustainable forest management criteria & indicators to guide the selection of conservation elements and setting of corresponding conservation targets for the selection of a natural forest reserve system

Criterion	Indicator	Planning element (data required)	Implications for using surrogate measures	Target/Selection criteria guideline (related C&I measure number)
1. Biodiversity Pattern elements and targets				
C2: Biodiversity of natural forests is conserved	Indicator 2.1: The extent of natural forests by forest type.	Forest type classification assigned to map of forests	Surrogate not needed (mapped forest classification available) Note: forest type classification is a surrogate for forest biodiversity	% area of natural forest by forest type under conservation management (measure 2.1.1.)
	Indicator 2.2: The extent of forest type occurring in protected areas.	Forest type classification assigned to map of forests	Surrogate not needed (mapped forest classification available) Note: forest type classification is a surrogate for forest biodiversity	% area of natural forest by forest type in IUCN category I, II or III (of the total percentage required by Indicator 2.1) (measure 2.2.1)
	Indicator 2.3: Presence of specific organisms as bio-monitoring indicators.	Distribution of forest-dependent, Red Data Book and endemic species in forest patches	Surrogate not needed (species distribution across forest patches available for selected groups)	At least X number of viable subpopulations or forest patches of minimum size able to support viable populations (measure 2.3.2)
	Indicator 2.4: Status of forest dwelling species at risk of not maintaining viable breeding populations.	Distribution of Red Data Book forest-dependent and endemic species in forest patches	Surrogate value based on abundance denoting population viability for each species for each forest from which it has been recorded (dependent on data availability)	At least X number of viable Red Data forest-dependent and endemic species subpopulations or forest patches of minimum size able to support viable populations (measure 2.4.1)

Criterion	Indicator	Planning element (data required)	Implications for using surrogate measures	Target/Selection criteria guideline (related C&I measure number)
C3: Forest ecosystem structures are conserved and processes maintained	Indicator 3.2: Condition of natural forest canopy.	Extent of old-growth forest mapped within each forest.	No mapping of old-growth forest available – investigate surrogate measures of old-growth, e.g. period since last logging.	At least X number of forests with old growth forest under conservation management. (measure 3.2.1.)
	Indicator 3.3: Population structure of target species.	For a set of target species, the age/size distribution within forests from which they have been recorded.	Data available for few species from a small set of forests – investigate potential surrogate measures or ignore.	At least X number of forests supporting the natural range of age classes for target species. (measure 3.3.1.)
2. Biodiversity process elements and targets				
C3: Forest ecosystem structures are conserved and processes maintained	Indicator 3.1: Condition of forest margins. .	Condition of forest margins mapped for each forest.	Data describing margin condition unavailable – investigate potential surrogate measures or ignore. Potential surrogate could be the perimeter/surface area for each forest.	At least X number of forests with favourable ratio of soft margin to total margin length (or perimeter:area ratio for suggested surrogate). (measure 3.1.1.)
	Indicator 3.4: Extent and connectivity of natural ecosystems	Connectivity between patches as a process element promoting persistence.	No surrogate needed. Inter-patch connectivity is a surrogate for processes occurring among patches (e.g., dispersal, gene flow).	Select forests along primary environmental gradients with maximum inter-patch distances of X km, with the intervening areas having a favourable ratio of transformed to untransformed land. (measure 3.4.1. and measure 3.4.3.) This process should be accounted for by assessing

Criterion	Indicator	Planning element (data required)	Implications for using surrogate measures	Target/Selection criteria guideline (related C&I measure number)
				linkages between patches using a spatial connectivity modelling procedure (e.g., friction modelling).

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Annex 1: Table summarising relevant policy and legislation underpinning natural forest protected area planning.

