Decision-Making in Conservation: A Model to Improve the Allocation of Resources amongst National Parks

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Decision-Making in Conservation: A Model to Improve the Allocation of Resources amongst National Parks

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ABSTRACT

Protected areas are of prime importance to conservation efforts worldwide because they provide society with a range of important environmental, economic, and social benefits. The ability of government agencies to manage threats to their national parks is often compromised by limited resources. There is a growing need to improve decisions about how resources are allocated amongst conservation responsibilities. Multiple Criteria Analysis (MCA) techniques are integrated decision systems that have the potential to reduce the complexity normally associated with decisions about public and quasi-public goods. The explicit expression of a decision-maker's preferences for certain decision attributes is a key stage in the MCA process. The ability of MCA to increase the understanding, transparency, and robustness of decisions has been demonstrated in many disciplines.

This research describes the development of a MCA model to assist decision-makers with the allocation of resources amongst national parks. After a thorough review of the conservation and protected area literature, a MCA model is developed to determine the utility of a group of national parks based upon environmental, economic, and social significance. The model is tested and applied to the national parks managed by the Parks and Wildlife Commission of the Northern Territory of Australia and to selected parks managed by the Department of Conservation of New Zealand.

The research highlights the need for protected area management agencies to take lessons from the commercial sector and incorporate elements of business practices, particularly comprehensive inventory and data management, into conservation decision-making. It is shown that the integrated decision-making approach taken in this research aggregates complex data in a way that improves managers' ability to make better informed decisions concerning the allocation and distribution of resources.

STATEMENT OF ORIGINALITY

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I declare that:

- This is an original thesis and is entirely my own work.
- Where I have made use of the ideas of other writers, I have acknowledged the source in every instance.
- Where I have used any diagrams or visuals I have acknowledged the source in every instance.
- This thesis will not be submitted as assessed work in any other academic course.

Student's signature: ………………………………………………………………………

Date: ………………………………………………………………………………………..

For Mum and Dad

"One of the most valuable things that we as conservationists can contribute to effective park management is to set clear goals. However, although this is universally applicable, the fact that it is also universally ignored, confused or contradictory should sound warning bells."

- Brian Child (2004, p. 254)

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1 INTRODUCTION

Protected areas, like national parks, are the cornerstone of global nature-conservation efforts and provide society with a range of important biological, social, cultural, economic, and political benefits (Bruner, Hanks, & Hannah, 2003). A consensus has emerged that the funding of protected areas worldwide is grossly inadequate and, as a result, many protected areas are in decline (Emerton, Bishop, & Thomas, 2006). In response to a clear need to supplement existing financial resources, the field of conservation finance has surfaced in the conservation literature. Conservation finance is concerned with financial and business planning for parks, and identifies financial mechanisms by which park management agencies and individual park managers can increase funding for protected areas (Rubino, 2000). Further to the financial need to secure adequate and reliable funds for protected areas, it is also necessary to question the economic effectiveness of current fund allocation (Emerton et al., 2006; Lockwood & Quintela, 2006; Wilson, McBride, Bode, & Possingham, 2006; Wu & Boggess, 1999).

Traditionally, protected areas were managed by government agencies and funded by annual government appropriations (Athanas, Vorhies, Ghersi, Shadie, & Shultis, 2001). Domestic government budgets will continue to be the largest source of protected area financing in most countries (Athanas et al., 2001; Emerton et al., 2006; Spergel, 2001; WCPA-IUCN, 2000). However, the allocation of funds amongst protected areas typically involves an *ad hoc* or piecemeal approach (Wu & Boggess, 1999). Despite the efforts of governments to gain the maximum conservation return by allocating and distributing limited funds amongst competing demands, it is becoming increasingly difficult for park management agencies to make pragmatic, transparent, and timely decisions that are ecologically, socially, and economically sustainable. A major problem is the requirement to make these decisions annually, while other government departments compete for the same government revenue. Both central government conservation ministries and park managers urgently need a rigorous and practical tool to assist with the complex task of allocating financial resources amongst protected areas.

Of the considerable debate in the literature concerning how to set priorities among conservation responsibilities, much is skewed towards biological considerations at the expense of economic and social principles (Hughey, Cullen, & Moran, 2003). Many approaches have been developed to assist with priority setting in conservation, but these focus on identifying areas for increased conservation effort. This means they are biologically biased and do not meet the practical needs of government park management agencies. Sustainably managed protected areas need to be underpinned by sound decision-making based on a wide range of ecological, economic, and social criteria that can be used to identify, quantify, value, and compare different courses of action. By doing this in a formal process, park management agencies can combine ecological and socioeconomic data to increase the likelihood that a country's protected areas can be sustained.

1.1 PROBLEM STATEMENT

Protected areas are of prime importance to conservation efforts worldwide. However, the range and complexity of attributes associated with protected areas make it difficult for decision-makers to set priorities and allocate scarce funds amongst them (Wu & Boggess, 1999). Such quasi-public goods are complicated by multiple actors with competing interests and objectives. Furthermore, some protected area attributes are difficult to quantify for comparative purposes (Harmon, 2003). In many countries, public funds are insufficient to ensure the adequate management, and therefore survival, of protected areas (Bonthuys, 2003; Bruner et al., 2003; Chape, Blyth, Fish, Fox, & Spalding, 2003; Child, 2004a; Dharmaratne, Sang, & Walling, 2000; Emerton et al., 2006; Hambler, 2004; O'Connor, Marvier, & Kareiva, 2003; Pressey, Humphries, Margules, Vane-Wright, & Williams, 1993; Rubino, 2000). Little research has been done on the development of pragmatic, integrated decision-making methods for protected area managers that allow complex data to be reduced to a common metric to assist them with the efficient and effective allocation and distribution of resources.

1.2 AIM

The aim of this research is to develop a rigorous and practical model to assist protected area decision-makers with the allocation of resources amongst national parks.

1.3 OBJECTIVES

The research objectives are to:

1. Review the methods employed by selected park management agencies to allocate resources amongst national parks;
2. Review established methods for setting conservation priorities;
3. Develop a model to help decision-makers allocate resources amongst National Parks in a more efficient and effective manner; and,
4. Determine the usefulness of the model to park management agencies.

1.4 LIMITATIONS

The problem of resource allocation is not limited to national parks, but applies to all protected areas, under both public and private management. To keep the scale of the project manageable, the model will be developed and applied to government-managed national parks; however, the model is intended to be robust enough for application to other types of protected area, including privately owned and/or managed protected areas.

Quantitative, reductionist science has been accepted as a filter for our perception of reality since the time of Descartes. It influences how we define questions, how we answer them, and the alternative solutions and explanations we view as possible answers to them (Jope & Dunstan, 1996). The real world is characterised by deep complexity and this has important implications for decision-making, because any representation of a complex system reflects only a sub-set of possible representations (Munda, 2003). Even seemingly easily quantified attributes are subjective. Soft data are hard to quantify and some argue, from an ethical standpoint, that certain attributes should not be quantified (Bell, 1983). However, if the attributes considered vital to a decision are not quantified in some manner, they will be subconsciously considered or completely excluded from the decision-making process (Brown & Paschoud, 2005). Thus, the attributes selected to construct the model presented here are supported by best practice methods identified in the literature, relevance to the problem according to international responsibilities, and data availability.

Although uncertainty is an inherent part of decision-making, decisions must still be made every year and factored into an annual report and budget. Given that there are no absolutes, all decisions must reflect the probability of different outcomes and the costs and benefits of each (Rubin, 1999). Degradation of the environment and the erosion of genetic variability are ongoing, so decision-makers must accept that scientific knowledge of these processes is incomplete (Tisdell, 2002). For this reason, the research aims to develop a model that is both rigorous and practical.

The final ranking of a country's national parks may be limited by the quality of data available for the model. Each data set has inherent bias; for example, species presence data are limited by the sampling location (accessibility), techniques available for data acquisition at the time, human error, and sampling intensity.

1.5 IMPORTANCE OF THE RESEARCH

To be effective, decision-making systems must reflect the increasing complexity of conservation decisions. In essence, the research reduces a large number of interdependent factors into a single matrix to meet the deadlines for annual budgetary allocations amongst national parks. It does not offer a panacea for all *ad hoc* resource allocation amongst conservation areas. However, it does provide a comprehensive and flexible methodology that can assist decision-makers to clarify priorities when allocating resources.

The model developed in this study ranks national parks in terms of economic, social, and biological criteria. It does not detract from, nor diminish the importance of research in each contributing field. Recognising that ongoing decisions are required to run national parks, the model employs the best current data. However, as research in each discipline provides higher quality data and better understanding of systems, subsequent iterations will make the model increasingly robust. Even if the data are incomplete, the model can still clarify assumptions, integrate knowledge from a range of sources, and force decision-makers to be explicit and rigorous in their reasoning. It is better to augment existing decision-making efforts with techniques based on current theory – however imperfect it may be – than to continue with the impractical, biased, and non-transparent status quo that may result in some national parks failing to meet their objectives.

In some ways this study is ambitious; it attempts to shed light on the relationship between operational costs, income, biological significance, and societal expectations and then bring these elements together systematically in the context of international environmental conventions. In doing so, it transcends a number of academic disciplines, including resource economics, conservation biology, geography, sociology, management, and decision science. The outputs of the research will be of particular interest to conservation practitioners in the fields of protected area management, conservation biology, and ecological economics. The challenges faced by the conservation community are pressing and are of regional, national and international significance and this study makes an important contribution to the debate.

1.6 CONTRIBUTION TO KNOWLEDGE

The principal contribution to knowledge from this research is a new integrated assessment model that helps decision-makers in protected area management agencies to allocate limited funds amongst protected areas. No such methods currently exist in the published literature. The unique system proposed in this research reduces the complex biological, economic, and social attributes associated with protected areas into a single matrix. The model allows decision-makers to compare the attributes of different national parks within a country, weigh the importance of each attribute, and rank each park in terms of natural heritage, economic, and social criteria. This improves managers' ability to make better informed decisions concerning the allocation and distribution of resources.

1.7 DEFINITIONS

The following terms have precise meanings in this thesis.

Benefit: A gain to an individual or group of people from the presence or ascription of a good. The terms ‘value’ and ‘benefit’ are often used interchangeably because they can have similar meanings. In this thesis, the term ‘benefit’ is employed to describe a property of something or an idea or feeling about something (see value).

Framework: A hypothetical representation of a complex entity or process using a system of rules, ideas, or principles to plan or decide something. Used in this thesis to describe decision-making and prioritisation models/techniques developed in the conservation and economic literature.

Model: A hypothetical representation of a complex entity or process using a system of rules, ideas, or principles to plan or decide something. Used in this thesis to describe both specific Multiple Criteria Analysis techniques and the decision-making tool that the research aim sets out to develop.

Protected Area Management Agency (PAMA): A state institution charged with national park management at the provincial/state or federal/national level. A PAMA may have other conservation responsibilities, like the management of other categories of protected area and biodiversity conservation on private land.

Value: The term ‘value’ can have several meanings, and these can cause confusion. In economics, ‘value’ means the worth of a thing, expressed in a measurable unit like dollars. ‘Value’ can also mean a property of something, like ‘this national park has high scenic value’. Finally, ‘value’ can be an idea or a feeling about something, for example ‘this national park has spiritual value to me’ (Najder, 1975 cited in Lockwood, 2006). The terms ‘value’ and ‘benefit’ are often used interchangeably because they can have similar meanings. In this thesis, the term ‘value’ will be used in the economic sense, referring to the worth of something in dollar terms (see benefit).

1.8 THESIS OUTLINE

The thesis comprises seven chapters, supplemented by three appendices. In the first chapter, the research problem, aim of the study, and research objectives are introduced, and terms used in the thesis are presented.

In Chapter Two, the background to the research is presented. The rationale for protected areas and the evolution of national parks is described. The institutional inefficiency of public park management agencies with regard to conservation funding and national parks, is discussed. The theory associated with public sector resource allocation processes is reviewed and it is suggested that allocation decisions could be improved if decision-makers adopt more integrated approaches and had more detailed and consistent information about the parks they manage. The parameters for a model to facilitate better resource allocation decision-making are outlined.

In Chapter Three, a description of the natural heritage, economic, social, and associated threat assessment criteria that could be used to compare and rank national parks is presented.

In Chapter Four, existing conservation prioritisation methods are critically reviewed, other decision-making frameworks are considered and the Multiple Criteria Analysis (MCA) approach is identified as an appropriate decision-making framework to fulfil the research aim. The generic approach to decision-making using MCA is then outlined, along with the types of environmental decision problems that MCA methods have been applied to.

In Chapter Five, the research method and results are presented. The process of structuring the MCA model is outlined. Weight assessment methods are trialled, and the consistency or robustness of the model is tested. Using a case study approach, the model is then applied to national parks managed by the Parks and Wildlife Commission of the Northern Territory (Australia) and the Department of Conservation of New Zealand.

Chapter Six comprises an in-depth discussion of the key findings of the research. linked to the research objectives and the pertinent literature. In particular, the discussion relates to the availability of good quality data for decision-making and the integrated assessment approach taken in the research.

Finally, in Chapter Seven, the conclusions and recommendations arising from the research are presented. These relate to resource allocation decisions made by public protected area management agencies, methods for setting conservation priorities and data management. The usefulness of the model developed in the research and future planning for national parks is also discussed.

2 BACKGROUND TO THE RESEARCH

The purpose of this chapter is to provide background to the research. The chapter has four sections. The first section describes conservation-related institutions, with a focus on the proliferation of protected areas and national parks across the globe. The role of protected area management agencies (PAMAs) and the management activities they undertake is also discussed. The second section provides an overview of the role and function of national parks. This focuses on attitudes towards the benefits national parks should provide. The economic rationale for national parks is also outlined and the section concludes that many national parks are failing to protect and provide the benefits for which they were established. The third section discusses the funding crisis faced by most protected areas worldwide, with a focus on the problems of inadequate income and ineffective expenditure caused by *ad hoc* resource allocation. The fourth and final section addresses the crux of this research, which is to overcome the resource allocation dilemma by developing a model to help decision-makers allocate funds among national parks. The section outlines the characteristics a potential model could have; characteristics that are examined in greater depth in the next two chapters.

2.1 INSTITUTIONS FOR CONSERVATION

The worldwide loss of natural habitats is causing widespread species decline, endangerment, and extinction (Bennett, 2003). Planet Earth is currently experiencing a phase of mass extinctions known as the Sixth Global Extinction. Where the five previous extinction events were caused by natural processes and disasters, human activities are responsible for the current extinction period (Anderson, 2001). Many of the non-human inhabitants of Earth are now threatened by habitat loss and fragmentation, the introduction of exotic species, species exploitation (hunting, collecting, fishing, or trading), and pollution. Conserving these species is critical because ecosystem processes and natural resources are the foundation of human economies and provide the living conditions that are vital to human existence on Earth (Munasinghe & McNeely, 1994).

Nature conservation involves the wise use of natural resources to preserve or protect living and non-living nature. The challenge is to maintain naturally-occurring species in landscapes threatened by the impacts of exotic species, further degradation by human resource use, and weakened resistance to natural environmental pressures like storms and floods (Bennett, 2003). There is increasing evidence that areas of high conservation importance that coincide with large human populations are consequently subjected to many threats (Balmford, Moore, Brooks, Burgess, Hansen et al., 2001).

Since the early 1900s, many conservation-related institutions have emerged at local, regional, national, and international levels. In particular, the conservation movement has been driven by nature-oriented non-governmental organisations (nature-NGOs). Nature-NGOs influence government policy and have instigated major international environmental agreements to protect biological diversity. The influence of these organisations has also lead most nations to establish protected areas, which are institutions that safeguard biological diversity *in situ.* Responsibility for the provision and management of protected areas lies with the nation state in most countries. The management structures of the agencies tasked with managing state-protected areas differ between countries, but all have a broad mandate for protected area management.

2.1.1 NATURE-ORIENTED ORGANISATIONS

Nature-NGOs are significant drivers of the global conservation movement. They are adaptable organisations, largely comprising natural scientists in both developed and developing countries (da Fonseca, 2003). The primary point of political intervention by nature-NGOs is the link between knowledge and action. This link is addressed by compensating for the lack of capacity in state institutions through criticism of existing policy, the creation of networks around environmental objectives, and knowledge transfer (Jasanoff, 2003).

During the decade to 2000 the number of nature-NGOs increased worldwide by 19.5% from 979 to 1,170 (Anheier, Glasius, & Kaldor, 2001). The most prominent international nature-NGOs include large, well-resourced organisations such as Fauna & Flora International (FFI, established 1903); the International Union for the Conservation of Nature (IUCN, established 1948); WWF, The Global Conservation

Organization[1] (WWF, established 1961); and Conservation International (CI, established 1987). The public sector has also responded to the crisis through the United Nations Environment Programme (UNEP; established 1972), which has a directive from the United Nations to provide national governments with expert environmental management advice.

Some of the influential political work of nature-NGOs is expressed in international environmental agreements. An international environmental agreement can be defined as:

> … an intergovernmental document intended as legally binding (whether an original agreement or a modification thereto) with a primary stated purpose of managing or preventing human impacts on natural resources. (Mitchell, 2003, p. 432)

Many such agreements exist, dealing with a wide range of environmental concerns such as atmospheric pollution, destructive fishing practices, and the migratory routes of threatened species. Mitchell (2003) divides environmental agreements into multilateral and bilateral agreements, identifying over 700 multilateral and 1,000 bilateral environmental agreements that fit the above definition.

In becoming party to an international environmental agreement, countries are responsible for reflecting commitments in their national law (Steiner, Kimball, & Scanlon, 2003). This influences national activities and budget allocations as well as indirectly guiding donor-supported activities and giving conservation agencies a stronger mandate domestically (Steiner et al., 2003). Parties to an international environmental agreement often gain access to knowledge, tools, and financial resources. The parties are made accountable through reports to the Conference of the Parties as called for in the respective agreement (Steiner et al., 2003).

Several environmental agreements have global relevance to conservation efforts. These include umbrella agreements (Table 2.1) such as the World Heritage

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[1] When founded in 1961, WWF stood for the ‘World Wildlife Fund’. This changed in the 1980s to "World Wide Fund For Nature" (except in North America where the old name was retained). To avoid confusion across borders and languages, WWF is now known as ‘WWF, The Global Conservation Organization’ (WWF, 2005a).

Convention, and other agreements that focus on regional concerns such as the protection of a specific species.

Table 2.1

Selected Multilateral Environmental Agreements of Global Relevance

Agreement	Date	Other Name	Overall Purpose	Number of Parties
Convention Concerning the Protection of the World Cultural and Natural Heritage	1972	World Heritage Convention (WHC) http://whc.unesco.org/	The protection of globally outstanding sites of cultural and natural heritage.	178
Convention on Biological Diversity	1992	CBD http://www.biodiv.org/	To conserve the variety of living species, and ensure that the benefits from using biological diversity are equitably shared.	188
Convention on International Trade in Endangered Species of Wild Fauna and Flora	1973	CITES http://www.cites.org/	To ensure that international trade in specimens of wild animals and plants does not threaten their survival.	166
Convention on the Conservation of Migratory Species of Wild Animals	1979	Convention on Migratory Species (CMS) or the Bonn Convention http://www.cms.int/	To conserve terrestrial, marine and avian migratory species throughout their range.	86
Convention on Wetlands of International Importance, especially as Waterfowl Habitat	1971	Ramsar Convention on Wetlands http://www.ramsar.org/	The conservation and wise use of wetlands and their resources.	138

The Convention on Biological Diversity (CBD) – one of the primary agreements arising from the 1992 United Nations Conference on Environment and Development (also known as the Earth Summit) held in Rio de Janeiro – is viewed as the core international environmental agreement related to conservation. It supersedes the 1980 World Conservation Strategy and has had a dramatic impact on bringing conservation concepts together (Dearden & Rollins, 1993). The CBD clarified objectives outlined in the World Conservation Strategy, establishing three objectives for biological diversity: the conservation of biological diversity; the sustained use of biological resources; and the equitable sharing of benefits arising from biological diversity including genetic resources (Convention on Biological Diversity, 1993; Siebenhuner & Suplie, 2005). In the sustainable development rhetoric, these objectives refer to the biological, economic, and social aspects of biological diversity. In particular, Articles 7, 8 and 9 of the CBD are concerned with aspects of biological diversity (refer to Appendix A for full text), while the other articles address sovereignty, legal, and social issues. Under the CBD many countries have undertaken national efforts to establish "a system of protected areas or areas where special measures need to be taken to conserve biological diversity" (Article 8(a)). These *in situ* conservation obligations were recently reinforced by the targets and indicators set in the Millennium Development Goals, and by decisions at the World Summit for Sustainable Development. One prominent exception to the parties of the CBD is the United States (Siebenhuner & Suplie, 2005).

2.1.2 PROTECTED AREAS

The primary mechanism for conservation today is a global network of protected areas (Bennett, 2003; Bruner, Hanks, & Hannah, 2003; Carabias, de la Maza, & Cadena, 2003; Carabias & Rao, 2003; Hughey, Cullen, & Moran, 2003; Margules & Pressey, 2000; Martin, 2003; Rodrigues, Andelman, Bakarr, Boitani, Brooks et al., 2003). The IUCN defines a protected area as:

> … an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means. (IUCN-WCMC, 1994, p. 4)

Simply put, protected areas prevent species extinctions by providing habitat and space in which species can persist. The traditional role of protected areas is to provide refuges for biological diversity. These areas also provide essential environmental services and economic benefits, protect spiritual sites, mitigate long-term global threats, reduce border tensions, and help reduce poverty (Martin, 2003). Although authority for the establishment and management of a nation's protected areas is a matter of government legislation and policy, nature-NGOs have been the most influential proponents for the creation and management of protected areas across the globe. For example, the IUCN led the worldwide national park movement and produced the protected area classification system, and now promotes the establishment and effective management of a worldwide representative network of marine and terrestrial protected areas through the World Commission on Protected Areas (Holdgate, 1999).

International environmental agreements such as the World Heritage Convention and the Ramsar Convention facilitate the establishment of individual protected areas to meet specific conservation objectives. In comparison, the CBD and other environmental agreements (such as the European Natura 2000[2] and many national policies) call for nations to establish a comprehensive national system of protected areas (Earthwatch Europe, IUCN, & World Business Council for Sustainable Development, 2002; Hockings & Phillips, 1999).

In 1987, the Brundtland Commission called upon all nations to set aside 12% of their land as protected areas (Noss, 1996). However, the Commission focused on human needs and provided no evidence to support its call for 12% (Rauschmayer, 2001). In 2002, the global network of protected areas represented over 12% of the Earth's terrestrial surface[3] (Martin, 2003). Unfortunately, this 12% is not a representative sample of the world's biological diversity because the geographical distribution of protected areas favours the protection of land not suitable for arable uses, with a large emphasis on steep, mountainous protected areas (Ryan, c. 1992). Pressey (1996) noted that to judge the success of the protected area movement by the hectares it constitutes is to miss the point because the effectiveness of protected areas is just as important as total area.

The increase in the number of protected areas corresponds with dramatic increases in human populations – associated with increased requirements for food, materials, energy, and waste dumps – so the pressure on biological diversity has also increased markedly. In recent decades, much research effort has been devoted to identifying conservation priorities at global, continental, national, and

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[2] Natura 2000 is the cornerstone of the European Union's nature protection policy. The Natura 2000 network comprises sites identified under the 1979 Birds Directive and the 1992 Habitats Directive, and represents over 17% of EU territory (EUROPA, 2006).

[3] This figure excludes the 10% of the Earth's terrestrial surface covered by Antarctica; marine protected areas are a relatively young concept and less than 1% of the Earth's oceans is protected (IUCN-WCPA, 2006).

regional scales in order to establish new protected areas in locations with high significance for nature conservation. Effort has also been placed on measuring the effectiveness of protected area management by assessing protected area importance and vulnerability, design and planning, resource needs, management conduct, the implementation of management programmes, and management outcomes (Hockings, Stolton, & Dudley, 2000) (this literature is reviewed in Chapter Four).

Management objectives for modern protected areas range from strict nature preservation to controlled resource harvesting (Pressey, 1996). Globally, more than 140 names have been applied to different types of protected area. The IUCN promotes an internationally applicable system of six categories of protected area management, reflecting the full spectrum of management objectives for protected areas; this brings some clarity to a massive global movement (Table 2.2) (IUCN-WCMC, 1994). These categories are specific enough to differentiate different types of protected area but broad enough to include all types of protected area.

The guidelines for the IUCN system stress that the number assigned to a category does not reflect its importance, as all categories are needed for conservation and sustainable development. Thus, countries are encouraged to develop a portfolio sufficiently diverse to include protected areas from the full range of management categories (IUCN-WCMC, 1994). The categories represent a gradation of human intervention and increasingly vague property rights, with the exclusion of traditional owners and local communities being most apparent in the ‘strict’ protected area categories I-IV (Pressey, 1996).

PAMAs ultimately come under their own nation’s jurisdiction. However, they gain valuable management direction though the influence of UNEP and nature-NGOs, international agreements on environmental management, and, in some cases, the recommendations of their own researchers and independent academic researchers. The World Parks Congress, a 10 yearly event organised by the prominent nature-NGOs, provides the major global forum for setting the protected areas agenda.

Table 2.2

IUCN Protected Area Categories and Their Management Objectives

Protected area Category	**Description**	**Management objective** 1 = primary objective, 2 = secondary objective, 3 = potentially applicable objective								
		Scientific research	**Wilderness protection**	**Preserving species & genetic diversity**	**Maintaining ecosystem services**	**Protecting natural/ cultural features**	**Tourism &recreation**	**Education**	**Sustainable use of resources**	**Maintaining cultural/ traditional attributes**
Ia	Strict nature reserve: managed mainly for science	1	2	1	2	-	-	-	-	-
Ib	Strict nature reserve: managed mainly for wilderness protection	3	1	2	1	-	2	-	3	-
II	National park: managed mainly for ecosystem protection and recreation	2	2	1	1	2	1	2	3	-
III	Natural monument: managed mainly for conservation of specific natural features	2	3	1	-	1	1	2	-	-
IV	Habitat/species management area: managed mainly for conservation through management intervention	2	3	1	1	3	3	2	2	-
V	Protected landscape/seascape: managed mainly for landscape or seascape conservation and recreation	2	-	2	2	1	1	2	2	1
VI	Managed resource protected area: protected area managed mainly for the sustainable use of natural ecosystems	3	2	1	1	3	3	3	1	2

Source: IUCN-WCMC (1994, p. 4).

The current focus of the conservation movement is on conserving biological diversity and ecosystem functions at the bioregional scale through the development of networks and systems of protected areas. While protected areas alone will not ensure the protection of the world's biological diversity, they remain a conservation mechanism of critical importance. There is a growing understanding of ecosystem complexity and the need to integrate protected areas into the management of surrounding tenures and land uses (Child, McKean, Kiss, Munthali, Jones et al., 2004; English & Lee, 2003; Halvorson, 1996). Conservation of biological diversity will rely largely on the unreserved matrix; that is, habitat occurring outside formally declared protected areas. UNESCO's Man and the Biosphere (MAB) programme, established in the mid-1970s, aims to protect biological diversity and the economic well-being of local human populations through protected areas having a core area of maximum protection, surrounded by concentric rings of moderated use. This means the strict protected area is in a matrix of land used for urban and agricultural development (Halvorson, 1996). Thus, the MAB programme represents an important step towards discarding the mindset of 'nature' and 'us'.

Increasingly, transboundary protected area arrangements are being established between adjacent countries. As well as the conservation benefits arising from larger areas of protected landscape, transboundary protected area arrangements promote international peace and co-operation, facilitate more effective research, and provide economic benefits to local and national economies (Sandwith, Shine, Hamilton, & Sheppard, 2001).

2.1.3 PROTECTED AREA MANAGEMENT AGENCIES

The traditional approach to protected area planning and management has been that of a government agency, funded by government revenue[4] (Athanas, Vorhies, Ghersi, Shadie, & Shultis, 2001). Responsibility for the establishment and management of protected areas in most countries still lies with the nation state and almost all governments now have departments or ministries responsible for environmental affairs and protected area management (Holdgate, 1999). However, there has also been growth in the number of protected areas managed by agencies other than government agencies, including private businesses, NGOs, private individuals, and local communities (Emerton, Bishop, & Thomas, 2006). Four main types of protected area governance have been identified: government

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[4] Government revenue is primarily derived from taxation.

protected areas (managed by government agencies at various levels), co-managed protected areas (managed by various, cooperating agencies), private protected areas (managed by private landowners); and community conserved areas (managed by indigenous peoples or local communities) (Borrini-Feyerabend, Johnston, & Pansky, 2006). The focus of this research is government PAMAs.

Many PAMAs are charged with managing biological research programmes beyond the borders of the national protected area system, while others are only responsible for certain categories of protected area, like national parks. For example, the Department of Conservation (New Zealand) and the Parks and Wildlife Commission of the Northern Territory (Australia) manage national parks as well as IUCN category III, IV, and V protected areas[5]. In comparison, agencies like South African National Parks are responsible solely for a network of national parks.

PAMAs have diverse responsibilities, complicated by the frequently conflicting wants of multiple stakeholders (Figure 2.1 shows stakeholders who obtain direct use values from the park). These agencies must also balance the often conflicting objectives of preserving biodiversity and providing visitor experiences in protected areas like national parks. Protected areas need effective and efficient management, meaning conservation needs are met while making the best use of resources (Borrini-Feyerabend et al., 2006).

Specific responsibilities include developing visitor facilities, providing recreational and educational experiences, research and monitoring, pest control, habitat

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[5] The Parks and Wildlife Commission of the Northern Territory (Australia) is responsible for two Bio Parks (educational parks), general biodiversity conservation, and the management of parks, including national parks, historical reserves, nature parks, coastal reserves, and conservation reserves (Parks and Wildlife Commission of the Northern Territory, 2006). The Department of Conservation (New Zealand) manages New Zealand's national parks, conservation parks (formerly called forest parks), reserves and conservation areas, protected indigenous forests, protected inland waters and wild and scenic rivers, indigenous/native wildlife, non-commercial freshwater fisheries, historic places on conservation land, marine reserves and the protection of marine mammals, and offshore islands set aside for conservation (Department of Conservation, 2006) .

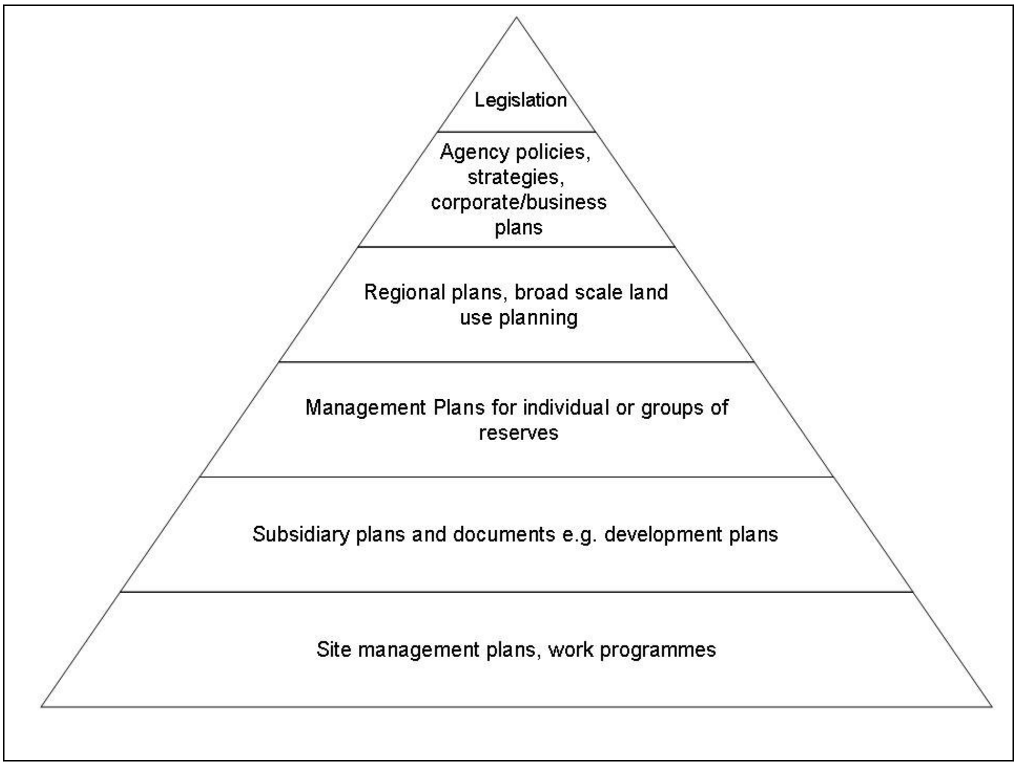
restoration, species management and reintroduction, enforcement of laws (e.g., anti-poaching), staff training and capacity building, interpretation and protection of historical or cultural features, liaison with stakeholders, and developing conservation policy. These responsibilities are often poorly defined and are complicated by ever-increasing numbers of visitors, declining physical infrastructure, budgetary constraints, changes in the political agenda, and an array of adverse land uses bordering almost every park (Wright & Mattson, 1996). Active management is necessary to ensure that national parks achieve their purposes, and management is complemented by monitoring, which gauges the effectiveness of particular approaches (Pressey, 1996).

Figure 2.1
Potential National Park Stakeholders

Source: Hall *et al.* (1996a, p.29)

Typical planning for PAMAs (Figure 2.2) comprises a hierarchy of policies and guidelines. It is common practice for PAMAs to prepare a management plan for each national park. These plans define the purpose and objectives for the park and provide direction for day-to-day management. The IUCN-WCPA has produced a series of guidelines for protected area management, including a volume on management planning for protected areas (Thomas & Middleton, 2003), which advocates 'management by objectives'.

Figure 2.2
A *Typical Planning Hierarchy for Protected Area Management Agencies*



Source: Adapted from Thomas *et al.* (2003)

This is a proactive results-oriented style of management. Thomas and Middleton (2003) outlined four steps that are integral to this type of management and decision-making: (1) formulate clear objectives; (2) develop realistic action plans to achieve the objectives; (3) measure and monitor performance and achievement; and (4) take corrective actions when necessary.

According to Hockings (2000) a range of factors influence the effectiveness with which PAMAs carry out their responsibilities, including:

- The nature of the protected area's resources – the state and resilience of the ecosystems and species present, the magnitude of threats, accessibility, and the ease of undertaking management activities;

- The governance systems and structures in place – political support, legislation and policy, and protected area system design;
- The level of awareness and support from local communities; and
- Agency inputs – staff, funds, infrastructure, and information.

A comparison of the characteristics of national park management in five nations with differing levels of development (Table 2.3) illustrates how some of these factors differ among PAMAs. Countries were selected from the three groupings of market economies used by United Nations for analytical purposes (United Nations Online Network in Public Administration and Finance, 2006). These are: developed market economies (Australia and New Zealand), economies in transition (the Czech Republic), and developing market economies (South Africa and Nepal). In the UN's 'developing economies' grouping, Nepal belongs to the 'least developed countries' sub-group.

Each agency operates within a different biological, administrative, political, and socio-economic framework. The national parks of Australia's Northern Territory, the Czech Republic, Nepal, New Zealand, and South Africa face diverse threats and management contexts. All these countries – bar New Zealand – border other provinces or countries. They are all signatories to the same international environmental agreements, but each has different institutional arrangements for national park management. The predominant model charges government departments with the management of national parks and other protected areas. The Czech Republic has a separate agency for each of its four national parks, while South African National Parks (SANParks) is a parastatal agency – meaning a semi-autonomous, quasi-governmental, state-owned enterprise (Child et al., 2004) – and is only responsible for national park management. All the agencies from these countries rely on government funding for part of their income. For further detail regarding the management of national parks in each of these five countries/provinces refer to Appendix B.

Table 2.3

Characteristics of Protected Area Management in Selected Countries

Country/Province:		**Australia's Northern Territory**	**The Czech Republic**	**Nepal**	**New Zealand**	**South Africa**
Market Economy:		Developed	In transition	Developing	Developed	Developing
Signatory to:	**CBD**	✓	✓	✓	✓	✓
	CITES	✓	✓	✓	✓	✓
	CMS	✓	✓	X	✓	✓
	Ramsar	✓	✓	✓	✓	✓
	WHC	✓	✓	✓	✓	✓
	IUCN (member)	✓	✓	✓	✓	✓
Agency:		Parks and Wildlife Commission of the Northern Territory (PWCNT)	Each national park is managed by a separate agency	Department of National Parks and Wildlife Conservation (DNPWC)	Department of Conservation (DOC)	South African National Parks (SANParks)
Agency Type:		Government Department	Four separate Government agencies	Government Department	Government Department	Parastatal agency
Agency Responsibilities:		The management of all protected areas and recommendations for biological diversity conservation throughout the Territory.	Each agency is responsible for the management of one national park.	Responsible for the management of all protected areas.	Responsible for the management of all protected areas.	Responsible for the management of all national parks.
Number of national parks		18	4	9	14	20
Number of Transboundary National Parks:		None	4	2	None	4
Major Threats to National Parks:	**Air pollution**		✓			
	Disease					✓
	Feral animals	✓			✓	
	Fire	✓				✓
	Insect pests		✓			
	Poaching					✓
	Resource extraction by local/displaced peoples			✓		
	Tourists in excessive numbers		✓			
	Weeds	✓			✓	✓
	Wildlife overabundance causing habitat destruction					✓
Annual Funding for national parks:		Government funds. Camping fees not retained by the park.	One agency relies solely on government funds, the other three rely on both park-generated revenue and government funding.	Partially government funded, partially park-generated.	Predominantly government funded, partially park-generated.	75% park-generated and 25% government funded. Cross subsidisation between a few profitable parks and the bulk of which cannot cover their own costs.

2.2 THE ROLE AND FUNCTION OF NATIONAL PARKS

The notion of setting land aside from unrestricted exploitative use has been in practice for centuries. Motivations have included the protection of commercial infrastructure (e.g., harbours), religion (e.g., sacred groves, and the temples of Asia), and setting aside resources for use by the privileged. These areas, where human activities were restricted rather than prohibited, were usually designated and managed by local communities.

The modern concept of a protected area, was initiated with the declaration of the world's first national park at Yellowstone in the north-western United States in 1872. The dominant Western worldview then was cornucopian; nature's bounty had no limits. Thus, the 19th century was a time of conquest and division of the globe by the advanced industrial nations of the West, and of the exploitation of natural resources using industrial technology. Establishing Yellowstone National Park was not an uncomplicated act of environmental preservation. Instead, by vesting 800,000 ha of north-west Wyoming in the State, private companies were prevented from acquiring geysers and hot springs. Furthermore, the establishment of national parks helped to give the United States a national identity after the Civil War (Grusin, 2004; MacEwen & MacEwen, 1982). The geysers and hot springs reserved in Yellowstone National Park served as scientific wonders and points of interest for visitors, and the park soon became a preserve for symbols of America's vanishing frontier heritage, such as buffalo and elk (Mason, 2004).

Yellowstone National Park's declaration was followed by the establishment of Royal National Park in Australia (1879) and Banff National Park in Canada (1885). However, the world's fourth national park was created under different conditions from the preceding three. In 1887, the peaks of the mountains that constitute Tongariro National Park were gifted to the people of New Zealand by the paramount chief of the Tuwharetoa tribe of Māori (the indigenous people of New Zealand), with the intention that their sacredness may be protected forever (Grace, 1959). In 1993, UNESCO formally recognised Tongariro National Park as the first property on the World Heritage List inscribed under the new 'cultural landscape' criteria (UNESCO, 2006).

Most national parks are established for natural values and are typically large geographical areas that protect ecosystems and watersheds. Wealthier nations generally have more, but smaller protected areas than poorer nations (McKinney, 2002). The establishment of protected areas has historically been sporadic, typically involving land that has no other major commercial use (1996).

The ‘national park’ has been the most and accepted type of protected area worldwide[6] (Ahmend, Giraldo, Oltremari, Sánchez, & Yerenda, 2003). While most nations have a range of protected areas, national parks are the most popular with tourists; they represent the most appealing species and landscapes, and their management involves more staff and funding than other types of protected area. National parks are, therefore, under severe pressure to deliver a range of biological, economic, and social benefits. For these reasons the focus of this research is national parks. However, because much of the research focuses on protected areas, rather than national parks specifically, the term ‘protected area’ is used, unless the subject applies to national parks.

2.2.1 EVOLVING CONSERVATION OBJECTIVES

National park objectives have evolved through four main phases (Figure 2.3). The first phase was the inception period which, through the efforts of nature-NGOs, saw national parks proliferate across the globe. Most national parks were set aside following the imperialist Yellowstone model, which was based on the exclusionary philosophy that nature – meaning visually outstanding landscapes and charismatic megafauna (the latter particularly true for national parks established on the African continent, where predators were culled in an attempt to raise the number of wild ungulates) – is best preserved in the absence of humans. Park management was based on a military model, where the park was treated as a fortress and protected from local communities wanting to exploit resources within the park boundaries (Anderson & James, 2001). The law that created Yellowstone National Park, the Yellowstone Manifest, dedicated the park for public recreation, excluding people

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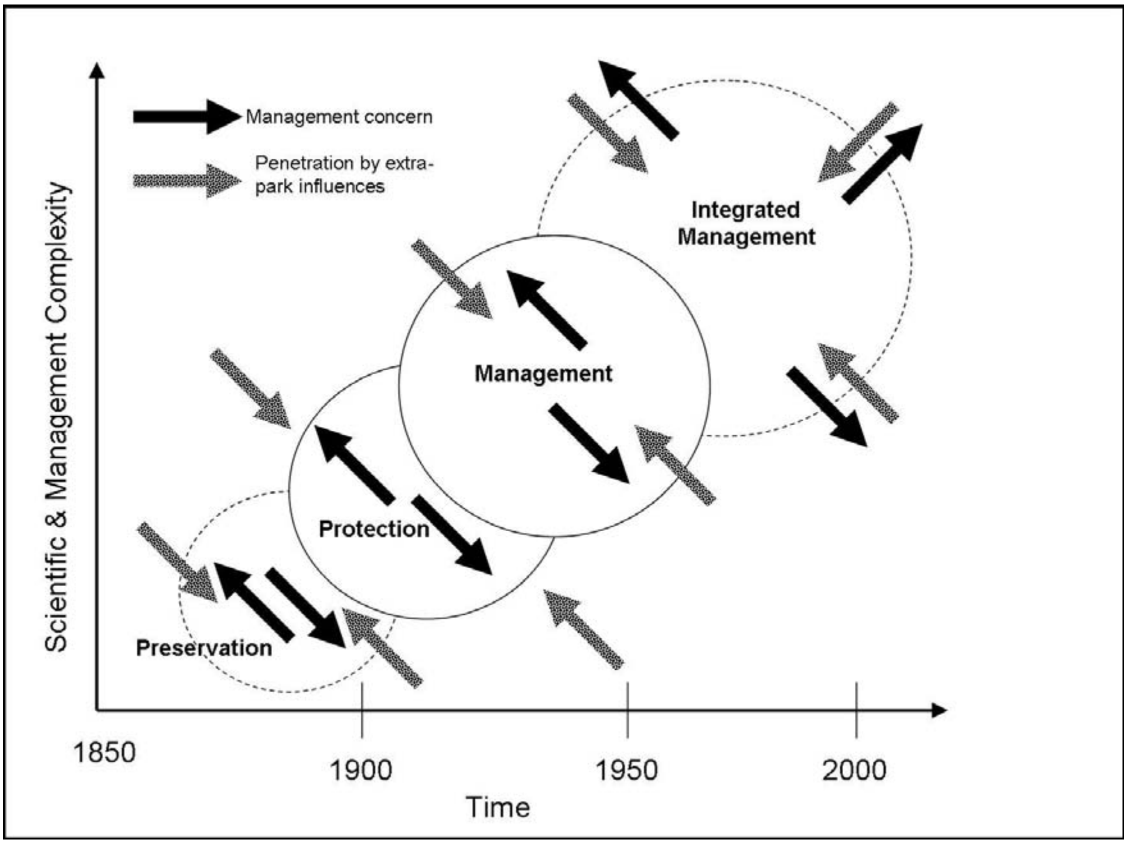
[6] This is true for many developed countries, but one notable exemption is Scotland where the national park movement failed to enter legislation because of factors including the strength of the landowning interest, rural depopulation, and concern for jobs in a depressed economy (MacEwen & MacEwen, 1982). Scotland now has two national parks; the first was declared in 2002.

from living within the park, and forbidding its sale (Ahmend et al., 2003). Since their inception, national parks have been characterised by a dual mandate of environmental protection and recreational use.

Figure 2.3

The Evolving Role of National Parks: From Isolation to Integration



Source: Adapted from Dearden and Rollins (1993)

The second phase was based on ideas presented by the 1933 London Convention,[7] including the protection of 'flora and fauna' and of sites of importance for public benefit (enjoyment and education) (Cumming, 2004). The London Convention also reinforced the Yellowstone Manifest's dual mandate. This was further strengthened at the 1969 Tenth Assembly of IUCN held in New Delhi where two main axioms for national parks were established, namely that they are unoccupied areas and that there is a central authority in the nation that has the power to take measures to guarantee their conservation (Ahmend et al., 2003).