Policy /legislation	General implications for protected area planning	Specific implications to indigenous forest protected areas	Reference to conservation targets for protected area coverage
International & regional			
Recommendation of WWF and IUCN, SBSTTA5 to COP5 for implementation of Convention on Biodiversity: Options for the Conservation and Sustainable Use Forest Biodiversity:	Obligation for the establishment and effective management of ecologically representative protected areas using the ecosystem approach	Establish and effectively manage ecologically representative networks of forest protected areas	Forest protected areas should cover at least 10% of each of the remaining major forest types.
UNEP. 2002. Proposed Global Strategy for Plant Conservation Targets in the Global Strategy for Plant Conservation (UNEP/CBD/SBSTTA/7/10)	Contains a proposal for a global strategy for plant conservation based on 14 outcome-orientated targets. The ultimate and long term objective of the proposed strategy is to halt the current and continuing loss of plant diversity	Not specified	10% of each of the world's ecological regions and 50% of the world's threatened species effectively conserved in situ
Southern African Development Community Forest Protocol (October 2001 Draft)	State Parties shall take all necessary legislative, administrative and enforcement measures to address natural and human-induced threats to forests.	Recognises importance of connectivity among trans-boundary forests	Not specified
National			
National Biodiversity Strategy and action plan (NBSAPS)	National planning processes leading towards development and implementation of CBD and Agenda 21	Not available for South Africa yet. Swaziland and Namibia used as regional comparisons	(Swaziland: at least 10 % of all vegetation types. Namibia: at least 15 % all vegetations types)

National Forestry Action plan	Essentially a program for implementing the new forestry policy as set out in the White Paper	Paragraphs 12.34 to 12.55 set out the principles and requirements for developing SFM C&I Refers to the need to address the issue of: the extent and current condition of forests and woodlands	Not specified
White Paper on Biodiversity	Goal 1 of the biodiversity white paper is to conserve the diversity of landscapes, ecosystems, habitats, communities, populations, species and genes in South Africa.	Policy objective 1.3 specifies the need to establish and manage efficiently a representative and effective system of protected areas	No specific commitment to conservation targets are mentioned
White Paper on Sustainable Forest Development in South Africa	This document recognizes the special value of natural forests and woodlands and describes them as a "national asset". It acknowledges our obligation to the global community to adequately protect the forests and biodiversity of the world.		No conservation targets mentioned

The National Forestry Act 84 Of 1998	Aims to promote the sustainable management and development of forests for the benefit of all; create the conditions necessary to restructure forestry in State forests; provide special measures for the protection of certain forests and trees;	Section 3 (principles) (b) a minimum area of each woodland type should be conserved; and (c) forests must be developed and managed so as to— (i) conserve biological diversity, ecosystems and habitats; Section 4(6)(a)(iii)) of the act refers to the need for conservation of processes (The health and vitality of forests is promoted and maintained)	No targets specified
Biodiversity Bill	Part 2 of the bill calls for co-ordination and alignment of plans, monitoring and research of biodiversity. The bill also gives effect to international agreements relating to biodiversity which are binding on the Republic (section 2b) and calls for the development of a national biodiversity framework that is integrated and uniform across all organs of state.	Section 47 (1) stipulates that the Minister must designate monitoring mechanisms, and set indicators, to determine – (a) the conservation status of various components of South Africa's biodiversity; and (b) any negative and positive trends affecting the conservation status of the various components. The biodiversity framework may determine norms and standards for provincial and municipal conservation plans (S38 (2))	Not specified in current public version (draft 9) (Further amendments to the bill have been put forward by NBI to include definitions of endangered, threatened and vulnerable ecosystems. These definitions may have implications for conservation targets)

Protected Areas Draft Bill	The Bill provides clear definitions for the purpose of protected areas (see section 38). Importantly, it points out the need for ecological viability and representivity of South Africa's biological diversity. The Bill also provides criteria for the classification of protected areas	Section 38 of the Bill: The purpose of the declaration of areas as protected areas is – (a) to select ecologically viable areas representative of South Africa's biological diversity;	Not specified
National Criteria and Indicators	C&I aim to provide a rational framework for monitoring and evaluation. Because protected area planning should be an interactive exercise, monitoring results of C&I should feedback and inform the Minister if obligations regarding conservation of forest biodiversity (principles 1, 2 &3) are being met	Principle 1: The forest resource base is secured Principle 2: Biological diversity in forests is conserved Principle 3: The health and vitality of forests is promoted and maintained	No targets specified (C &I can be used to guide selection of biodiversity elements for target setting)