[7] The full title is the 1933 London Convention on Preservation of Fauna and Flora in Their Natural State. It focused primarily on Africa.

The third phase was characterised by the emergence of Conservation Biology as a discipline in the 1980s. This led to a management focus concerned with the full range of biological diversity from genes to ecosystems, functional landscapes, and evolutionary processes (Cumming, 2004). These objectives were reflected in the Convention on Biological Diversity in 1992 and it is now recognised that they are best achieved through a combination of species and habitat conservation (Hambler, 2004).

The fourth and most recent phase, integrated management, increasingly emphasises social and economic benefits, 'parks for people' and the potential role of parks in rural development (Cumming, 2004).

National parks are still characterised by a dual mandate, defined most recently by the IUCN as a Category II protected area "managed mainly for ecosystem protection and recreation" (IUCN-WCMC, 1994, p.4). The IUCN Guidelines for Protected Area Management (Figure 2.4) describe the objectives of a national park as the protection of ecological integrity, management of threats, and provision for spiritual, scientific, educational, and recreational opportunities that are culturally compatible (IUCN-WCMC, 1994). Because most governments are members of the IUCN, this definition should apply to all national parks. However, some protected areas are known as national parks but do not fit the IUCN definition. For example, the national parks in England, established 20 years before the IUCN definition, incorporate human settlement and extensive resource use. These parks would be more appropriately assigned to Category V. However, a change in terminology now would be interpreted as downgrading the status of the parks (MacEwen & MacEwen, 1982). Many national parks in other countries also have resident human populations for park and tourism related staff, which is acceptable where the park is managed mainly for ecosystem protection and recreation.

Park managers face the challenges posed by the potentially conflicting dual mandate of national parks, which raises questions of conflict between preservation and use, and the diversity of the abovementioned objectives. In the late nineteenth century the 'environmental crisis' had not yet arrived and visitors on packaged tours were not envisaged because of high travel costs (Shah, 1995). Thus, the prime objective of national park management was preservation of the park's pristine condition, or at least the preservation of wildlife that was highly valued at that time, while human activities in and surrounding a national park were required to be minimal and unobtrusive. National park managers were initially concerned with the regulation of natural hazards like droughts, floods, fire and disease; wildlife management; modifying the mix of vegetation; reinforcing natural barriers against soil erosion; and biological and zoological research (Shah, 1995). Animal poaching was the only serious economic problem faced by park managers during this period (Shah, 1995).

Figure 2.4
Guidelines for the National Park Management Category

CATEGORY II National Park: protected area managed mainly for ecosystem protection and recreation

Definition
Natural area of land and/or sea, designated to (a) protect the ecological integrity of one or more ecosystems for present and future generations, (b) exclude exploitation or occupation inimical to the purposes of designation of the area and (c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.

Objectives of Management
- to protect natural and scenic areas of national and international significance for spiritual, scientific, educational, recreational or tourist purposes;
- to perpetuate, in as natural a state as possible, representative examples of physiographic regions, biotic communities, genetic resources, and species, to provide ecological stability and diversity;
- to manage visitor use for inspirational, educational, cultural and recreational purposes at a level which will maintain the area in a natural or near natural state;
- to eliminate and thereafter prevent exploitation or occupation inimical to the purposes of designation;
- to maintain respect for the ecological, geomorphologic, sacred or aesthetic attributes which warranted designation; and
- to take into account the needs of indigenous people, including subsistence resource use, in so far as these will not adversely affect the other objectives of management.

Guidance for Selection
- The area should contain a representative sample of major natural regions, features or scenery, where plant and animal species, habitats and geomorphological sites are of special spiritual, scientific, educational, recreational and tourist significance.
- The area should be large enough to contain one or more entire ecosystems not materially altered by current human occupation or exploitation.

Organizational Responsibility
Ownership and management should normally be by the highest competent authority of the nation having jurisdiction over it. However, they may also be vested in another level of government, council of indigenous people, foundation or other legally established body which has dedicated the area to long-term conservation.

Source: IUCN-WCMC (1994, p. 10)

Some wildlife management strategies adopted in the early years of national park management are now viewed as inappropriate. For example, wolves were eradicated from many national parks in the USA because public opinion favoured protecting the interests of livestock farmers. This attitude extended to national parks in order to protect neighbouring livestock and the national park's large ungulates. Wolves are keystone predators that play and important role in the regulation of ungulate species. In the absence of predators, ungulates have serious impacts on vegetation, their populations fluctuate greatly, and individuals often starve to death (Fritts, 1996)[8]. In southern Africa, artificial waterholes were created in many national parks in order to attract animals for tourists to view (Child, 2004b). This is thought to have contributed to a series of changes in species composition that lead to the near extinction of the roan antelope (*Hippotragus equinus*) (t' Sas-Rolfes & Fearnhead, 2001). In other national parks exotic species were intentionally introduced; for example, heather (*Calluna vulgaris*) was introduced by park rangers to Tongariro National Park, New Zealand, with the intention of providing habitat for grouse hunting (*Tetrao tetrix* and *Lagopus lagopus scotica*), though grouse were never introduced. Heather is now considered a serious invasive weed throughout the park.

Many national parks were established without the participation of the local people who lived in or near the area and/or used it for their livelihoods. Such parks were characterised by centralist management that corresponded with national, rather than local interests (Abakerli, 2001; Ahmend et al., 2003). 'Third World' national parks were established for various reasons. Many parks in India were originally the hunting preserves of maharajahs. In Africa, some parks resulted from the whims of influential individuals, while others were created in order to protect a single species such as the gorilla (Shah, 1995). Many authors have noted that unless conservation has local support, it will fail (Beltran, 2000; Brosius, 2004; Child, 2004a; Geist & Galatowitsch, 1999; Huston, 2001; Kiss, 2004; Nepal, 2000; 1998).

We know human life depends upon natural systems, but many people believe if natural resources do not generate some economic benefit, their protection is unnecessary (Nicholls, 2004). National park systems generate greater total economic benefits than those obtained from continued habitat conversion (Balmford, Bruner, Cooper, Costanza, Farber et al., 2002). However, the benefit

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[8] Wolf populations in the USA reached their lowest numbers in 1930. Wolves were protected with the passing of the 1973 Endangered Species Act and reintroductions to national parks began in the 1990s following largely successful efforts to change public attitudes towards wolves (Fritts, 1996).

distribution from protected areas is not geographically homogenous and in many nations the conservation of nature is perceived as an elitist luxury. In developing countries, park management has had to address issues like consumptive uses of wildlife, cultural obligations, and the involvement of stakeholders in land management strategies. Similar issues have been brought to the fore in developed countries through land claims by traditional owners. In some cases, joint management arrangements that attempt to satisfy both Western agendas and those of traditional owners have emerged (English & Lee, 2003). Thus, protected area management is increasingly focusing on the economic values of natural systems, on equity issues regarding benefit distribution, and on stakeholder involvement in the designation and management of protected areas.

Evidence of the change in approach to national park planning and management since 1872 and the diverse range of benefits now associated with national parks are highlighted in Table 2.4. This diversity is reflected in the staff of national park management agencies around the globe, with many of these agencies now employing specialists in disciplines including ecology, anthropology, law, history, archaeology, and public education (English & Lee, 2003).

Simply contemplating the outputs from the IUCN's six commissions – including the World Commission on Protected Areas (Table 2.5), which unite volunteer experts from a range of disciplines – gives an impression of the conservation movement's perspectives on the many facets of what constitutes good conservation practice.

Table 2.4
Traditional and Emerging Protected Area Paradigms

	Traditional paradigm	Emerging paradigm
Objectives:	- 'set aside' for conservation/taken out of productive use - established mainly for scenic protection and spectacular wildlife - managed mainly for visitors and tourists, whose interested normally prevail over those of local people; - management focussed on the protection of existing natural and landscape assets	- run with conservation, recreations, social, and economic objectives - often established for scientific, economic and cultural reasons - managed in order to help meet the economic and cultural needs of local people - management focussed on restoration and rehabilitation, as well as protection, so that lost or eroded values can be recovered
Governance:	- usually run by central government	- run by many partners; e.g. different tiers of government, local communities, indigenous groups, the private sector, non-governmental organisations
Local people:	- parks planned and managed against the impact of people (except for visitors), and especially to exclude local people - managed with little regard to the local community, who are rarely consulted or informed of management intentions	- run with, for and, in some cases, by local people who are seen as active partners – even initiators and leaders – in policy and management decisions - managed to help meet the economic and cultural needs of local people
The wider context:	- planned one by one, in an *ad hoc* manner - managed as 'islands' without regard to the areas around them	- planned as part of national, regional and international systems - developed as 'networks' linked by green corridors, and integrated within surrounding land that is managed sustainably by communities
Perceptions:	- viewed primarily as a national assets, with national considerations prevailing over local ones - viewed exclusively as a national concern	- viewed as a community asset, balancing the idea of a national heritage - management is guided by international responsibilities and national/local concerns, sometimes resulting in transboundary arrangements
Management technique:	- technocratic with little regard to political considerations - little regard to the need to learn from experience	- adaptive according to a long-term, learning perspective - selection, planning and management are viewed as a political exercise, requiring sensitivity, participation and astute judgement
Finance:	- government-funded	- funded through a variety of means to supplement/replace government subsidy
Management skills:	- managed by natural scientists or natural resource experts - management is expert led	- managed by people with a range of skills, especially people-related skills - management values and draws on the knowledge of local people

Source: Adapted from Lockwood and Kothari (2006) and Phillips (2003)

Table 2.5

The Roles of the IUCN's Six Commissions

Commission	Role
Species Survival Commission (SSC)	Provides advice on technical aspects of species conservation and mobilises action for species threatened with extinction.
World Commission on Protected Areas (WCPA)	Promotes the establishment and effective management of a worldwide representative network of terrestrial and marine protected areas.
Commission on Environmental Law (CEL)	Advances environmental law by developing new legal concepts and instruments, and by building the capacity of societies to employ environmental law for conservation and sustainable development.
Commission on Education and Communication (CEC)	Champions the strategic use of communication and education to empower and educate stakeholders for the sustainable use of natural resources.
Commission on Environmental, Economic and Social Policy (CEESP)	Provides expertise and policy advice on economic and social factors for the conservation and sustainable use of biological diversity.
Commission on Ecosystem Management (CEM)	Provides expert guidance on integrated ecosystem approaches to the management of natural and modified ecosystems.

Source: Adapted from IUCN (2005a)

2.2.2 ECONOMIC RATIONALE

An economic good can be defined as "a commodity or service that satisfies a human need" (Butterfield, 2003, p. 702). The economic rationale for government provision of national parks involves two perspectives: a national park as a good, and a national park as a provider of goods to individuals and society.

The government supply of a good like a national park does not necessarily mean that the good is a 'public good' (Kahn, 2004). Both public and private goods may be collectively or privately provided, depending upon the degree of rivalness of consumption and excludability associated with the good (Kahn, 2004; Lovett, 1998) (Table 2.6). Public goods are characterised by non-rival consumption, meaning that a unit of a public good can be consumed by an individual without excluding consumption of the same unit by others. The second characteristic of public goods is the impossibility of exclusion, meaning that a public good cannot be supplied to one person without being supplied to everyone (Athanas et al., 2001; Kahn, 2004; Lovett, 1998; Turner, 2002). In contrast, private goods are rival and excludable. They are characterised by full property rights, meaning rights to a private good are specific, enforceable, and transferable (Kahn, 2004).

Table 2.6

Classes and Characteristics of Goods

	Rival	**Non-Rival**
Excludable	Pure private goods - may be traded freely in competitive markets - completely exhaustible and excludable - ability to exclude potential customers - experience full property rights (property rights meet the criteria of being specific, enforceable, and transferable) - e.g., cars	Quasi-private goods or toll goods -provided by either the public sector, which charges fees for use, or the private sector - pricing is not perfectly discriminatory - e.g,. national parks in the Republic of South Africa
Non-excludable	Quasi-private goods or common property goods -provided by either the public sector (financed by general revenues) or private philanthropy (usually in sub-optimal quantities) - impossible to collect payments for their provision so cannot be offered in private markets - e.g,. national parks in New Zealand	Pure public goods -provided by either the public sector (financed by general revenues) or private philanthropy (usually in sub-optimal quantities) - cannot exclude potential customers - not traded in any organised market - property rights will not meet all three criteria of being specific, enforceable, and transferable - e.g., national defence

Source: Adapted from Athanas *et al.* (2001), Mitchell and Carson (1989) and Randall (1987)

In reality, goods lie on a spectrum with pure private goods and pure public goods at the extremes (Kahn, 2004; Mitchell & Carson, 1989). If the sole purpose of national parks was wilderness protection, they would function as pure public goods (non-excludable and non-rival). However, some visitor activities in national parks are congestible, meaning the activities of one person may crowd other people and thereby reduce the benefits they derive from their own activities (Turner, 2000). Activities resulting in congestion, or in environmental degradation like erosion or littering, can mean parks are not completely non-rival in consumption (Kahn, 2004). Property rights to a national park are specific and enforceable, but they are non-transferable because they cannot be freely traded in the marketplace (Mitchell & Carson, 1989).

Most national parks fit the IUCN definition of a national park, but each nation's national parks occur in different positions on the public-private goods spectrum, because some management arrangements are more exclusive than others. For example, entrance fees are not charged for national parks in New Zealand or Australia's Northern Territory, so they are closer to the pure public good end of the spectrum than are the federal national parks of Canada, Australia, or South Africa, where a fee is charged for park entry that excludes some people from visiting national parks.

Many of the goods provided by national parks are pure public goods. The concept of Total Economic Value (TEV) is a widely used typology that illustrates the nature of the goods provided by environmental assets like national parks (Pearce, 1990; WCPA-IUCN, 1998). The TEV of a site is the sum of its on and off-site use values, option values, and existence values as shown in Figure 2.5.

Direct use values are derived from activities such as timber extraction, recreation, hunting, education, or research. Commercial uses are relatively easy to value, but the prices set by the PAMA for these activities may not reflect the true value of the product (Mitchell & Carson, 1989). Indirect use values are benefits that are not directly consumed. These include ecosystem services like watershed protection and climatic stabilisation (WCPA-IUCN, 1998). Option values relate to the potential use of the protected area at some future time, and can act as either use or non-use values because they exist on the assumption that future use will take place but do not involve current use (WCPA-IUCN, 1998).

Existence value reflects the benefit of knowing that a protected area exists; it can be defined as:

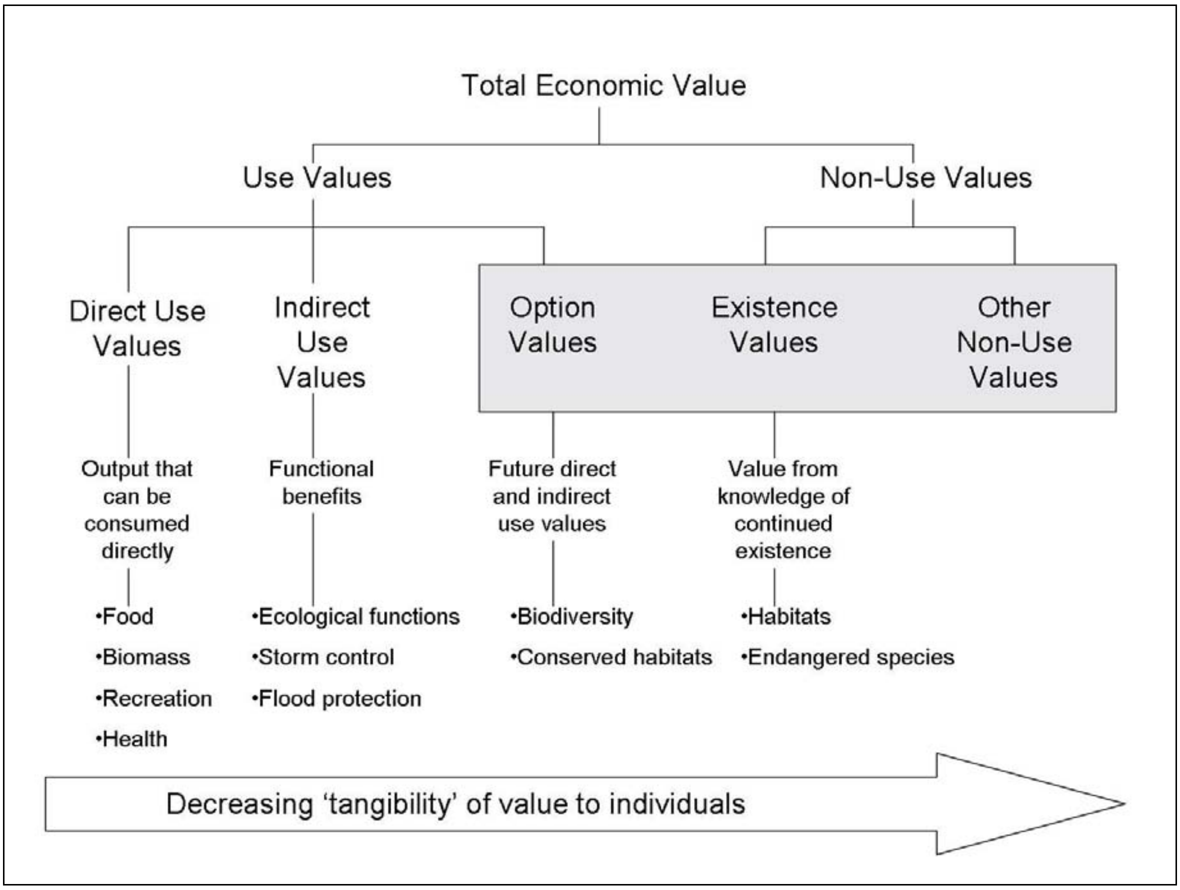
> … the satisfaction, symbolic importance, and even willingness to pay, derived from knowing that outstanding natural and cultural landscapes have been protected and exist as physical and conceptual spaces where all forms of life and culture are valued and held sacred. (Putney, 2003, p. 8)

Other non-use values include bequest value, which is the benefit of knowing that others will gain value from the area in the future. The future value of information derived from the area falls under this category and may include genes that prove vital to agriculture, pharmaceutical, or cosmetic products (WCPA-IUCN, 1998).

Option, existence, and bequest values are 'fuzzy' values, because they are intangible and hard to measure. Other non-use values include spiritual, cultural, aesthetic, educational, scientific, peace, and therapeutic benefits (Barnes, 2003). Because most of these benefits are not exchanged in markets it is hard to determine their value (Dixon & Sherman, 1990,1991). Techniques for deriving the value of these goods and services are reviewed in Chapter Three.

Figure 2.5

Categories of Economic Values Attributed to Environmental Assets (with examples from a Tropical Forest)



Source: Munasinghe (1994, p. 37)

The characteristics of some of these goods are outlined in Table 2.7, which shows that many of these goods and services are pure public goods because they are both non-rival and non-excludable. Further, many of the goods provide benefits beyond the borders of the protected area. A PAMA can enhance or hinder the provision of some goods through management activities.

Table 2.7

Characteristics of Goods and Services Associated with Protected Areas

Good/Service	Non-rival	Non-excludable	Off-Site Effects	Estimation of Value
Recreation/tourism	XC	P	-	S
Erosion control	X	X	X	S
Local flood reduction	X	X	X	E
Regulation of stream flows	X	X	X	E
Fixing and cycling nutrients	-	X	X	S
Soil formation	-	-	-	S
Cleansing air and water	X	X	X	S
Gene resources	X	P	X	E
Species protection	X	X	X	E
Evolutionary processes	X	X	X	E
Education	X	P	X	E
Research	X	P	X	E
Aesthetic	X	X	X	S
Spiritual	X	X	X	E
Cultural/historical	X	X	X	E
Option value	X	X	X	E
Quasi-option value	X	X	X	E
Existence value	X	X	X	E
Global life support	X	X	X	E

C=congestible, P=possible, S=somewhat difficult, E=extremely difficult, X=attribute is present

Source: Adapted from Dixon and Sherman (1990)

National parks may not be pure public goods, but if they have been set aside by governments on behalf of society to provide collective goods and services, the state, in theory, should be accountable for their doing so (Child et al., 2004). Historically, national parks have been supported by government appropriations and managed primarily for their public (non-market) goods benefits. Often, park managers have not capitalised on potential private goods and services like tour guide companies or restaurants because of legal restrictions and/or established public perceptions that private capital should not be involved in the provision of national parks. In these situations, private good aspects of national parks are often either available free of charge or simply unavailable (Athanas et al., 2001). On the other hand, where private-public partnerships are allowed, these are becoming more common in parks, especially where restaurants and shops can be tendered for. In addition, the tourist carrying capacities of parks are increased by the development of accommodation and other facilities in surrounding areas.

Combined demand for the private and public benefits of protected areas is obviously much greater than private demand alone. Justification for government funding as the primary source of long-term income for managing protected areas is based on the disparity between the willingness to pay for the public and private values that protected areas provide. Because the undersupply of public goods fails to maximise social economic welfare, government funding is required to provide these public good benefits. In addition, governments should meet obligations to maintain the non-use values provided by protected areas and to protect the natural assets belonging to their constituents (Lockwood & Quintela, 2006). Authors like Balmford and Whitten (2003) and Turner (2002) assert that the greatest benefits of parks are the off-site, option, bequest, and existence values, rather than recreational opportunities and associated fees; however, because markets do not exist in which to trade these goods, the government must continue to provide them by contributing most of the funding for protected area management (Lockwood & Quintela, 2006).

2.2.3 FAILURE TO FULFIL CONSERVATION OBJECTIVES

Evidence suggests that national parks are failing to safeguard what they were established to protect; that they are neither sustainable nor examples of good land management (Child, 2004a). National parks face many threats to their integrity both from within and beyond their boundaries. Too many parks, in developed as well as developing countries, are known as 'paper parks' (Bonthuys, 2003; Bruner et al., 2003; Child et al., 2004; Dharmaratne, Sang, & Walling, 2000; Murphee, 2004; Pressey, 1996). This pejorative term applies to parks that are not actively managed, implying they are no different from surrounding areas that lack protected area status. In developing countries, inadequate funding leads to shortages of basic necessities like staff, vehicles, and fuel (James, Gaston, & Balmford, 1999a; Wilkie, Carpenter, & Zhang, 2001). The problems facing national parks in many developing countries are related to increased human activity in and around national parks. Much of this activity is economic, and examples of associated problems include wildlife poaching, the harvesting of wood and other fibres and foods, the grazing of cattle in and around national parks, and negative impacts from tourist activities (Shah, 1995). In southern Africa, for example, many parks are subject to poaching and settlement, and many tropical parks around the globe are downsized, degraded, and feel the effects of paper parks syndrome (Balmford & Whitten, 2003; Cumming, 2004; Hockings et al., 2000; Ryan, c. 1992).

Because national parks require active management, each national park must have clear objectives supported by a management plan and financial resources adequate to undertake the necessarily management activities (Child, 2004a; Hockings et al., 2000). The effectiveness of national park management must be improved in order to reduce the impacts of these threats and help national parks meet their conservation and socio-economic objectives. Effective management is limited by an urgent need for technical and financial resources (Chape, Blyth, Fish, Fox, & Spalding, 2003). Lack of funding is a basic limitation; if the minimum levels of funding and staffing required to protect and manage parks are not met, a national park will fail (Bruner et al., 2003; Cumming, 2004; Lockwood & Quintela, 2006).

2.3 THE FINANCIAL CRISIS FACING STATE-PROTECTED AREAS

Adequate finance and effective management are critically important for the success of protected areas in providing benefits to society. Financial resources are required not only during the establishment phase of a protected area, but are needed for the long-term management of the park. Viewed globally, funding for protected area management is grossly inadequate (Athanas et al., 2001). Park management agencies face a funding crisis that prevents protected areas, including national parks, from meeting their biodiversity conservation and social objectives (Balmford & Whitten, 2003; Carabias et al., 2003; Carabias & Rao, 2003; Cumming, 2004; de la Harpe, Fearnhead, Hughes, Davies, Spenceley et al., 2004; Dixon & Sherman, 1991; Guikema & Milke, 1999; Olson & Dinerstein, 1998).

Consequently, the financial sustainability of protected areas is gaining increased attention from academics and park managers. There has been a major shift in the way that protected area funding is viewed. Increasingly, the state is not expected to provide all the funding for protected area management; rather, there is increasing recognition of the private goods provided by protected areas and the customer groups that could pay a fair price for the consumption of those goods (Athanas et al., 2001; Carret & Loyer, 2003; Davies, 2003; Dharmaratne et al., 2000; Emerton et al., 2006; Gossling, 2002; James, Kanyamibwa, & Green, 2001; Rubino, 2000; Spergel, 2002; WCPA-IUCN, 2000). The search for new models of financing has been supplemented by efforts to find new administrative structures that are more adaptable and innovative in securing funding from non-government sources (Athanas et al., 2001).

The financial sustainability of protected areas has been defined as:

> … the ability to secure sufficient, stable and long-term financial resources, and to allocate them in a timely manner and in an appropriate form, to cover the full costs of PAs and to ensure that PAs are managed effectively and efficiently with respect to conservation and other objectives. (Emerton et al., 2006, p. 15)

This definition implies that the financial crisis facing protected areas arises from inadequate income and ineffective expenditure. Inadequate funding is addressed by securing and managing additional funds for protected area management. This is the realm of conservation finance, which focuses on the institutions and processes involved in generating financial resources by and for parks. It must be stressed that a small proportion of parks globally could be self-sustaining through privatisation, the rest will always need some form of subsidy (Athanas et al., 2001). Research on ineffective expenditure is concerned with how funds – whether limited or not – are distributed among conservation responsibilities. This is the domain of economics, concerned with the optimal allocation of scarce resources (Lockwood & Quintela, 2006).

2.3.1 THE INCOME PROBLEM

Annual government appropriations are typically the primary source of finance for PAMAs (Athanas et al., 2001; Davies, 2003; Emerton et al., 2006; Lockwood & Quintela, 2006; Spergel, 2001; WCPA-IUCN, 2000). In some countries with a high GDP, such as Oman, the government is the sole provider of funds for managing the protected area estate (Andrew Spalton, personal communication, 8 September 2003). In poorer countries that are eligible for donor support, the government is only responsible for providing a proportion of protected area funding. Donations and grants are provided by nature-NGOs, international donor agencies, individuals, corporations, and foundations, and include 'debt-for-nature-swaps' and conservation trust funds (Spergel, 2002). In some particularly poor countries, such as Cambodia, the protected area network is funded entirely by donors (James, Green, & Paine, 1999b). In many countries, additional income is derived for protected areas from user fees and environmental taxes (Spergel, 2002).

In developing countries, donor funds tend to be tied to capital investments, with government appropriations covering the bulk of a protected area's operating costs. Reliance on donor support is temporary because donors inevitably change their priorities, experience budget crises, or have short funding cycles. The direction of donor funds is subjective, often aimed at fashionable rather than core management activities. The donor process is bureaucratic and cumbersome, thus lacking innovation and responding only slowly to opportunities. The project cycle is also fundamentally flawed, often giving too much funding early on and withdrawing it as the PAMA's capacity to manage the funds improves (de la Harpe et al., 2004). Consequently, government funding is the most reliable funding source over the long term (Spergel, 2001).

Income from tourism and charges for other resource use supplement some protected area budgets, but few parks have a diversified funding base (Emerton et al., 2006). In general, this additional income is not retained by the protected areas that generate it; instead, it is often lost to the state's central treasury (de la Harpe et al., 2004). The result can be a set of perverse incentives where the park management has an incentive to minimize the provision of tourist services because these compete for funds that could be used for conservation. In the United States PAMAs typically generate small revenue flows, leading to a weak political and fiscal rationale to increase grants from central government. This vicious cycle of low revenue and weak government budget allocation leads to inadequate management, including weakness in financial operations (Laarman & Gregersin, 1996); furthermore, poor pricing and inefficient allocation mechanisms mean protected areas often derive less for their services than the market would provide (de la Harpe et al., 2004).

Conservation throughout the world is widely recognised as under-funded (Balmford & Whitten, 2003; Bonthuys, 2003; Bruner et al., 2003; Chape et al., 2003; Child, 2004a; Dharmaratne et al., 2000; Emerton et al., 2006; Hambler, 2004; Lockwood & Quintela, 2006; O'Connor, Marvier, & Kareiva, 2003; Pressey, 1996; Rubino, 2000). Traditionally, funding from national and/or regional governments has been the primary source of protected area finance, and this funding has been focussed on the direct operational and management costs of protected areas (Athanas et al., 2001; Emerton et al., 2006). These costs include the salaries, infrastructure, equipment, and maintenance required to set up and administer protected areas (Emerton et al., 2006). However, these do not reflect all the expenses associated with protected areas, and activities including research, monitoring, management programmes, education, and compensation receive little or no funding (Hambler, 2004). In addition, government appropriations rarely meet the needs of infrastructure projects, staff development, and special maintenance costs (Athanas et al., 2001). These problems are exacerbated because low salaries preclude quality leadership (Child, 2004a). According to Sheil (2001), field staff in developing countries often go without payment for months at a time, even in seemingly well-funded conservation projects.

The Vth World Parks Congress in 2003 represented the largest gathering of protected area experts in history, with 2,897 participants from 160 countries. A survey of Congress participants[9] showed inadequate funding was considered the key barrier to protected area management effectiveness (IUCN, 2005b). Insufficient funding is not the sole obstacle to national parks achieving their objectives, but it results in lost opportunities for better management (Balmford & Whitten, 2003; Leader-Williams & Albon, 1988).

Recent Funding Trends

Because protected areas rely primarily on government appropriations; parks compete for funds with other sectors like education, defence, and health. These

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[9] Most of the 455 survey respondents had more than 10 years experience in protected areas: 2.9% had no experience, 17.9% had less than 5 years experience, 17.9% had 5 to less than 10 years experience, 31.3% had 10 to less than 20 years experience, and 29.1% had greater than 20 years experience in protected areas.

other sectors are often seen as higher priorities, and in times of financial hardship, investment in protected areas falls because economic growth and jobs are considered more important than outdoor recreation and intangible conservation goods and services (Athanas et al., 2001; de la Harpe et al., 2004). Therefore, protected area funding may be vulnerable to shifts in government spending priorities and to sweeping budget cuts during economic crisis (Spergel, 2001). The number of protected areas has grown rapidly, especially in the tropics, yet, at the same time, budgets for protected area management have stagnated. This also coincides with increasing threats to protected areas and the need for management responses. In addition, developing countries have been placed under international pressure to focus on poverty alleviation (Emerton et al., 2006; Lockwood & Quintela, 2006).

During the 1990s, investment in nature conservation by governments, international donors, and development banks declined. By the mid-1990s James, Green, and Paine (1999b), estimated that worldwide average expenditure on protected areas was US$893 per km^2 per year, totalling just over US$3 billion per year. They found expenditure by protected area agencies varied hugely amongst nations. One hundred and eight countries responded to the survey, representing 28% of global protected areas at the time. Reported expenditures ranged from less than US$1 per km^2 (Angola, Cambodia, and Laos) to over $1,000,000 per km^2 (St. Lucia), with a global mean expenditure of US$893 per km^2 (1996 dollars, not corrected for inflation). Average expenditures in developing countries were only 30% of the estimated minimum required to conserve these areas. Budgets ranged widely in most geographic regions. In the Caribbean, budgets ranged from US$73 per km^2 in the Dominican Republic to over US$1 million per km^2 in St. Lucia. In Europe, the range was from US$199 per km^2 in the Slovak Republic to US$134,507 per km^2 in Malta. Australia and New Zealand spent $21,199 per km^2 and $89,978 per km^2 respectively. Global extrapolations of shortfall estimates concluded that an additional US$2.3 billion per annum would have protected the world's existing nature reserves effectively. This is considerably less than government expenditures on environmentally harmful subsidies (t' Sas-Rolfes & Fearnhead, 2001). These figures are trivial compared to the value of the Earth's ecological systems and services, such as watershed protection and carbon sequestration, valued at US$33 trillion or more annually (Costanza, d'Arge, deGroot, Farber, Grasso et al., 1997).

By 2004 global spending on protected areas was believed to have reached US$6.5 billion per year (Emerton et al., 2006). The cost of establishing and effectively managing a global system of protected areas over the decade to 2013 has been estimated as US$23 billion per year (Bruner et al., 2003). A less conservative estimate suggests US$45 billion per annum over 30 years may be needed to expand the global protected area network into a representative network covering 15% of terrestrial and 30% of marine ecosystems (Balmford et al., 2002). These figures are not directly comparable because each estimate relates to different time periods, and aspects of park management and establishment. What these figures do emphasise is that global spending on protected area management and establishment is inadequate.

An analysis of park management agency budgets in Canada revealed a continuing loss of management capacity (van Sickle & Eagles, 1998). This was attributed to reliance on insufficient government funding for operational and capital needs. Traditionally all income from a national park (e.g., user fees, taxes) goes to a central consolidated revenue fund and money is distributed by central government administration to expenditure units that include PAMAs. This means annual government allocations for a park are not related to the amount of revenue earned at that park; this acts as a disincentive for park managers to increase the revenue generation from their parks (van Sickle & Eagles, 1998). Furthermore, over the decade from the late-1980s to late-1990s societal demand saw more national parks created even while budgets were restrained or cut (van Sickle & Eagles, 1998).

In many countries public expenditure has been restricted by progressive economic liberalisation, deregulation, and decentralisation. This has had a negative impact on protected area funding because nature conservation has always been a low priority for public spending (Emerton et al., 2006; Polishchuk, 2002). In addition to decreases in government funding, earnings from tourist visits can also be insecure and subject to fluctuations. Tourist numbers drop drastically during civil wars, natural disasters, or pandemics – events that PAMAs have no control over. For example, civil unrest in Kenya, Uganda and Zimbabwe during the 1990s caused visitor numbers to national parks to drop markedly in these countries. More recently, visitor revenue decreased dramatically in the protected areas of Asia and Latin America following the terrorist events in the United States on 11 September, 2001, as global security has been questioned in the travel and tourism industries (Emerton et al., 2006). Tourists can also be fickle; the popularity of a destination can be subject to fashions and trends.

Following the Millennium Summit of 2000 and the 2002 World Summit on Sustainable Development, poverty reduction has become a prominent priority. This has caused a shift in donor and government priorities from protected areas to country-level poverty reduction strategies. This means international financial assistance is increasingly determined by social and economic objectives. While evidence suggests most countries are committed to providing protected areas, the managers of existing protected areas face serious funding shortfalls, and with the rapid growth of protected areas this money is expected to stretch further. Clearly, financial resources for protected areas must be increased (Emerton et al., 2006).

A Business Approach to Protected Area Management

The role of economics and financing in protected area management received attention in the academic literature during the 1990s (e.g. Dixon & Sherman, 1990,1991; James et al., 1999b; Langholz, 1996; Moran, Pearce, & Wendelaar, 1997; Munasinghe, 1994; Munasinghe & McNeely, 1994; Pearce, 1990,1994; Shah, 1995; Wescott, 1994). Later in the same decade, the IUCN began to focus on financial and economic advice for protected area practitioners through the IUCN Economics Unit and World Commission on Protected Areas (e.g. WCPA-IUCN, 1998,2000). In response to the clear need to supplement existing financial resources, a formal field of literature called 'conservation finance' surfaced (e.g. Athanas et al., 2001; Carret & Loyer, 2003; Davies, 2003; Dharmaratne et al., 2000; Emerton et al., 2006; Gossling, 2002; James et al., 2001; Rubino, 2000; Spergel, 2002; WCPA-IUCN, 2000). In 2002, the Conservation Finance Alliance was formed to encourage collaboration on aspects of protected area and biodiversity finance (Conservation Finance Alliance, 2006).

Protected areas are typically managed by government agencies, but a wide range of customers to a protected area can be encouraged to make financial contributions to the park in ways compatible with the park's conservation objectives. Financial mechanisms can be employed to get a fair return from individuals, communities, and companies consuming the private goods provided by a protected area. The aims of conservation finance are to increase funds for protected area management and to provide incentives for sustainable use and biodiversity conservation (Emerton et al., 2006).

Conservation finance recognises that business managers need good information on costs, cash flow, investment strategies, and potential sources of funds in order to improve a business, and that protected area managers need similar information in order to manage their site or system well (Emerton et al., 2006). To do this, protected area managers are encouraged to adopt a business approach, which matches financial opportunities with the short and long-term requirements of a protected area (Athanas et al., 2001; Emerton et al., 2006; WCPA-IUCN, 2000). This means recognising that protected areas have both business and public good functions, and encouraging managers to be entrepreneurial about the private good aspects of a protected area without compromising its fundamental conservation objectives.

As well as exploring public and private opportunities for generating finance, managers must continue to service public and private users (Athanas et al., 2001). With adequate investment in appropriate infrastructure and enforcement of laws against illegal use of resources within protected areas, tourism from these parks can generate significant revenue through user fees and employment. Protected areas also provide valuable services to which the government might otherwise need to allocate budget resources, for example, potable water and hydroelectric power from protected watersheds (Spergel, 2002). Thus, a government is investing in a protected area on behalf of its people for more reasons than biodiversity and natural heritage conservation alone. For example, a sustainable financing plan developed for Madagascar's protected areas identified increasing entrance fees at protected areas, transferring national benefits of the protected area network through revenue from tourists visas, and capitalising on developed countries' willingness to pay for Malagasy biodiversity conservation through an Endowment Fund (Carret & Loyer, 2003).

Because benefits like biodiversity conservation and watershed protection are responsibilities that cannot be shifted to private bodies, governments must retain and honour their obligations to establish and manage a representative system of protected areas (Athanas et al., 2001); furthermore, by funding protected areas, governments demonstrate that nature conservation is of national importance (Spergel, 2001).

A business approach to protected area management involves development of a hierarchy of planning documents for each protected area, including a management plan, business plan, and financial plan. The management plan clarifies a protected area's management objectives, customer groups or users, financial needs, and available financial resources. This leads directly into the business plan, which examines the customer base in greater detail, identifies the goods and services provided by the protected area, and outlines a marketing and implementation strategy for the protected area. In turn, this leads to the financial plan, which provides a detailed break-even analysis and profit and loss projections (WCPA-IUCN, 2000). Unlike a budget, a financial plan identifies the most appropriate funding sources for short, medium, and long-term needs (Athanas et al., 2001). A diversified financial portfolio gives protected area managers greater capacity to cope with risk and uncertainty if any single source of funding declines or fails (Emerton et al., 2006).

As outlined by WCPA-IUCN (2000) and Athanas *et al.* (2001) the guiding principles for conservation finance are:

1. Business planning is undertaken in concordance with the legal and planning frameworks in place, so that generating revenue is used as a means towards the end of better protected area management rather than becoming an end in itself;

2. A business approach should be taken, which involves capturing fair returns from customers who consume the private goods a protected area provides; and,

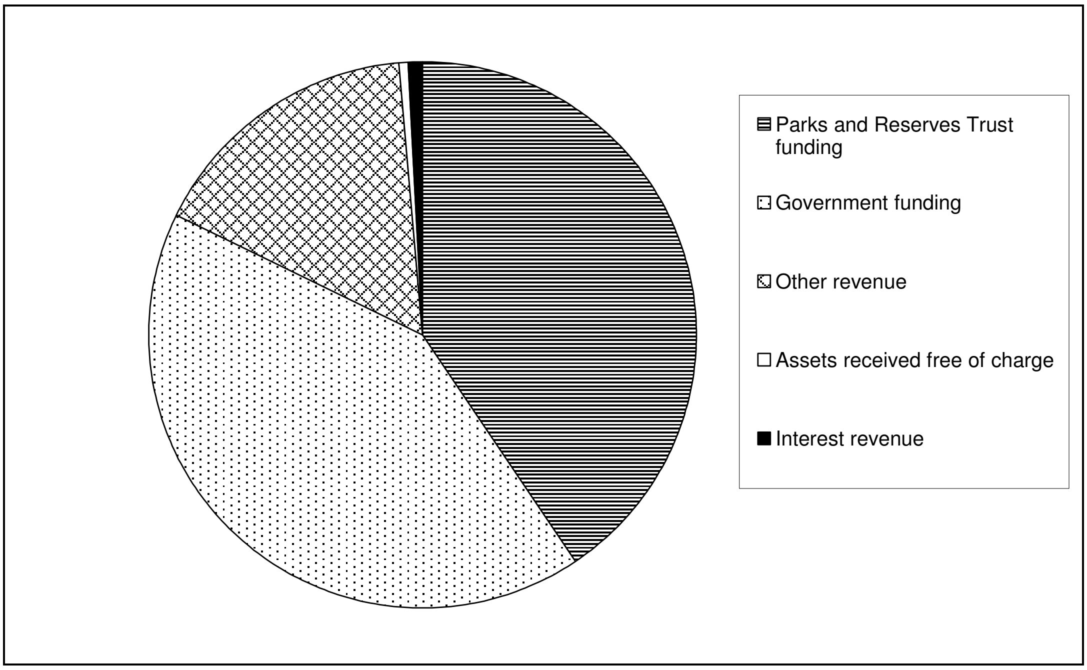
3. Protected areas should be financed by both public and private revenue, the latter linked to private goods provided by the protected area and the former linked to public goods.

Not all protected areas can generate profits because revenue from tourism is unlikely to be distributed evenly across a country's protected area network. Some protected areas may have greater biodiversity value than others but are not popular with tourists and thus cannot be managed as autonomous units. Others may generate more income than required to cover the costs of management and conservation. This presents a case for managing a country's network of protected areas as a single operating unit, maximizing revenues and minimising costs at the level of each individual protected area, and reallocating surplus funds to other protected areas that are not capable of self-sufficiency (de la Harpe et al., 2004; Hughes, 2001; James et al., 2001; La Page, 1994; Leal & Fretwell, 2001).

Some government PAMAs have implemented a process of 'commercialisation' to improve the financial flows to and within their organisation. This means adopting management practices similar to those used by private-sector commercial organisations, with an emphasis on revenue and expenditure, performance management, and the effectiveness of the structures and systems in place (de la Harpe et al., 2004; t' Sas-Rolfes & Fearnhead, 2001). For example, sweeping changes were made to the public sector in the Australian state of Victoria under the Kennett Government, which was in power from 1992 to 1999. Parks Victoria runs the national park network in the state, and was structured according to an economic rationalist approach committed to the privatisation of state resources. This meant a business approach to conservation, where visitors are customers. However, finding a balance between conservation and commercialisation proved problematic, and the agency today relies heavily on government funding (Parslow, 2002). Parks Victoria's budget in the 2006 financial year comprised government funding (42%), trust funding (41%), and other revenue (16%) (Figure 2.6). Other revenue sources include accommodation/camping fees, park entrance fees, berthing/mooring fees, cave tour fees, fit shop sales, rent and licences, and funding by external parties (2006).

In some instances PAMAs are being converted to parastatal agencies (e.g., South African National Parks and the Uganda Wildlife Authority), which have property rights over park revenues. These rights provide ‘institutional incentives’ to improve the financial performance of national parks by raising revenues, reducing costs, and attracting foreign support, while keeping biodiversity conservation as the primary objective (James et al., 2001). A review of parastatal agencies in developing countries showed that control over the finances of individual protected areas significantly increases their revenue earnings (James et al., 2001). However, in gaining freedom from the government budgeting and expenditure systems, the government often relinquishes tax-based funding (de la Harpe et al., 2004). In southern Africa, the private and community sectors have demonstrated the commercial potential of wildlife. In response there has been a general trend for park agencies to convert to parastatal agencies, which are more independent from the political centre, and the outcome has been increased revenue generation and installation of more efficient managerial practice, as well as the development of partnerships with communities, the private sector, and nature-NGOs (Child et al., 2004).

Figure 2.6
Income Sources for Parks Victoria in 2006



Source: Adapted from Parks Victoria (2006)

Commercialisation is a relatively new financial mechanism in conservation. Some evidence suggests decentralisation improves park management by strengthening the links between management and value, internalising decisions, reducing externalities, providing opportunities for innovation, and improving landscape linkages between parks and their surrounding land use and communities. In southern Africa, some private conservation agencies operating on private and communal land are achieving as much biodiversity conservation as state parks and are more profitable (Child, 2004a). However, successful commercialisation depends on a minimum number of tourists and, as mentioned previously, in a changing world tourist numbers cannot be relied upon. Furthermore, private reserves are profitable because they can focus on the affluent with a high willingness to pay, while the state park often has a social mandate that precludes this sort of approach. To address this, PAMAs can differentiates to facilitate cross-subsidisation within the park network. This could be achieved by offering a range of service qualities at different prices, or subletting selected areas to private contractors.

The conservation finance movement is gaining momentum and ample information resources are available to PAMAs and park managers through the Conservation Finance Alliance. As PAMAs and park managers start to diversify their funding bases to secure more reliable, long-term funding, the negative impacts of the income shortage facing protected areas worldwide will be reduced.

2.3.2 THE EXPENDITURE PROBLEM

The other aspect of the financial crisis facing protected areas is that of inefficient and ineffective expenditure, resulting in PAMAs getting less value for money (Athanas et al., 2001; Balmford & Whitten, 2003; de la Harpe et al., 2004; Emerton et al., 2006; Wu & Boggess, 1999). In some ways this side of the financial crisis is harder to address, and this is reflected in the literature, which focuses on protected area income rather than protected area spending (de la Harpe et al., 2004). Many decisions in conservation relate to the availability and use of limited funds, at a global level and within countries (Balmford, Gaston, Blyth, James, & Kapos, 2003; Hambler, 2004). Financial resources will always be limited and funds must be allocated strategically to maximise the benefits society receives from protected areas (Emerton et al., 2006). Inefficiencies are more apparent in developing countries and include too many staff, insufficient funds for implementation, petty corruption, and the retention of poorly-performing staff. Problems of ineffective resource allocation arise mainly from the wide mandate of PAMAs; this forces them to focus on many tasks while achieving few objectives (de la Harpe et al., 2004), meaning there are no clear signals to help set priorities for expenditure.

As previously mentioned, government funding will remain the core source of long-term funding for state-protected areas (Emerton et al., 2006). This funding mostly accrues from taxation revenue and is usually allocated from national and/or sub-national treasuries each year. Annual appropriations tend to support both recurrent and capital expenditure. Recurrent (variable) costs include the ongoing maintenance of equipment, staff salaries and other personnel costs, fuel and energy, and other monthly/annual charges for goods and services provided continuously or regularly. Capital costs (fixed costs) involve investments in new equipment, facilities, or projects like wildlife monitoring, and are generally large, irregular charges for assets with a long life-span (Emerton et al., 2006; Lockwood & Quintela, 2006). Conservationists widely agree that the limited funds available should be directed to the species or habitats where the greatest good can be achieved (Ginsberg, 1999; Kareiva & Marvier, 2003). However, expenditure is often skewed towards recurrent costs – particularly staff costs – leaving critical capital investment needs like, research facilities and monitoring programmes under-funded (Emerton et al., 2006).

The Resource Allocation Problem

Most PAMAs rely heavily on government funding and some operate within an administrative framework that allows them to generate revenue. However, revenue generation does not necessarily mean revenue retention. The most fundamental challenge to the accountability of state-owned park management agencies is that they are budget-funded public institutions (Child et al., 2004). Government-financed organisations lack the financial incentives and penalties to which private sector organisations are subject (de la Harpe et al., 2004; Dixon & Sherman, 1990,1991). In a competitive business environment the pressures of competition encourage the monitoring of efficiency and elimination of activities that are not adding value (de la Harpe et al., 2004). Where government-financed organisations are concerned, money is allocated centrally with the expectation that it will be apportioned where it is most needed. It is not clear how much value PAMAs add to the parks because, in the absence of financial performance incentives, PAMAs typically offer limited service and encourage park overuse by subsidising goods and services (Leal & Fretwell, 2001). They are poor at setting priorities and directing their limited funding, often resulting in all activities being under-funded and therefore under-managed (de la Harpe et al., 2004).

Central financing and planning encourages an ever-widening mandate, emphasis on image and publicity, and little accountability for the delivery of real results. In order to satisfy all stakeholders, PAMAs are unable to concentrate on their core competency: conservation. The centralisation of PAMAs also exacerbates the influence of politics and special interest groups (Bell & Martin, 1987; Child et al., 2004). An inflexible system will miss out aspects currently not recognised as valuable, but which may be of future importance. However, with no formal processes, decisions lack robustness and transparency, contributing to the failure of protected areas to meet their objectives (Bell & Martin, 1987).

Although PAMAs employ *ad hoc* processes when allocating resources among their conservation responsibilities, the conservation and park management literature provides little guidance regarding the processes that PAMAs follow when they make resource allocation decisions (Bell & Martin, 1987; de la Harpe et al., 2004; IUCN, 2005b). Researchers usually encounter secrecy when PAMA decision-makers are approached for information regarding budget setting and allocation processes (Cumming, 2004). For example, in an assessment of PAMAs in southern Africa there was little evidence of standard performance criteria, principles, or targets; nor the systematic monitoring of these. Attempts to get time-line or trend data regarding national park budgets, even for recent years, failed (Child et al., 2004; Cumming, 2004). These agencies were unable, or reluctant, to provide financial data or records summarizing their progress in biodiversity conservation, despite the role of protected areas as the central focus of a productive tourism economy in southern Africa.

In a review of the use of quantitative methods for conservation programme planning Guikema and Milke (1999) found that only five of 22 governmental and non-governmental organisations worldwide involved in aspects of biological conservation used quantitative methods. None of the quantitative methods used were linked to the agency's strategic objectives. The other agencies relied on non-quantitative methods such as managerial experience and the political process (Guikema & Milke, 1999). The same study found that methods for deciding which projects to fund relied mainly on negotiation, managerial experience, and simple scoring procedures (Table 2.8).

Table 2.8
Summary of Conservation Planning Procedures

Protected Area Management Agency	Planning Process Employed
New Zealand Department of Conservation: conservancy level planning	Negotiation and interpretation of guidance documents. Some project scoring.
New Zealand Department of Conservation: regional level planning	Project scoring with cut-off scores.
USA National Park Service: conservation planning	Project scoring with weighted additive aggregation model.
USA National Park Service: staff level planning	Gap analysis based on current and required staffing level.

Source: Adapted from Guikema and Milke (1999)

Resource allocation in the USA National Parks Service (NPS) falls into two areas based on the distinction between base operating funds and project funds. Formal guidelines have been developed for project funding, and addressing and evaluating the proposed natural resource projects. Projects might involve natural resource preservation, research, water resources, geologic resources, inventory and monitoring, and visitor education. The project guidelines outline which types of projects are acceptable, the duration of projects, and parameters for minimum and maximum allowable budgets. Limits on the number of projects each region can propose are based on expected funding levels. Projects are ranked against a set of criteria including the significance of the resource to the park, the severity of resource threat/need, feasibility, and cost effectiveness. The scores for each criterion are weighted and aggregated into a project score. The NPS also uses a quantitative process to set staffing levels for each park. First, the natural resources of each park are assessed based on surrogate indicators in 15 categories.

Appropriate staffing levels are determined based on the resource assessments, and these are compared with the current staffing levels (Guikema & Milke, 1999).

In the 1990 fiscal year, Simon *et al.* (1995) found that the USA Fish and Wildlife Service (FWS) did not use its own Priority Ranking System as a basis for funding endangered species recovery. In a more recent study (Restani & Marzluff, 2002) the FWS responded to the same criticism, claiming that factors such as cooperative opportunities, state and regional priorities, and congressional interest influenced the implementation of its endangered species recovery policy. The Priority Ranking System ranks species based on degree of threat, recovery potential, and taxonomic distinctness (Restani & Marzluff, 2002).

When PAMAs have been commercialised, there have been far-reaching philosophical changes within the agency. The expensive and inefficient public service mentality of providing all things to all people has had to be abandoned for one of clearer objectives, with a focus on activities that add value. With this focus firmly in mind, activities that do not add value are reduced or abandoned. Likewise, the capacity to outsource the management of commercial activities allows agency staff to focus on natural science and conservation outcomes – the disciplines in which they have been trained (de la Harpe et al., 2004; t' Sas-Rolfes & Fearnhead, 2001). While full commercialisation does not always succeed, there is significant potential for improved efficiency in nature conservation if it is approached with a more business-oriented mindset.

A Weak Philosophical Framework

The primary constraint to robust and practical decision-making by PAMAs is the absence of clear policies (Child, 2004a). The goals of national park management agencies are rarely defined in a manner that can be measured. There is little evidence of consensus on what increasingly complex biological, economic, and social attributes parks should provide. The diversity of outputs national parks are expected to deliver may look good on paper; however, these ‘feel good’ objectives tend to hide contradictions and misalignments and enable managers to avoid accountability. This allows conservation practice to follow fashions and relinquishes much of the power to determine resource allocation to media manipulation and political correctness (Child, 2004a). Park plans often comprise vague objectives covering more needs than the agency can possibly address, and they lack precisely defined accountabilities against which to measure conservation and development progress. Park plans are often unimplemented or abandoned, reflecting a conflict between blueprint management models and the reality of managing dynamic natural systems where centralised control undermines the principle of subsidiarity[10] (Cumming, 2004). Ultimately, this means national park management is characterised by a weak philosophical basis and decisions are often weighted more by public opinion and politics than ecological science or pragmatism. The increasing influence of public opinion and the media on the policies of national park management agencies means uninformed, subjective emotionalism can override objective management. For example, some national parks in South Africa contain elephants in numbers that exceed the park's carrying capacity. Elephant numbers must be reduced in these parks if the habitats that they and other species depend upon are to be saved. Some animal rights proponents consider the reduction of elephant populations by culling to be unacceptable and advocate the capture and relocation of animals. However, the relocation of elephants may cause more animal welfare problems (resulting from trauma) than the culling of entire herds (Child, 2004b).

While the conservation of biodiversity is the main claim for the existence of national parks, this is seldom defined or measured and the monitoring and management of biodiversity is neither systematic nor of high priority (Child et al., 2004). Good monitoring and research programmes are essential to improve management practices and experience shows that resource protection and visitor-use dilemmas are better balanced with the help of scientific processes than through belief-based decisions (Halvorson, 1996). Evidence suggests that park management planning is not based on the latest research published in academic journals. Pullin, Knight, Stone, and Charmon (2004) assessed the extent to which scientific evidence is used in management plan development by major conservation organisations in the United Kingdom. They found that the predominant sources of information used to support decision-making in the

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[10] The principle that larger organisations should not take over activities that smaller/lower organisations can do efficiently.

development of management plans were existing management plans, expert opinion from beyond the decision-making group, and documentation or personal accounts of traditional management practices. Least frequently used information sources included: web-based materials, published popular articles, and published scientific papers. When asked why these information sources are rarely accessed, respondents said that the literature was too time-consuming to locate, access, and read. However, a quarter of respondents relied on 'in-house' advisors to interpret literature from primary sources like scientific journals.

It is critical that planning processes for national parks are long-term, rather than annual events. However, budgets are an annual commitment and national park management agencies must make allocation decisions each year. Funds should aim to add value by achieving well-defined performance targets. PAMAs should be accountable to their constituents by providing what society wants, and politically accountable to a minister or board (Child et al., 2004). Accountability and effective protected area management by PAMAs are hindered by institutional inefficiency, namely, the absence of clear and measurable goals and lack of practical and robust resource allocation processes. Compared to threats to biological diversity such as exotic species and climate change, these institutional inefficiencies can be addressed relatively easily and positive results can potentially be produced quickly (de la Harpe et al., 2004).

Summary of the Resource Allocation Problem

Financial sustainability for protected areas was identified as a priority concern at the Vth IUCN World Parks Congress in 2003. The 6th part of the 7th recommendation of the World Parks Congress is:

> … that governments, national and international non-governmental organisations, international conventions, indigenous and local communities, and civil society:
>
> 6. REMOVE policy and institutional barriers to sustainable financing solutions, including barriers to the effective allocation of resources across protected area networks and systems, so that funding from both new and existing sources, and revenue generated by protected areas can be fully and efficiently directed to protected area management; (IUCN, 2005b, p. 155)

Lockwood and Quintela (2006) suggested that one such institutional barrier is inappropriate management structures that are cumbersome and inefficient when channelling funds to protected area management. Further, there is a worrying lack of transparency regarding the way PAMAs allocate public funds among a protected area system. Government agencies have a mandate of public transparency, yet, in some instances, a culture of secrecy surrounds the allocation of conservation funds. Evidence suggests that resource allocation processes are *ad hoc* and lack transparency (Cumming, 2004; Wu & Boggess, 1999). Improving the way limited dollars are spent could quickly increase conservation benefits (de la Harpe et al., 2004). Conservation decisions made without economic tools and models can lead to errors in project selection and failure to maximise conservation achievement from the available resources (Cullen, Hughey, Fairburn, & Moran, 2005a). To maximise the conservation outputs arising from investments in conservation areas, conservation organisations need help to improve the robustness and transparency of their resource allocation decisions.

2.4 IMPROVING RESOURCE ALLOCATION DECISIONS

This thesis addresses the resource allocation problem by developing a model that PAMA decision-makers can use to make their resource allocation decisions more transparent and robust. This section is divided into two parts. First, I present a brief review of decision making theory for the public sector, focusing on the rational decision-making approach. I then explore design parameters for a model to help PAMAs allocate funds among national parks.

2.4.1 DECISION THEORY FOR THE PUBLIC SECTOR

As indicated above, information regarding resource allocation decisions by PAMAs is scarce, as is literature regarding how these decisions should be made. Consequently, this section utilises the body of theory concerned with resource allocation in the public sector.

The literature on contemporary decision making deals with how decisions should be made (March, 2002). The evolution of decision making theory is outlined by many authors (for example, Caroll, 2004; Fitzgerald, 2002; Hastie & Dawes, 2001; Mjelde, 1983), while others, such as Baron (2001), describe the processes individuals follow when making decisions. Literature about resource allocation decisions focuses on the management of private, for-profit businesses (for example, Bower & Gilbert, 2005; March, 2002; Mjelde, 1983; Simon, 1979). The limited literature that does address resource allocation decisions in the public sector (for example Carroll, 2004; Elster, 1992; Fisher, 1998) does not discuss the unique complexities faced by national park management agencies when making resource allocation decisions; however, it does provide some important background theory regarding the basic principles of resource allocation in the public sector.

The human brain can consider only a limited quantity of information simultaneously (Hastie & Dawes, 2001; Kornov & Thissen, 2000; Simon, 1979). Simon (1979) called this limited cognitive capacity ‘bounded rationality’. He argues that in the real world decision-makers display ‘satisficing’, rather than optimising behaviour; that is, they choose a solution just good enough to solve a problem, rather than finding and choosing the optimal solution. Thus, without decision analysis tools, decision-makers focus on a small subset of criteria and tend to base judgments on insufficient information (Simon, 1979). However, satisficing is not necessarily primarily the result of inadequate information; the optimal solution may be unattainable for other reasons, or there may be multiple optima. In general though, public sector managers tend to employ value judgements heuristically in their resource allocation decisions instead of following a rational approach,(Fisher, 1998).

A public service is provided by the state because it is considered sufficiently important for the well-being of its citizens to justify the state’s paying for, subsidising, or regulating that service. Because the economic wealth and circumstances of countries differ, the definition of public services is relative, not absolute, and in most economies a diversity of organisational forms exists in the public and private sectors (Carroll, 2004; Fisher, 1998). Decision-makers in public services must decide how scarce resources should be allocated among competing demands. Public agencies, organisations, bureaus, and departments, (hereafter referred to as agencies) cannot behave independently or counter to legislative preferences, but they are not subject to the exigencies and constraints facing private business managers (Carroll, 2004).

Public sector agencies are owned by the nation's citizens, who are represented by legislators (Ministers or Council members). Under bounded rationality and with limitations on information processing, the diversity of interest of each owner is unknown to the legislators; therefore, in democratic nations the owners of public agencies are represented based on policies at the most recent election. The managers of the agency report to the legislators and must provide annual reports for release to the owners. Legislators can be viewed as investors in agencies who expect a return on their investment. The expected returns may or may not be pecuniary (Carroll, 2004). The capacity of an agency's managers to make optimal resource allocation decisions should be enhanced through the budgeting process. Optimality relates to the provision of services that are responsive to the needs of the agency's constituents. In reality, the public resource allocation process is a continuous series of decisions that may be disaggregated and fragmented, but involve interdependence and overlap (Rubin, 1993). The formal budgetary process simply provides a summary snapshot of the decision-making process.

The Budget Process

Agency budgets are typically developed for a 12-month period, but long term budgetary frameworks are increasingly widespread. Government agencies in most countries are subject to annual financial audits, which look for compliance between actual and planned or budgeted expenditure. Government agencies are usually required to publish annual reports which cover all aspects of management including the management of finances and how parts of the budget have been spent. Unfortunately, in many developing market economies government agencies have weakly developed systems and abilities, meaning such organisations cannot efficiently utilise human, financial, physical, and informational resources. Furthermore, corruption is often prevalent, as is the belief that bribery is needed to get things done (Worboys & Winkler, 2006a).

The process of developing and approving a budget starts with top level management seeking budget forecasts for approved strategic objectives. In the case of government agencies, this is completed in the context of whole-of-government processes. Budget proposals tend to be developed by front line and middle-level managers for approval by top-level management. Because funds are insufficient, front-line and middle-level managers compete even though they are working together to achieve the same overall vision. Organisational, social, and political priorities can influence the way funds are divided. The budget will have separate summary statements of individual budget proposals from different geographic or functional divisions within the agency, with these being underpinned by full budget statements for each divisional budget request (Worboys & Winkler, 2006a).

Divisional budgets may include budgets for activities such as routine maintenance, routine administration, specialized training, capital improvement works, equipment purchases, event management, and investments. According to Worboys and Winkler (2006a), detailed divisional budgets typically include:

- Budget plans – clear plans for projects or actions involving objectives, milestones, and a timeline. Forecast expenditure is determined for each of the project milestones. Later, actual expenditure will be measured against these. Forecasts are based on previous performance where applicable;

- Cost estimates – for employees, the costs of services such as specialist advice or technical designs, material costs, logistic support costs like vehicle and plant hire, and project consumables like electricity and office supplies; and,

- The identification of fund sources – these include funds for annual operating costs, capital costs, and grants. Grant applications often require the organisation to provide partial or in-kind funding.

Making Decisions in the Public Sector

According to economic theory, the 'free market' efficiently allocates resources among competing uses based on the demand, and hence willingness to pay, for a product or service (Baker & Forbes, 2008; Irwin, 2005; Salvatore & Diulio, 1996; Smith, 1976; Waldfoget, 2007). This theory is relevant to private sector organisations. However, public sector organisations exist in the absence of a true market for the trade of the goods and services that they provide, but because they work within budgets insufficient to address all demands they must somehow allocate funds among these needs without guidance from the market (Mabin, Menzies, King, & Joyce, 2001). Unlike private-sector market transactions, the public sector is characterised by the overproduction of some services and the underproduction of others. One reason for this is that resources are allocated not on the basis of demonstrated need and established efficiency, but according to the political power of competing interest groups (Gianakis & McCue, 1999).

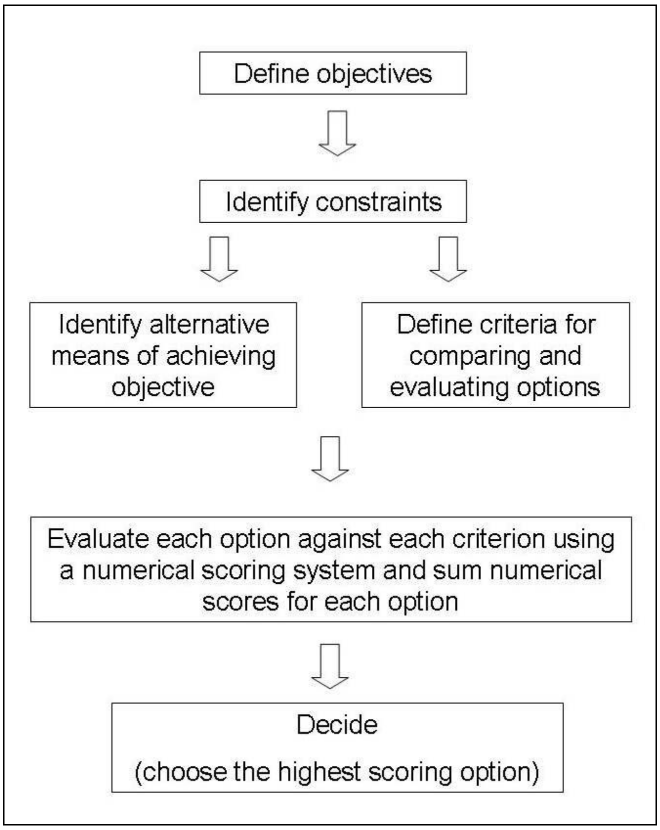
Most decisions are reached via informal means that may be intuitive or based on careful reflection. Over the centuries people have recognised the need for systematic processes to reach more defensible decisions (Brown & Paschoud, 2005). Because models are conceptualisations intended to represent complex phenomena, they are by their very nature gross simplifications and tend to exclude as much as they include (Fitzgerald, 2002). However, when viewed with healthy scepticism, a good model will help decision-makers better understand those phenomena. Models typically fall into three categories: descriptive models are concerned with how decisions are made in the real world; predictive/prescriptive models take a systematic approach to increasing the likelihood of making a successful decision; and, normative models determine the one best way to make a decision (Fitzgerald, 2002).

The most pervasive and influential decision making approach is the rational approach, which most models follow (Fitzgerald, 2002). The rational approach is a logical sequence of steps that bases decisions on knowledge and analysis of the subject and its context (Figure 2.7).

The option selected should be that expected to best achieve the decision-maker's goals or objectives (Kornov & Thissen, 2000). Thus, making a decision can be viewed as a sequence of logical steps, starting with the establishment of objectives or goals, followed by identification of constraints, identification or design of alternatives, identification of criteria with which to measure the alternatives, assessment of the performance or impacts of alternatives, and choice of the 'best' alternative in view of the decision-maker's goals or objectives (Fisher, 1998; Fitzgerald, 2002; Kornov & Thissen, 2000). The measure of the extent to which the goal is achieved is called utility (Baron, 2001).

Figure 2.7

The Rational Model of Decision Making



Source: Fisher (1998, p. 30)

The rational approach sets forth a logical sequence of steps to follow for every decision. The approach is based on the economic theory prevalent in the early industrial period that believed human behaviour is logical, and predictable if the circumstances are known (Fitzgerald, 2002). According to the rational approach, managers optimize their decision-making behaviours by deliberately choosing and implementing the best alternatives. However, Fitzgerald (2002) argues that this belief is based on a suite of assumptions, including:

- That all possible alternative solutions and the specific results that will flow from each can be known in advance;
- That there is one optimal solution, which is included among the identified alternatives;

- That it is possible to measure accurately the various alternatives, the probabilities of their outcomes, and the desirability of the alternatives and outcomes;
- That decision-making is free of emotion, prejudice, and politics because decision-makers always act rationally; and,
- That the desire to maximize profits is the driver for business decisions.

In practice, situations rarely accommodate these assumptions and public sector managers seldom follow the rational decision approach. Fisher (1998) found public sector managers actually employ criteria or value judgements heuristically in resource allocation decisions. Heuristics are mental rules of thumb learned from various sources and acting to reduce the complexity of decisions (Fisher, 1998). Heuristics operate as part of a person's worldview and facilitate decision-making where values conflict. The concept arose in the psychological literature, but in resource allocation decisions, heuristics are sets of values used to edit competing demands upon attention, rather than tools for the detailed analysis of policy dilemmas (Fisher, 1998; Kiker, Bridges, Varghese, Seager, & Linkov, 2005). This means that when taking a heuristic approach to decision-making, important information may be lost, opposing points of view may be ignored, and elements of uncertainty may be neglected (Kiker et al., 2005). Therefore, heuristics can bias or distort decisions (Fisher, 1998).

According to Fisher (1998) the predominant value judgements employed by public sector decision-makers include:

- Deservingness – moral worth;
- Individual need – objective assessments of individuals' needs;
- Fairness – all people having equal access to standardised services;
- Utility – maximising a utility function or the good obtained;
- Ecology – taking into account the aspirations and anxieties of critical stakeholder groups; and,

- Personal gain and competence – using public resources to benefit the decision maker in some way, possibly including the use of proper and justifiable decision methods.

The limited literature addressing conservation decision-making supports Fisher's findings. For example, a formal assessment of the extent to which scientific evidence is used in conservation practices in the UK suggested that management planning is experience-based (Pullin et al., 2004).

In comparison to the heuristic approach, the rational decision-making approach offers a more formal and transparent process (Table 2.9). Decisions in the public sector must be transparent because public sector organisations are accountable to the agency's owners (taxpayers). Many of the value judgements employed heuristically by decision-makers in the public sector should be part of the decision-making process, but they need to be incorporated into decision-making formally rather than intuitively. For this to occur, decision-makers need models or tools to formalise and increase the transparency of resource allocation decisions.

Table 2.9

Comparing the Rational and Heuristic Approaches to Decision-Making

The rational approach	**The heuristic approach**
Value judgements enter at the end of the decision making process	Value judgements are used at the start of the decision making process
Value judgements are used as yardsticks for formal evaluation	Value judgements are used to filter and categorise the available information
Value judgements are taken as a given	Value judgements are the subject of argument
Value judgements are variables to be maximised	Value judgements are principles which can trigger a veto
Emphasises the quantity of options evaluated	Emphasises the quality and flexibility of options
Uses a process of elimination	Uses a 'design' process moving incrementally towards an ill-defined end
Analysis	Synthesis
Uses procedures and algorithms	Uses informal cognitive processes
Formal	Intuitive

Source: Adapted from Fisher (1998)

2.4.2 A MODEL TO SUPPORT RESOURCE ALLOCATION DECISIONS

A network of national parks can be viewed as a management portfolio of natural assets that have a 'business goal' of maximising the flow of benefits from national parks to society (Stephens, 1999). However, inadequate funding is a significant factor in the failure of national parks to meet their objectives, and the problem is exacerbated by the *ad hoc* decision-making processes used by national park management agencies to allocate these limited funds among their conservation responsibilities (Bell & Martin, 1987). These decision-making processes need to be improved.

When examining environmental decision-making, concepts like efficiency, equity, effectiveness, and legitimacy are raised (Adger, Brown, Fairbrass, Jordan, Paavola et al., 2003; Fisher, 1998). In economics, efficiency relates to the maximisation of human welfare; effectiveness refers to the capacity of a decision to achieve its objectives; equity is a matter of distributive justice or the distributional consequences of a decision; and legitimacy relates to the acceptability of the decision process to participants on the basis of who makes and implements the decisions (Adger et al., 2003). These concepts may have multiple meanings depending on who is defining them, and it is unlikely that all four concepts will be maximised in a decision (Fisher, 1998). A new approach is needed for resource allocation decision-making; one that transcends concepts of effectiveness, efficiency, equity, and legitimacy. Decisions must be transparent, repeatable, and based on current best practice. Decision-makers need practical and robust models to help them better understand their asset portfolio so they can make better annual resource allocation decisions in both the short-term and the long-term.

The focus of the research is to develop a decision-making model to assist decision-makers with the allocation of resources among national parks. To do this, parameters for the proposed model must be identified. Following from the above discussion, the model will take a rational decision approach. This approach is the most appropriate because the proposed model is intended to facilitate better decisions, not explain or predict behaviour. The parameters for the proposed model are outlined below. The sub-headings refer to the aspects of the rational decision-making approach outlined in Figure 2.7. These are: (1) define objectives; (2) identify constraints; (3) identify alternative means of achieving the objective; (4) define criteria for comparing and evaluating options; and, (5) evaluate each option against each criterion using a numerical scoring system and sum numerical scores for each option (Fisher, 1998).

(1) Objectives

The objective of the proposed model to aid decision-making is to allocate resources among a set of national parks; the purpose of the national parks must be agreed upon so that the characteristics or benefits they deliver can be compared. Biological considerations alone are an inadequate guide to conservation priority because environmental decisions typically draw on multidisciplinary knowledge bases (Clarke & Bell, 1986; Kiker et al., 2005). The Convention on Biological Diversity (CBD), which most nations are party to, is concerned with the conservation of biological diversity; the sustained use of biological resources; and the equitable sharing of benefits arising from biological diversity including genetic resources (Convention on Biological Diversity, 1993; Siebenhuner & Suplie, 2005). This corresponds with the principles of 'sustainable development', which is the dominant rhetorical device of environmental governance. Sustainable development incorporates environmental, economic, and social dimensions. Relevant national policies and legislation, and other environmental agreements as they relate to national parks must also be accommodated.

The IUCN's Southern African Sustainable Use Specialist Group (SASUSG) made suggestions for improving protected area outcomes by clarifying the principles underlying park management (Child, 2004a). The group suggests that:

- Parks are areas set aside for the purpose of serving a local or national constituency;
- Parks should meet the dual objectives of ecological conservation and the provision of socio-economic value by aiming to maximise socio-economic value within constraints imposed by ecosystems;

- The ecological conservation objective for parks should be to ensure that ecosystem health and diversity thresholds remain intact and that these are measured systematically, accepting that in some cases other factors (e.g., single species) may take specific and overriding priority;
- The socio-economic objective for parks should be to actively encourage the maximisation of benefits to society, and that any socially acceptable or humane use is acceptable provided that ecosystem health and diversity thresholds remain intact. This means that jobs, economic growth, and rural development are social goals every bit as legitimate to societies where rural poverty is common as are wilderness and science to North Americans; and,
- That there are complex trade-offs between producing social value and distributional issues relating to who benefits from that value. All these must be addressed, in order to maximise the benefits provided by national parks.

The purpose of the proposed model is to help decision-makers to better view the nation's national park system as an asset portfolio and as a result improve the transparency and robustness of resource allocation decisions. Thus, the model's objective is *to rank national parks in terms of conservation importance*, where conservation importance is determined by a combination of the biological, economic, and social net benefits associated with each national park.

(2) Constraints

The constraints confronting decision-makers who try to rank order national parks are largely related to reliable data, and the degree of subjectivity inherent in making environmental decisions.

The people charged with making annual resource allocation decisions amongst national parks are often not expert natural scientists, economists, or social scientists. They need a practical model that is easy to use and understand and is not excessively time-consuming to regularly update; furthermore, it should reduce complexity into a simple procedure. Once resources have been allocated to a national park, it is the responsibility of the park manager to distribute the money to different management activities. Guidance for doing this should be taken from the Management Plan for each park (and associated operational, corporate, and business plans). A park Management Plan that follows best practice identifies, describes, and prioritises the management actions required to achieve the management objectives (de la Harpe et al., 2004; Thomas & Middleton, 2003).

Because many national park management agencies are also responsible for other types of protected area, it is important that the proposed model can be modified to accommodate these areas. Rather than attempting to rank the full range of a nation's different protected areas types, the focus of this research will be to develop a model to rank a set of national parks only. National parks are the obvious and best choice because they are the most assimilated and accepted type of protected area worldwide[11] (Ahmend et al., 2003), and have the clearest property rights (aside from Strict Nature Reserves, IUCN protected area category I, which have no direct human use element beyond a research capacity). In the future, the model could be tailored to include other types of protected area. This means that the 'conservation importance' criteria chosen will be in the context of areas managed as national parks, according to the IUCN definition, for ecosystem protection and recreation.

Sound management decisions should be based on quality data and information. It is impossible to predict the consequences of every decision, but use of the most relevant and recent information is a good start (De Lacy, Chapman, Whitmore, & Worboys, 2006). For the proposed model to be robust, the specific attributes selected must have associated data that are both meaningful and available. Some data are difficult and expensive to acquire. The availability of data also differs between nations (Table 2.10) with developed countries often having greater access to data. Signatories to the CBD are required to assess and monitor biological diversity. However, the CBD text provides no guidance for undertaking biodiversity assessments or monitoring; standards do not exist (Sheil, 2001).

Fine-scale data (if collected over a large extent) can always be amalgamated to provide coarse-scale data, but not the reverse (Hartley & Kunin, 2003). The literature concerned with selecting areas for conservation assumes complete

[11] This is true for many developed countries, but one notable exception is Scotland where the national park movement failed to gain legislation due to factors including the strength of the landowning interest, rural depopulation, and concern for jobs in a depressed economy.

information about the incidence and survival of species. In practice, species incidence and survival at a locale is uncertain (Camm, Norman, Polasky, & Solow, 2002). Not all benefits and costs associated with conservation can be expressed in currency or other, non-monetary units (Hughey et al., 2003), so the particular rational decision framework constituting the model must deal competently with incommensurate data.

Table 2.10

Characteristics of Economic Values Associated with Protected Areas in Developed and Developing Countries

	Type of Economic Value				
	Use Value		**Non-use Value**		
	Direct[1]	**Indirect[2]**	**Option[3]**	**Bequest[4]**	**Existence[4]**
Developed Country					
Ease of measurement	Easy	Moderately easy	Difficult	Difficult	Difficult
Available data	Many	Some	Some	Some	Some
Realisable as income	Easy	Moderately difficult	Difficult	Difficult	Difficult
Developing Country					
Ease of measurement	Easy	Difficult	Difficult	Very difficult	Very difficult
Available data	Some	Few	Very few	None	None
Realisable as income	Easy	Moderately difficult	Difficult	Difficult	Difficult

1 Direct use values include those benefits derived from consumptive use of a protected area for activities such as harvesting, recreation, tourism, hunting, education, and research.
2 Indirect use values are benefits derived from the protected area, but not necessarily experienced on-site, for example, ecosystem services such as carbon sequestration, watershed protection, breeding habitat for migratory species, and climatic stabilisation.
3 Option values are derived from the option of using the protected area, either directly or indirectly, at some future time.
4 Bequest and existence values include spiritual, cultural, aesthetic, educational, scientific, peace, and therapeutic values.

Source: Adapted from Barnes (2003)

The data employed in a ranking model will be unavoidably biased. For example, biological databases are heavily biased by road-access research facilities and site-choice by researchers. It is easier for researchers to access survey areas by road, so areas that are relatively inaccessible are surveyed less often. However, it is now possible to analyse vegetation assemblages using recent satellite imagery in a Geographic Information System, which removes most of the bias associated with survey-based data (Vreugdenhil, Terborgh, Cleef, Sinitsyn, Boere et al., 2003).

The ideal allocation of conservation funds is not simply a matter of giving the park with the most pristine contents the most money. Decision-makers must decide whether funds should be prioritised for areas with the worst environmental problems, or areas that have made some environmental improvements (Wu & Boggess, 1999). This means that some form of weighting procedure needs to be incorporated into the proposed model.

However, while any prioritising exercise involves a degree of subjectivity, value judgements are not necessarily bad (Bell & Martin, 1987; Hambler, 2004). Components of the natural environment merge in space and time, but humans divide nature into subjective sets of objects (Bell & Martin, 1987), so people with different perceptions of conservation importance will assign values in different ways (Hambler, 2004). Weights are inherent in conservation legislation and funding, but the weighting processes are usually subconscious. Biological components tend to be subjectively sorted into grades of importance; for example, threatened species are generally considered more important than unthreatened species, large species more important than small species, and vertebrates more important than invertebrates (Bell & Martin, 1987). Therefore, to be transparent, the proposed model must incorporate weighting processes that are explicit.

To accommodate the constraints outlined above, the rational decision-making framework on which the proposed model is built must meet the following parameters:

1. The biological, economic, and social attributes used to compare the national parks in a country's national park network should be based on conservation best practice;

2. To be practical for PAMAs to apply, the attributes chosen depend on existing data sets that the agency can access;

3. To ensure fair comparisons, data must be available for all national parks in the country's network. However, in some instances surrogate data could be used for some national parks if data about a specific attribute is available for the rest. Consequently, the decision-making framework must allow the use of surrogate data;

4. The decision-making framework chosen for the model must accommodate a large range of incommensurate data; and,

5. Because not all attributes will have the same importance in the allocation decision, the framework must allow attributes to be weighted.

(3) Alternatives

Alternatives are the different options for achieving the decision objective. In this research, the alternatives are the different national parks in the country's national park network.

(4) Criteria

Suitable criteria against which to compare national parks in terms of conservation importance are discussed in Chapter Three, using the Convention on Biological Diversity's biological, economic, and social attribute categories. The criteria employed in the proposed model are essentially indicators of the significance of different attributes of a national park. According to Margoluis and Salafsky (1998), a good indicator is:

- Measurable – in either quantitative or qualitative terms;
- Precisely defined – to ensure that the same data is collected over different geographic locations and by different people over time; and,
- Consistent and sensitive – to accurately reflect changes in a condition over time.

Possible indicators for progress towards meeting the objectives for national park management as stipulated in the IUCN guidelines are outlined in Table 2.11. Some of these indicators will be suitable criteria for inclusion in the decision-making model.

(5) Evaluation

An evaluation can only occur once a formal rational decision framework has been selected in which to 'build' the proposed model, in accordance with the parameters outlined above. Existing frameworks are reviewed in Chapter Four, culminating in the selection of a Multiple Criteria Analysis method. The remainder of the thesis is concerned with the development, application, and suitability of the model.

2.5 CONCLUSION

In this chapter, a description of the nature of parks and why they are short of funds was presented. The need to make transparent and internally consistent decisions when allocating resources was also highlighted. The conservation finance literature focuses on ways to generate funding for national parks, but is lacking in guidance regarding how funds could or should be allocated amongst different conservation responsibilities. This problem exists at multiple spatial scales; funds must be allocated amongst projects at the local level, conservation units at the national level, and also at regional and international scales. The research presented here attempts to address the research gap by improving resource allocation at the national scale amongst the national parks managed by a government agency.

The suggested approach identified here is to overcome decisions based on intuition and heuristics, by helping decision-makers to understand the relative significance of different national parks in biological, economic, and social terms via a rational decision model. This approach is both reductionist and utilitarian. It proposes that the important aspects of national parks should and can be expressed for comparative purposes, and that this information can assist with transparent decision-making. The significance of a national park is greater than the sum of its parts, but decisions need to be made annually, and should be based on the best available knowledge in light of imperfect information. The approach also makes assumptions about the relationships between humans and nature, that protected areas are not just important because they protect nature. These assumptions are derived from the both the internationally recognised definition for national parks (IUCN, 1994), and the Convention on Biological Diversity (1992). The former recognises the role of national parks in both nature conservation and the provision of recreation (and other) opportunities. The latter recognises that natural areas provide important ecological, economic, and social benefits.

Table 2.11

Indicators Associated with National Parks in Accordance with the IUCN Guidelines

Objectives	Site Level		System Level	
	Possible indicators	**Method of data collection**	**Possible indicators**	**Method of data collection**
To perpetuate, in as natural a state as possible, representative examples of physiographic regions, biotic communities, genetic resources, and species to provide ecological stability and diversity	Population estimates of key species	Field survey	Extent of ecosystem stresses	Survey of managers and others with relevant expertise
	Indicators selected to reflect key processes for the particular ecosystem involved	Field survey	Population estimates of key species	Collate data from site-based monitoring
To protect natural and scenic areas of national and international significance for spiritual, scientific, educational, recreational or tourist purposes	Extent of use-related degradation or stress	Field survey		
To eliminate and thereafter prevent exploitation or occupation inimical to the purposes of designation	Extent of encroachment considered inimical to purposes of designation	Mapping of encroachment area	Evidence of system-wide pressures on protected areas from sources, e.g., unregulated tourism or mining	Site by site collection of information
To manage visitor use for inspirational, educational, cultural and recreational purposes at a level that will maintain the area in a natural or near natural state	Visitor experiences, satisfaction and understanding	Visitor surveys	Visitor experiences and satisfaction levels	Visitor surveys
	Extent of visitor-related degradation or stress	Field survey	Extent of visitor-related degradation or stress	Survey of managers and others with relevant expertise
	Number of visitors	Manager's report		
	Number of participants in educational/interpretive programmes	Manager's report		
To eliminate and thereafter prevent exploitation or occupation inimical to the purposes of designation	Extent of encroachment considered inimical to purposes of designation	Mapping of encroachment area	Population estimates of key species	Collate data from site-based monitoring programmes
To an extent consistent with the foregoing objectives, to provide opportunities for research, education, interpretation and public appreciation	Visitor/use understanding and satisfaction levels	Visitor/user surveys	Visitor/user understanding and satisfaction levels	Visitor/user surveys
	Extent of use-related degradation or stress	Field survey	Extent of use-related degradation or stress	Survey of managers and relevant experts

Source: Adapted from Hockings et al. (2000)

Parameters for the proposed model were identified. Accordingly, the model should:

- Incorporate criteria for which data are readily available in order for the model to be practical for PAMAs to use;
- Accommodate incommensurate and subjective data because the biological, economic, and social net benefits of parks are not expressed in the same units; and,
- Involve a transparent procedure for weighting individual criteria because some criteria will have greater importance to decision-makers than other criteria.

A review of criteria that could be used in the ranking model is presented in Chapter Three. This is followed in Chapter Four by a review of decision-making frameworks in which the most appropriate framework for the ranking model is identified.

3 CRITERIA FOR ASSESSING NATIONAL PARKS

National parks provide a diverse range of values and benefits to society. Many of nature's properties are intrinsic and can be observed and appreciated by people. The resulting benefits, values, and feelings associated with natural environments are dynamic social constructs. The attributes of a park can be said to have importance simply because they exist, but they do not necessarily have equal importance (Harmon, 2003; Putney, 2003). Endangered species and visually outstanding landscapes, for example, are typically considered more important than common species and landscapes (Eagles, 1993). Further, the characteristics of wilderness areas are appreciated differently from generation to generation. One of the premises of sustainability is the responsibility of the current generation to pass on natural and cultural heritage for the benefit of future generations. Any assessment of national park significance should be undertaken in the knowledge that future generations view attributes differently.

The purpose of this chapter is to explore appropriate criteria against which to compare and prioritise national parks. There are numerous ways that the benefits and values associated with national parks can be classified and described. Some benefits are difficult to express and/or are multifaceted and could belong to more than one classification category (Lockwood, 2006). The structure of this chapter is based on the biological, economic, and social pillars set out in the 1992 Convention on Biological Diversity. The biological category includes geological features, but because these are abiotic, this category has been called 'natural heritage'. In the first section, natural heritage criteria are outlined followed by economic and social criteria in the second and third sections respectively. In the fourth and final section criteria with which to measure the presence and magnitude of processes that may threaten a park are reviewed. For each possible criterion identified in this chapter a brief discussion of its suitability is provided. The process for choosing the final set of criteria for the decision-making model is described in Chapter Five.

3.1 NATURAL HERITAGE CRITERIA

Conservation biologists worldwide recognise that biodiversity's greatest hope is the *in situ* protection of as many of its elements as possible (Pressey, 1996). The maintenance of biological diversity – more commonly referred to as biodiversity – is seen as the most important function of protected areas (IUCN-WCMC, 1994). Biodiversity is defined as:

> The variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems. (Convention on Biological Diversity, 1993, p. 146)

Thus, biodiversity is multidimensional, because it includes all species, genetic variation within species, and all varieties of habitats and ecosystems (Dixon & Sherman, 1991). These dimensions of biodiversity feature in the IUCN Guidelines, where national parks should be managed:

> To perpetuate, in as natural a state as possible, representative examples of physiographic regions, biotic communities, genetic resources, and species to provide ecological stability and diversity. (IUCN-WCMC, 1994, p. 4)

In recent years, substantial international attention has been devoted to identifying indicators with which to measure components of biodiversity and the success of conservation efforts (Sayer, Ishwaran, Thorsell, & Sigaty, 2000; Stork, Samways, Bryant, Cracraft, Eeley et al., 1996). Measures of nature follow Cartesian reductionism, where natural elements are divided into discrete entities like soil, water, vegetation, geology, vertebrates and invertebrates. However, the dynamic processes that unite the parts into a system produce properties that the individual parts do not have when simply placed together (Jope & Dunstan, 1996; Possingham, Andelman, Noon, Trombulack, & Pulliam, 2001).

A large literature has developed around criteria to determine the biological importance of an area and there is much duplication of effort across organisations (Mace, Balmford, Boitani, Cowlishaw, Dobson et al., 2000). The sets of principles behind the approaches for designing protected area systems are known more formally as 'systematic conservation planning' principles. These are based on the idea that the best set of protected areas satisfies a number of conditions relating to protected area comprehensiveness, representativeness, adequacy, efficiency, flexibility, irreplaceability, connectivity, and shape (Groom, Meffe, & Carroll, 2006).

Prominent theories from conservation biology that contribute to systematic conservation planning include ‘island biogeography theory’ (MacArthur & Wilson, 1967), ‘metapopulation theory’ (Hanski, 1999), and ‘source-sink theory’ (Pulliam, 1988). According to island biogeography theory, large reserves are better than small reserves, and connected (or close) reserves are better than unconnected reserves (Possingham et al., 2001). Metapopulation theory is concerned with increasing the likelihood that a species will persist. The probability of survival increases if local extinction rates are decreased, between-patch colonisation rates are increased, there is an increase in the number of suitable habitat patches, and there is an increase in the number of occupied habitat patches (Possingham et al., 2001). Source-sink theory is used to identify habitats where population growth rates are consistently positive, following the rule to “protect source populations and ignore sink populations" and that "reserves with a low edge-to-area ratio are better than reserves with a high edge-to-area ratio" (Possingham et al., 2001, p. 22). These rules form guiding principles for conservation management. However, it has proved problematic to apply such theory to real-world situations (du Toit, Walker, & Campbell, 2004; Noss, 1996).

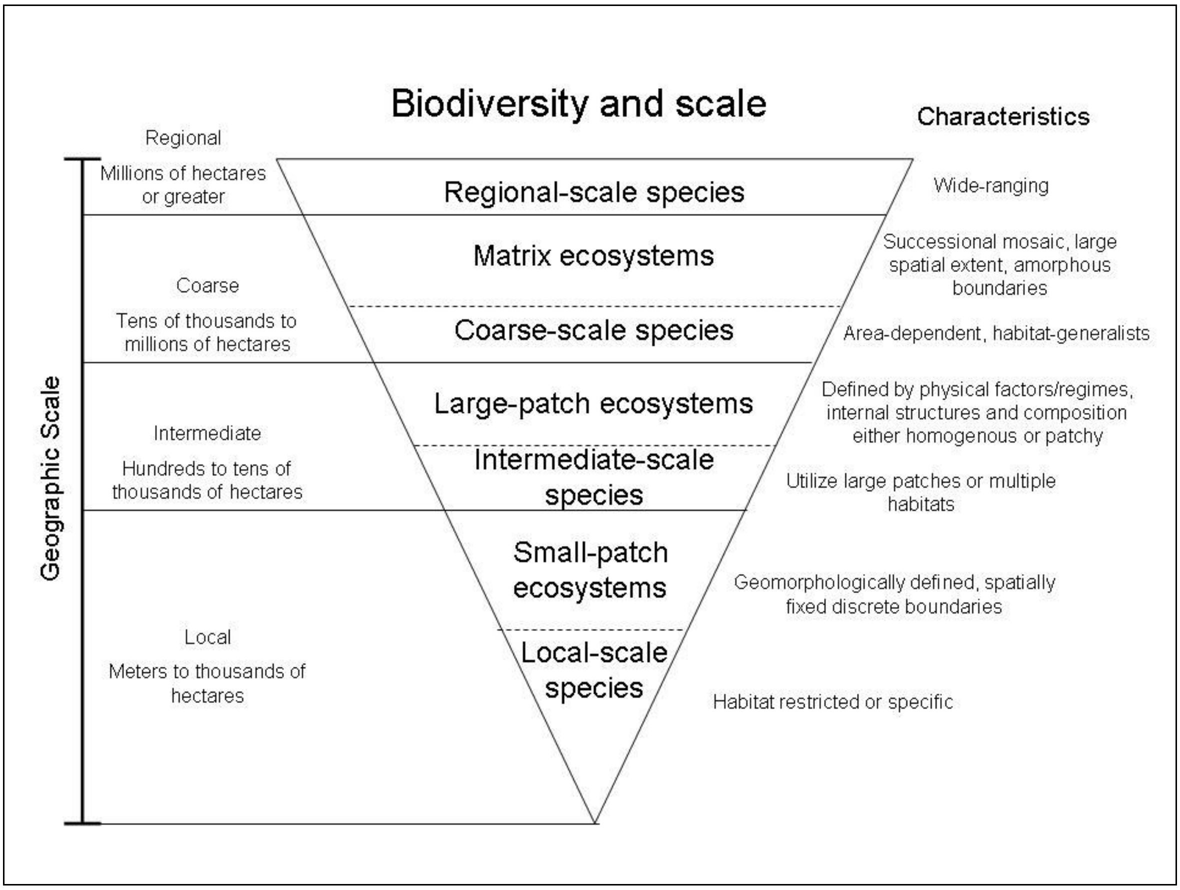
Humans place importance on what is rare and/or threatened so nationally significant sites are likely to include threatened species and unique ecosystems (Hockings, Stolton, & Dudley, 2000). According to Turpie et al.(2002), the conservation importance of an area is usually based on the following concepts:

- Rarity – limited abundance or geographical range; rare physical types, rare habitats or rare species, where rarity implies scarcity;
- Abundance (quantity) – size, habitat area, habitat diversity, species diversity, population size, productivity; and,
- Ecosystem function – for example nursery areas for marine fish, although it is usually difficult to quantify in practice.

Policy-makers and specialists have adopted the three components of biodiversity identified in the Convention on Biological Diversity: ecosystems, species, and genes (Earthwatch Europe, IUCN, & World Business Council for Sustainable Development, 2002). When assessing areas for protection experts like Noss and Roper-Linsday (2004) include a further landscape-level category. The following review of natural heritage criteria is divided into these four levels of organisation.

Biodiversity exists at different levels of organisation and occurs at different spatial scales as shown in Figure 3.1, where local, intermediate, coarse, and regional scales are specified. Protected areas generally contain ecosystems – or parts of ecosystems – and species at multiple scales (Poiani, Richter, Anderson, & Richter, 2000). The minimum size for a national park according to the IUCN Guidelines is 1,000 ha, so national parks may involve species and ecosystems at any of the four geographic scales (IUCN-WCMC, 1994).

Figure 3.1
Biodiversity at Various Spatial Scales



Source: Poiani et al. (2000, p. 134)

Natural heritage criteria can be divided into four levels of biological organisation, landscape, ecosystem, species, and genetic levels. A summary of the natural heritage criteria that have potential for use in the proposed model is provided in Table 3.7 at the end of this section.

3.1.1 LANDSCAPE LEVEL/ECOLOGICAL CONTEXT

Landscape level criteria refer to the ecological context in which a park exists (Norton & Roper-Lindsay, 2004). The integrity of a protected area, or its insulation from adverse outside influences, depends on its size, shape and the nature of its boundaries (Hockings et al., 2000; Pressey, 1996).

Size

A park's size can dictate the number of species present and the susceptibility of the park to external threats. When faced with the question 'how large should a park be to sustain its biological contents for the foreseeable future?' the albeit impractical response is 'as large as possible' (Terborgh, 1999). More specifically, the area should be large enough to sustain genetically viable populations of top predators, terrestrial and aquatic species of fauna, plants, and fungi. However, the viability of species populations is difficult to determine (Vreugdenhil, Terborgh, Cleef, Sinitsyn, Boere et al., 2003).

A long-running debate in the ecological literature has centred on the optimal number of reserve sites under a fixed maximum total reserve area, known as the SLOSS (Single Large or Several Small reserves) problem. Reviews of the arguments presented in the literature are summarised in detail by Groenveld (2004) and Vreugdenhil et al. (2003). Those in favour of a single large reserve argue that it is more resistant to external threats, can hold more species, and will have lower extinction rates than several small reserves equalling the same total area. The primary argument in favour of several small reserves is that, assuming a standard concave specie-area curve, a greater number of sites covers more species than one single site. Groeneveld (2004) divides the debate into two parts according to the conservation objective:

- The species richness SLOSS problem, focusing on maximising the number of species protected; and,

- The metapopulation SLOSS problem, focusing on maximising the time to extinction for a metapopulation, or metapopulation size.

Empirical analyses are used to determine the maximum species richness in a given area, which often favour several small reserves. Findings suggest that the solution is dependant on whether the species found in the species-poor biota can also be found in species-rich biota. If they are, small habitat patches typically contain species that are also found in large patches and the large reserve is the preferred option. The problem has been approached from a more theoretical perspective where metapopulation size or persistence is the focus. Metapopulation theory identifies several mechanisms that influence the vulnerability of a species to fragmentation and it is hard to make general reserve design recommendations because they are dependant on the real-world situation (Groeneveld, 2004). Some conservation objectives can be met with a few large reserves, but others require a set of smaller parks (Agee, 1996).

The SLOSS debate is a somewhat hypothetical one, as many protected areas have already been established, and when establishing new protected areas, the size of the area is determined more by land use and tenure, than science. Vreugdenhil et al. (2003) suggest that Some Large and Several Small (SLASS) reserves are best, where the latter are required to protect those ecosystems that are absent in the existing protected areas.

As a general rule, however, bigger parks are better because a large protected area:

- Will contain a greater total number of viable species (Hockings et al., 2000; Pressey, 1996);
- Will support more species of a particular taxonomic group (Pressey, 1996);
- Is more likely to have large animal species present because larger species tend to have larger space requirements (Pressey, 1996; Woodroffe & Ginsberg, 1998);
- Has a greater resilience to buffer internal habitat from external influences such as gradual changes like climate change, or major changes like

damage by fire or a severe pest outbreak (Halvorson, 1996; Hockings et al., 2000; Pressey, 1996). In theory a protected area should be of sufficient size to contain a complete range of fire and successional stages, minimising the chance that a park is completely affected by a single fire (Groom et al., 2006); and,

- Has a greater capacity to maintain natural ecological and evolutionary processes including a natural disturbance regime, reducing the need for active management interventions (Hockings et al., 2000; Pressey, 1996).

The size of a national park is one of the easier criteria to measure as the total area can be determined using standard maps or satellite imagery in a geographic information system. The total area can be expressed in units of area – typically metric measures – either hectares (ha) or square kilometres (km^2). The size of a set of national parks can be considered in a numerical fashion, or grouped using descriptive categories such as those presented in Table 3.1 below.

Table 3.1
Descriptive Categories for Park Size

Category	**Park Size(ha)**	
	Parks Victoria Assessment (Victoria, Australia)	**Conservation Priority System (Southern Africa)**
Very large	>40,000	>1,000,000
Large	>10,000–40,000	100,000–1,000,000
Medium	>400–10,000	10,000–100,000
Small	>200–400	1,000–10,000
Very small	<200	<1 000

Source: Adapted from Parks Victoria (2000) and Bell and Martin (1987)

According to the IUCN guidelines, in order to qualify as a national park, the area must be 1,000 ha or greater in size (IUCN-WCMC, 1994). From the table, Parks Victoria scale was applied to the full range of protected areas managed by that Parks Victoria, not national parks specifically. In comparison, the scale used in the Conservation Priority System was intended for use in southern Africa where some conservation areas are on a greater scale than those in Victoria, Australia. A similar descriptive scale could be employed in the decision-making model, but this may have to be tailored to the country.

Shape and Adjacent Land Use

The shape of a protected area is important because parks with long boundaries are more susceptible to negative impacts from adjoining land uses (Hockings et al., 2000; Pressey, 1996). These impacts are called 'edge effects' and can be defined as "the negative influence of a habitat edge on the interior conditions of habitat or on species that use interior habitat" (Primack, 2004, p. 85). Edge effects include abiotic changes in environmental conditions, changes in species abundance, and changes in species interactions (Norton, 2002). Abiotic changes can include alterations in microclimates, radiation receipt, nutrient cycling, disturbance regimes, gradients of moisture, soil and air temperature, wind speed, and species composition (Groom et al., 2006). Changes in species abundance occur in response to modified abiotic conditions and through increased exposure to or displacement by invasive plant and animal species and diseases. Species behaviour can in turn be influenced by changes in both abiotic conditions and the abundance of species. The result of these changes is different habitat and species composition at the edges of a habitat type.

The amount and type of edge effect depends on the size and shape of the park, as well as the adjacent land uses. A park may border urban areas (for example, housing, industry, or parkland), rural areas (for example, agriculture, horticulture, or planted forests), or other natural areas (for example wetland or scrub) (Norton, 2002). The edges created by people may cause edge effects that reduce the number and quality of species present as a whole (Bannerman, 1998; Groom et al., 2006). Where urban areas border a park the main problems are likely to be weeds, especially from dumped garden waste; cats and dogs, which may kill native animals; human damage such as litter, trampling, or vandalism; and, the diversion of rainwater carrying pollutants. The encroaching problems from rural areas may include animal pests; stock grazing and trampling; and, spray drift (Norton, 2002). The edge effects from adjoining natural areas are comparatively negligible. Such borders may be exceptionally species-rich areas supporting specialist species and species that use both habitats (Bannerman, 1998; Groom et al., 2006). Where private protected areas or protected areas in neighbouring countries border a protected area these areas may function as an extension of the protected area habitat without notable changes at the border.

A management technique to reduce edge effects is to designate a buffer zone around a protected area. Management objectives for the buffer zone may include restricted resource extraction by local communities (Ahmend, Giraldo, Oltremari, Sánchez, & Yerenda, 2003; Pressey, 1996). Buffer areas slow water runoff, trap sediment, are a source of food, and provide additional habitat for wildlife species (Groom et al., 2006). Another management strategy to eliminate negative external effects is to align boundaries with watersheds. In doing so, protected areas will be less susceptible to waterborne pollutants, like sediment from upstream erosion and chemical pollutants (Pressey, 1996).

The general rule for protected area shape is that parks with irregular and elongated shapes (low area to perimeter ratios) are more susceptible to edge effects. Thus, a circular-shaped protected area is optimal (Groom et al., 2006; Halvorson, 1996; Possingham, Ball, & Andelman, 2000; Pressey, 1996). From an economic perspective, the boundaries of a protected area should be minimised to reduce maintenance costs. For species that are edge-sensitive, the effectiveness of a protected area in protecting those species is reduced if the area has a high edge to area ratio (Groom et al., 2006). Admittedly, the shape of a park is important for small areas but there is a size beyond which shape does not really matter (Saunders, Hobbs, & Margules, 1991). According to Norton (2002), edge effects are unlikely to be important in forest remnants greater than 1000ha in size, which is the suggested minimum size for a national park according to the IUCN criteria.

The shape of a park is best measured by dividing the total area of the park by the length of its boundary; the higher the ratio the better the shape. Parks Victoria determined area-to-boundary ratios for 124 parks using geographic information systems and determined the area-to-boundary categories shown in Table 3.2 below. The largest parks were found to have the highest area-to-boundary ratios and are consequently the least susceptible to edge effects (Parks Victoria, 2000).

The variability in park size can distort this measure of park shape. If all the parks were the same size but their border length differed this ratio would be more comparable. A similar, but more meaningful measure involves dividing the boundary length by the circumference of a circle of the same total area as the park. Values approaching the number one are the most compact because they represent the shape of a circle (Groom et al., 2006).

Table 3.2
Park Shape Categories

Category	Area-to-Boundary Ratio
High (best)	>100 ha/km
Medium	10-100 ha/km
Low	<10 ha/km

Source: Adapted from Parks Victoria (2000)

Habitat Continuity

Habitat fragmentation is defined as "disruption in continuity in pattern or processes" (Primack, 2004, p. 88). Fragmentation can be the result of both natural and human activities, where a habitat patch is progressively subdivided into smaller, isolated fragments (Leitão, Miller, Ahern, & McGarigal, 2006). The habitats of many protected areas were once connected by a wide expanse of natural habitat, but are now isolated, existing within a landscape modified by human use. The consequences of habitat fragmentation are edge effects, barriers to dispersal, potential invasion by exotics, and local and regional extinctions (Groom et al., 2006). The extent of these negative impacts vary with the time since isolation, distance from other remnants, and degree of connectivity with the remnants (Saunders et al., 1991). Landscape patterns that promote connectivity for species and ecological processes help overcome the effects of fragmentation (Bennett, 2003).

Landscape connectivity can be defined as:

> The spatial continuity of a patch type…across a landscape (i.e., structural connectivity) or the degree to which specific ecological flows (e.g.,

> movement of energy, materials, and organisms) across a landscape are facilitated or impeded (i.e., functional connectivity). (Leitão et al., 2006, p. 211).

The degree to which a species moves amongst habitat patches is determined by both the characteristics of the organism and the structure of the landscape through which it must pass (Taylor, Fahrig, Henein, & Merriam, 1993; Tischendorf & Fahrig, 2000). In the context of this thesis, connectivity relates to the degree to which an individual protected area is connected to either other protected areas within the network or to land managed for conservation . The habitat configurations that enhance connectivity include habitat mosaics, corridors, and stepping stones. A habitat mosaic is a landscape pattern encompassing habitats of varying quality for animal species that are managed to promote movement. Corridors and stepping stones are elements of a habitat mosaic (Bennett, 2003). A corridor is a narrow, continuous strip of vegetation that links two otherwise unconnected habitats (Bennett, 2003; Tischendorf & Fahrig, 2000). In comparison, stepping stones are one or more separate habitat patches in the space between two habitats (Bennett, 2003). The characteristics of these types of landscape linkage are shown in Table 3.3 below.

Table 3.3
Landscape Configurations to Enhance Connectivity for Animal Populations at Different Spatial Scales

Landscape configuration	Landscape scale (1 – 99 km)	Regional or biogeographic scale (100+ km)
Habitat corridor	Rivers and associated riparian vegetation; broad links between reserves	Major river systems; mountain ranges; isthmus between land masses
Stepping stones	Series of small reserves; woodland patches in farmland; urban parks	Chains of islands in an archipelago; wetlands along waterfowl flight paths; alpine habitats along a mountain chain
Habitat mosaics	Mosaics of regenerating and old-growth forest in forest blocks	Regional soil mosaics supporting different vegetation communities

Source: Adapted from Bennett (2003)

The theory associated with corridors and stepping stones between protected areas arose from island biogeography theory. The size, shape, and management of corridors and stepping stones varies, but their primary purpose is to allow the movement of individuals between otherwise isolated habitat patches (Groom et al., 2006).

A number of benefits and drawbacks are associated with elements of landscape connectivity and these are outlined in Table 3.4 (Bennett, 2003; Pressey, 1996).

Table 3.4
Reported Advantages and Disadvantages of Linkages for Biodiversity Conservation

Reported Advantages	**Reported Disadvantages**
Linkages can assist the movement of individuals through disturbed landscapes, including: ▪ Wide-ranging species that move between habitats on a regular basis; ▪ Nomadic or migratory species that move between irregular or seasonally-varying resources; and, ▪ Species that move between habitats at different stages of their life-cycle.	Linkages can increase immigration rates to habitat isolates**:** ▪ Facilitating the spread of unwanted species such as pests, weeds and exotic species; ▪ Facilitating the spread of disease; and ▪ Introducing new genes which could disrupt local adaptations and co-adapted gene complexes (out breeding depression) and promote hybridisation between previously disjunct taxonomic forms (races, sub-species).
Linkages can increase immigration rates to habitat isolates which could**:** ▪ Maintain a higher species richness and diversity; ▪ Supplement declining populations, thus reducing their risk of extinction; ▪ Allow re-establishment following local extinction; and, ▪ Enhance genetic variation and reduce the risk of inbreeding depression.	Linkages can Increase the exposure of animals to: ▪ Predators, hunting or poaching by humans or other sources of mortality (e. g. road kills); and, ▪ Competitors or parasites.
Linkages can facilitate the continuity of natural ecological processes in developed landscapes.	Linkages can act as ‘sink habitats’ in which mortality exceeds reproduction, and thus functions as a ‘drain’ on the regional population.
Linkages can provide habitat for many species including: ▪ Refuge and shelter for animals moving through the landscape; and, ▪ Plants and animals living within linkages.	Linkages can facilitate the spread of fire or other abiotic disturbances.
Linkages can provide ecosystem services such as the maintenance of water quality, reduction of erosion, and stability of hydrological cycles.	The costs of establishing and managing linkages can reduce the resources available for more effective conservation measures, such as the purchase of habitats for endangered species.

Source: Adapted from Bennett (2003)

Connectivity amongst protected areas is important for species with populations distributed across the landscape that depend on dispersal for maintaining genetic variability; without movement between protected areas these populations will suffer from problems associated with inbreeding (Groom et al., 2006).

Wide-ranging species may require more space than could reasonably be provided for them in a single protected area, and their survival depends on their ability to move between protected areas. Climate change may affect the ranges of species, and ensuring that there is connectivity between protected areas gives hospitable options to species that need to move to maintain their range. Furthermore, conservation activities outside of protected areas can help to reduce the sources of threats to biodiversity. The primary focus of a protected area system is to secure sites that are critical for the protection of biodiversity, but planning for the landscape mosaic is also important for meeting the objectives of protected area systems (Groom et al., 2006).

Protected areas that are well connected to other reserves may be at a disadvantage if this connectivity increases the chance of a disease spreading, or alien species invading the park. Likewise, connectivity can allow disturbance events like fires to spread from one protected area to another. By separating protected areas by a minimum distance, these risks are reduced. In addition, corridors and stepping stones are prone to edge effects because they have high edge to area ratios. Identifying potential corridors that are robust to edge effect problems can increase the costs of a reserve system significantly (Groom et al., 2006).

In a review of 32 studies regarding the utility of corridors, Beier and Noss (1998) concluded that a connected landscape is preferable to a flat fragmented landscape. The quality of a linkage is context specific, but Bennett (2003) suggests that a linkage of highest conservation quality would meet the following criteria:

- Irreplaceability/redundancy – the linkage contains habitat that is unique and essentially irreplaceable;
- Use – the linkage includes entire assemblages and/or threatened species;

- Scale – the linkage maintains the integrity of ecological processes and biological communities at the biogeographic scale and is therefore of national or international significance;
- Condition – the linkage comprises natural vegetation of moderate/late maturity and has a high area to boundary ratio; and,
- Longevity – the linkage is legally protected against future clearing or disturbance.

A simpler measure of connectivity could be a rating of the naturalness of adjacent land uses, based on a buffer area radiating 50km from the park boundaries.

International Recognition

The designation of an area under international environmental agreements is a clear indication of significance (Hockings et al., 2000; Thomas & Middleton, 2003). The global designations granted on the basis of biological and/or geological significance that are of relevance to this research include:

- UNESCO World Heritage site (natural as opposed to cultural sites);
- Ramsar wetlands of international importance;
- Important Bird Areas and Endemic Bird Areas according to the global assessments undertaken by BirdLife International;
- WWF Global 200 Eco-regions; and,
- Transboundary protected area arrangements with neighbouring countries, where an area of land and/or sea dedicated to the protection and maintenance of biological diversity straddles one or more borders between countries and the area is managed cooperatively through legal or other effective means (Sandwith, Shine, Hamilton, & Sheppard, 2001).

Other designations relevant to some countries include the ASEAN Heritage sites (Europe), Natura 2000 sites (under the European Union's Birds and Habitats

Directives), and the South Pacific Regional Environment Programme. Some designations – such as Natura 2000 – are precise about management requirements, while others are discretionary (Thomas & Middleton, 2003).

3.1.2 ECOSYSTEM LEVEL/REPRESENTATIVENESS

The Convention on Biological Diversity defines an ecosystem as "a dynamic complex of plant, animal, and micro-organism communities and their non-living environment interacting as a functional unit" (Convention on Biological Diversity, 1993, p. 146). The ecosystem-level significance of a protected area is concerned with the representation of important ecological assemblages (Norton & Roper-Lindsay, 2004). Globally significant sites often include unique ecosystems and/or ecosystems for which the country holds a significant part of the world total (Hockings et al., 2000).

Protected areas should promote the long-term survival of biodiversity by maintaining natural processes and viable populations (Margules & Pressey, 2000). Ideally, a country's protected area system will adequately support the persistence and continued evolution of all the natural features contained within it (Groom et al., 2006). Representativeness is a long established goal in systematic conservation planning. A representative reserve system will sample the range of natural variation in a region to a targeted level. Natural features may be vegetation types, animal species, and geomorphologic types (Margules & Pressey, 2000; Pressey, 1996; Worboys & Winkler, 2006b). Ideally, the samples of a biodiversity feature in a protected area are representative of that feature. That is, a habitat sample should cover the range of variation within that habitat (Groom et al., 2006).

The irreplaceability of a natural feature is a function of its typicalness, rarity, and fragility. Some areas are irreplaceable, meaning that no alternatives exist to represent one or more species. If an area contains only common and widespread species found in many other protected areas it has a low irreplaceability value. In contrast, if the area has attributes found nowhere else it will have an irreplaceability value of 100%. The higher the irreplaceability, the more essential the protection of that ecosystem. In comparison, an area with low irreplaceability can be substituted by other sites (Ferrier, Pressey, & Barrett, 2000; Groom et al., 2006; Pressey, Humphries, Margules, Vane-Wright, & Williams, 1993; Pressey, Johnson, & Wilson, 1994). These areas are ‘flexible’ because the species and habitats they protect may be represented by an alternative area or combinations of alternative areas (Williams, Moore, Toham, Brooks, Strand et al., 2003).

Areas with high irreplaceability include fragile and late-successional habitats which are hard to replace once damaged. Fragile habitats tend to be those where the productivity of terrestrial plants is low. This is the case in montane, polar and tundra habitats, upland bogs, and caves because low temperatures restrict vegetative growth (Hambler, 2004). Landscape features like mountains, canyons, lakes, waterfalls and rock formations are attributes that draw visitors to a protected area. These abiotic features influence the aesthetic, cultural, and biotic elements of a protected area (De Lacy, Chapman, Whitmore, & Worboys, 2006). The aesthetic and cultural elements are discussed in the section on social criteria. Geomorphological features are important components of ecosystems and, according to the IUCN Guidelines, national parks “… should contain a representative sample of major natural regions, features or scenery …” (IUCN-WCMC, 1994, p. 4).

Jope and Dunstan (1996) describe ecosystems as ‘medium number systems’, meaning that they are complex systems of unlike components that have structured interrelationships. Because they are not static and have too few parts to reliably average, yet too many parts to devise an equation for each relationship both mechanical and statistical approaches are inadequate (Halvorson, 1996). Rather, ecosystem or habitat types can be identified and mapped by grouping like components together. All such classifications are arbitrary because decisions about where to locate boundaries between classes are subjective. Clear-cut dividing lines between biological communities are rare, scale selection may mean that small communities will be too small to be mapped, the components of many biological communities vary over time and decisions need to be made regarding how much change is acceptable in the definition of each community (Clarke & Bell, 1986).

There are global classification systems for habitat types such as the Udvardy system, which is based primarily on vegetation type, followed by the presence of fauna and the distribution of flowering plants. It is a coarse-scale classification dividing the world into eight realms (continent-sized units), 227 provinces or subdivisions of realms, and 14 biomes that reflect major vegetation types (Dearden & Rollins, 1993). More detailed continental, national, and regional scale classifications are available in some countries. The Land Environments of New Zealand (LENZ) classification divides New Zealand into 20 national-scale environments and 500 regional/district-scale environments. These are based on 15 climate, landform and soil variables using multivariate classification techniques in a geographic information system (Leathwick, Wilson, Rutledge, Wardle, Morgan et al., 2003).

The ecosystems considered most irreplaceable are those poorly represented in the current park system. Ecosystem representation can be calculated using a biogeographical classification at an appropriate scale based on satellite imagery, aerial photography, ecological survey, and 'gap' analysis using geographic information systems (GIS). This involves digital maps of vegetation types, species distribution, land ownership, and land management status that are overlaid in a GIS. The resulting maps are then analysed to identify animal species and vegetation types that are under-represented in the existing protected area network. Gap analysis can be undertaken rapidly in considerable detail from recent data (Norton & Roper-Lindsay, 2004; Rodrigues, Andelman, Bakarr, Boitani, Brooks et al., 2003; Vreugdenhil et al., 2003; Wright & Scott, 1996). Similarly, a 'complementarity' analysis can be undertaken to determine the extent to which reserves complement one another in the features they contain (Pressey, 1996; Pressey et al., 1993; Williams et al., 2003). This involves an iterative procedure to determine the most efficient (minimal) set of sites that represent all of the natural features of a region (Pressey et al., 1993).

It is problematic defining thresholds for what constitutes adequate representation (Clarke & Bell, 1986; Pressey, 1996). In particular, information is incomplete regarding the full set of species or of ecosystem interactions, raising questions about how to incorporate the precautionary principle in determining the most efficient (minimal) set of sites. Representation percentages should be determined based on the characteristics of particular ecological districts in the country being assessed. Some communities may require 100% protection while adequate conservation of other communities may require much smaller areas (Clarke & Bell, 1986). Two guidelines are reliable in all cases: more replicates of natural features are better than less, and larger proportions of species ranges are better than smaller ones (Pressey, 1996). For habitats on the African continent Cumming and Jackson (1984) and Clarke and Bell (1986) suggest that at least five examples of the same community type should be protected in three countries. In comparison, Norton and Roper-Lindsay (2004) suggest that any ecosystem that has been reduced to less than 10-20% of its original extent in New Zealand should be carefully considered under-represented.

Representativeness can be expressed on a descriptive scale, where parks with high representativeness values are those containing ecosystems that are poorly represented within the country's national park network.

3.1.3 SPECIES LEVEL/RARITY AND DISTINCTIVENESS

The basic unit of biodiversity is the species (Heywood, Baste, & Gardner, 1996). A species is a group of organisms formally recognised as taxonomically distinct from other groups. Distinguishing features are a combination of physical and biological characteristics. Individuals belonging to a species normally breed only with one another. Species also have specific habitat requirements and every species has a peculiar geographical distribution (Earthwatch Europe et al., 2002).

For prioritisation exercises, species are usually assessed in terms of their rarity and/or distinctiveness. Rare species are those that are uncommon at a specific spatial scale. Distinctive species include unusual, vulnerable, uncommon, or functional species at a site (Norton & Roper-Lindsay, 2004). Species diversity and richness are also commonly used to determine the biological importance of a site (Perlman & Andelson, 1997).

Presence

Conservationists often measure the success of an area by listing how many species are present (Molnar, Marvier, & Kareiva, 2004). Species can be divided into taxonomic categories, such as bacteria, fungi, molluscs, crustaceans, insects, plants, reptiles, amphibians, birds, fish, and mammals. Approximately 1.7 million species have been discovered and described, but the total number of species thought to exist is much greater (Earthwatch Europe et al., 2002).

It is easier to list the plants located at a site that it is to list the animals present there. Plant communities are dynamic, but aside from planktonic forms, plants do not move. Rather, the challenges of flora sampling are presented by different forms during the life-cycle and the consequent identification difficulties. Many plants, namely annuals, are short-lived and are only available for sampling during part of the year. Others will be present at a site and later die out. Some plants are hard to identify unless they are in flower and others can only be identified through tasting the bark or acquiring fruit or flowers from the canopy (Hambler, 2004).

Invertebrates are of great importance in ecosystems, but due to sampling difficulties they have been relatively neglected in conservation. Invertebrates are particularly challenging to survey because they are numerous, species-rich, small, highly seasonal and hard to identify. Many invertebrates can only be identified under a microscope and therefore most sampling methods are destructive, requiring a sample to be killed. The sampling methods for micro-organisms involve molecular probes and are in their infancy. (Hambler, 2004).

Vertebrate fauna may be highly mobile and migratory, meaning that the density will vary throughout the year. Larger animals are typically surveyed without capture. Individuals may be observed directly in the day or via spotlight for nocturnal species. Indirect techniques include the analysis of scats and observation of animal signs, tracks, and diggings. Selected field survey techniques for identifying the presence of animals are given in Table 3.5 below. The techniques described are more invasive for smaller animals, which usually must be caught to be identified.

For some areas there is extensive data available about some species. This might include information about species composition, diversity, distribution, habitat, and vulnerability, or it may be time-series data, tracking the effects of factors such as climate change (De Lacy et al., 2006). Information on the presence or absence of species is virtually always incomplete and assumptions are often made about species distribution as a result. For example, species thought to have a greater than 50% chance of being located at a site are often assumed to be present, while those with a less than 50% chance are considered absent (Polasky, Camm, Solow, Csuti, White et al., 2000). Conservation practitioners may use population estimates of key species as 'indicator' species to indicate changes in some of the less well known species groups (Ferrier et al., 2000; Hambler, 2004; Hockings et al., 2000; Moore, Balmford, Brooks, Burgess, Hansen et al., 2003).

Table 3.5

Selected Field Survey Techniques for Fauna Inventory

Fauna field survey technique	Notes
Direct identification: observation and listening	Bird, frog, and some mammal species have distinguishing calls or sounds from which they can be identified. Standard fauna inventory forms have been produced by many organisations to facilitate the recording of observations
Observation: fauna tracks and diggings	While often difficult to discern, signs of fauna, such as footprints and scratchings, are an invaluable aid to fauna observers and researchers
Collection and analysis of fauna scats	Predator scats can be valuable for rapid inventory of native fauna populations. Researchers have found that the scats from such animals are often deposited close to a food source. After *carefully* collecting the scat (given the chance of contracting a disease such as *hydatids*), it can be dried and analysed for hair and bone content. Scats from native animals themselves are important inventory diagnostics.
Collection and analysis of bird pellets	Some birds regurgitate bone, feather, fur and other fragments of their meals that they are not able to digest. Owl pellets, for example, contain a small mammal bones in stratified deposits at some cave sites. They have provided valuable contemporary and historical records of small mammal populations used as prey by the birds.
Fauna signs in their habitat	Animal runways in heath and native grasslands, burrows, nesting hollows, incisions in trees that mark nesting sites, claw marks on trees, and damage to trees and shrubs from animal feeding are all signs that indicate the presence of fauna.
Trapping and collection of insects	Water traps, flight interception traps, light traps, and bait traps are methods used for collecting insects.
Spotlighting	Many species are only active during the night. The use of a portable light will reflect the retina colour of animals' eyes. The colour, shape, and size will help in identifying species.
Call playback	Many animals have distinctive calls, and when these are recorded and played back through a loud speaker, species can be prompted to respond.

Fauna field survey technique	Notes
Use of pit-traps	This is a technique used by zoologists to capture small mammals, reptiles, and invertebrates. Use is made of a barrier and a small container that is sunk into the ground. Animals are directed to the container by the barrier and are captured in the pit as they try to pass through the 'opening' in the barrier.
Reptile searches	This technique is usually undertaken for a small area during the middle of the day. Favoured habitats for these species (under logs and rocks, in leaf litter, in hollows and so on) are searched.
Use of hair tubes	A hair tube is a length of plastic pipe (about 90mm in diameter for small species) that has a bait sealed at one end and double-sided sticky tape on the side of the pipe. When feeding, the small mammal leaves some hair on the tape, which is subsequently analysed to determine the species.
Use of small mammal traps	Collapsible aluminium traps (Elliot traps), which capture their specimens live using a bait, pressure pad and spring rear-door trap, are a common tool of scientists undertaking fauna inventories. Typically, specimens are captured, identified, weighed, measured, and released on site. Larger live traps (cage traps) are used for the capture of larger species.
Use of nets, including harp nets and 'fish' nets	Harp nets (vertical filaments of nylon organised to form a barrier to bats) are generally placed on bat flight paths. They are designed to minimise their detection from bat sonar signals and to minimize any impact on the bats. Nets are commonly used for the capture of birds.
Use of specialised traps	Large traps are often used for the capture of bigger animals, such as salt-water crocodile (*Crocodylus porosus*) of northern Australia. This technique is used when a 'problem' animal needs to be relocated.
Aerial monitoring	Aerial methods of monitoring fauna and their environment offer distinct advantages when dealing with remote areas or areas that are otherwise inaccessible, such as major waterways or other water bodies to count waterfowl and eagles. Even relatively small fauna may be indirectly monitored in this way, for example, beaver dams. Analysis of aerial surveys may be facilitated using computer programmes.
Global positioning systems (GPS) and geographic information systems (GIS)	GPS and GIS permit efficient and accurate collection of spatial data, while combining and comparing time-sequential maps and satellite imagery for estimating, for example, global change and environmental degradation. GIS are also ideal for comparing flora or fauna species diversity with variables in their habitats in order to help manage conservation areas. Conversely, habitats can be identified with overlay analysis, producing maps of where field teams might locate rare or endangered species of plants and animals.

Source: Adapted from Kirkpatrick and Kiernan (2006) and Worboys, Lockwood and De Lacy (2005)

A good indicator species must be easy to sample, easy to identify, and be responsive to changes in habitat conditions. Using indicators is a shortcut which carries the risk that important features will be overlooked. It is unreasonable to expect a single group to provide a complete picture (Hambler, 2004). It can be problematic selecting the most appropriate indicator species and in some cases attributes like the demographic parameters of species populations may be more useful than the indicators themselves (Noss, 1999). Birds are the most widely employed terrestrial indicator group because they are well known biologically due to their popularity with observers, and many of them are specialist species. In addition, the taxonomy of birds is relatively stable and it is believed that most of the world's bird species have been discovered (Hambler, 2004).

Moore et al. (2003) investigated six major taxonomic groups to see how well they performed as indicators for continent-scale conservation for 3882 vertebrates in sub-Saharan Africa. The indicator groups used were birds, mammals, amphibians, snakes, threatened birds, and threatened mammals. The study concluded that indicator groups provide a pragmatic approach for the immediate assessment of priorities for conservation at a continental scale. The representation of non-indicator taxa was encouragingly high and much greater than if areas were chosen at random. However, complete and efficient representation will not be achieved through indicator groups alone. Representation at a large scale is likely to over estimate the representation of species at smaller scales. Thus, rare and threatened taxa can only be guaranteed protection if they are explicitly incorporated into priority setting work.

Rarity

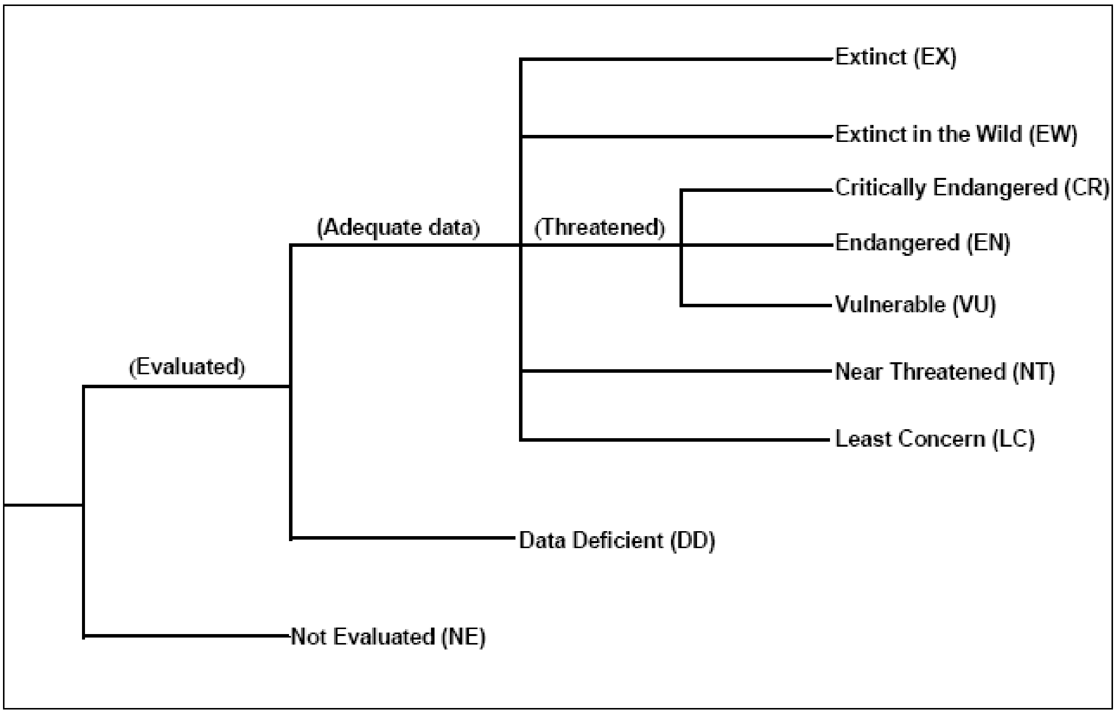
Rarity refers to the presence of species that are uncommon at a particular spatial scale (Norton & Roper-Lindsay, 2004). If a species is known to be vulnerable to global extinction it should be a prime candidate for conservation. Resources are often focussed on the protection of rare species because they are believed most likely to go extinct (Hartley & Kunin, 2003). Hambler (2004) advocates prioritising species on the basis of threat to the global population. Unfortunately, some conservation practitioners display ‘parochial’ behaviour when assessing species priority, meaning they favour species rare to their own region or country. This attitude may be counterproductive to global conservation efforts because it leaves fewer resources for the species that are globally rare. It must also be noted that many species are naturally rare and are not threatened. Conservationists are concerned if a species is rare because of human activities and if it is getting rarer (Hambler, 2004).

The degree of threat faced by a species can be calculated based on the 'viability' of its populations. A species is viable if it has a self-maintaining population of healthy individuals. Many animals and plant species have difficulty breeding successfully once the population falls below a certain number or density. Population Viability Analysis (PVA) uses mathematical models to predict the Minimum Viable Population (MVP) for a population found within a defined area. The MVP gives the probability of the population's survival in successive generations based on genetic considerations (Hambler, 2004; Ralls, Beissinger, & Cochrane, 2002; Soulé & Simberloff, 1986). Both extrinsic and intrinsic forces act on small populations to make them extinct. Extrinsic forces include deleterious interactions with other species like increases in predation, competition, parasitism, disease; decreases in mutualistic interactions; deleterious events; and changes in habitat. Intrinsic factors relate to random variations in genetically based traits of the species and interactions of the traits with the environment. These are outlined by Soule and Simberloff (1986) and include: demographic stochasticity, the random variations in the sex ratio, and birth and death rates; social dysfunction or behaviour that prevents small populations from adapting to their environment; and, the genetic deterioration effects of inbreeding and genetic drift.

There is no single process that constitutes PVA, but all approaches are concerned with a population's risk of extinction (or quasi extinction) or its projected population growth under current conditions or those expected from proposed management (Reed, Mills, Dunning, Menges, McLelvey et al., 2002). These models might interpret past population trends, evaluate likely threats to a population, or project future population trends (Ralls et al.). The validly of PVA models is dependent on the appropriateness of the model's structure and data quality (Ellner, Fieberg, Ludwig, & Wilcox, 2002; Reed et al., 2002).

The IUCN Species Survival Commission produces The Red List of Threatened Species, which is the most comprehensive global survey of flora and fauna at risk. Red List species are categorised according to levels of threat, the five highest being Extinct (EX), Extinct in the Wild (EW), Critically Endangered (CR), Endangered (EN), and Vulnerable (VU), as shown in Figure 3.2 The Red List is published regularly in electronic form by the IUCN and BirdLife International (Earthwatch Europe et al., 2002; Hambler, 2004). The Red List threat status of a taxon is based on five criteria (1) population decline (past, present and/or projected); (2) changes in geographic range size; (3) fragmentation, decline, or fluctuations in population size; (4) population size and distribution; and, (5) PVA (quantitative analysis of extinction risk) (IUCN, 2001). Most quantitative measures of these concepts are sensitive to the scale at which they are made (Hartley & Kunin, 2003).

Figure 3.2
Red Data List Threat Categories



Source: IUCN (2001, p. 5)

The IUCN Red List Categories and Criteria were first published in 1994 following six years of research and broad consultation. In version 3.1, published in April 2005, the objectivity and transparency of the red list guidelines was improved by assessing the conservation status of species to improve consistency and understanding among users (IUCN, 2005c)

Some countries are producing their own Red Lists using different criteria. For example, there is a list of the birds in Britain that have lost at least 50% of their range in the last 20 years. Unlike the IUCN Red List, some lists have no official status, have not been reviewed by experts, and may be misleading or distracting (Hambler, 2004).

In principle, all species should be saved. However, consciously choosing to let certain species become extinct may be an increasingly realistic alternative. Where the costs of saving some species far outweigh the perceived benefits, resources may be better invested elsewhere (Doerksen, Leff, & Simon, 1998; Myers, 1983).

Distinctiveness

Distinctive and focal species provide a focus for conservation managers because they are deemed to be 'important' (Hambler, 2004). Distinctiveness assessment is usually based on good understanding of the distribution of species and habitats. Distinctive species include those that are globally and nationally rare, those present at a national distributional limit, those entirely dependent on a single area for survival (endemic species), and those that are common elsewhere, but particularly uncommon in the target area (Norton & Roper-Lindsay, 2004). Focal species are organisms that play important ecological roles or are of particular interest to humans. These include taxa with special legal status; endemic taxa; keystone taxa, that dominate or control ecosystems; taxa that are exceptionally common; and, flagship species that have general public support (Halvorson, 1996). Some focal species characteristics used to prioritise conservation management decisions are outlined in Table 3.6 .

A globally significant site is likely to be home to endemic threatened species and globally threatened species for which the country holds a significant part of the world population. Sites that are nationally significant are likely to include nationally threatened populations of species that are not globally threatened, endemics that are not threatened, and/or species-rich ecosystems (Hockings et al., 2000). It is possible to experience overlap between the focal species categories presented in Table 3.6. For example, flagship species are often threatened, k-selected, slow to mature, and may also be sensitive, migratory, top carnivores, living fossils, social, dispersal-limited, or any other any other type of focal species.

Table 3.6
Characteristics of Selected Focal Species

Species Characteristic	Reason	Example
Area-limited	Species that need large patch sizes to maintain viable populations because they have a large home range and/or low population density (Beazley & Cardinal, 2004; Lambeck, 1997; Noss, 1999).	Blanding's turtle (*Emydoidea blandingi*) in Nova Scotia (Beazley & Cardinal, 2004)
Dispersal-limited	Species with limited ability to move between habitat patches, or that face a high mortality risk attempting to do so (Beazley & Cardinal, 2004; Lambeck, 1997; Noss, 1999).	Lake trout (*Salvelinus namaycush*) in Nova Scotia (Beazley & Cardinal, 2004)
Dominant	Species present in high abundance that influence numerous other species and ecosystem services (Hambler, 2004; Kunte, 2008)	Nectar-feeding butterflies (*Anartia fatima* and *Anartia jatrophae*) in Corcovado National Park, Costa Rica (Kunte, 2008)
Endemic	Restricted-range species found in a particular geographic area only (Cavieres, Arroyo, Posadas, Marticorena, Matthei et al., 2002; Hambler, 2004; Stattersfield, Crosby, Long, & Wege, 1998).	The ground woodpecker (*Geocolaptes olivaceus*) in South Africa (Bonn, Rodrigues, & Gaston, 2002)
Flagship	Charismatic species that can be used to build public interest in an area or to raise funds for a habitat (Hambler, 2004).	The logo for WWF is the Giant panda (*Ailuropoda melanoleuca*)
High habitat specificity	Species requiring increasingly rare habitats to survive (Hambler, 2004).	*Saproxylic* beetle species only live in dead wood (Schiegg, 2000)
High natural mortality	Species that are easily overexploited regardless of reproductive rate (Hambler, 2004).	The green turtle (*Chelonia mydas)* (Bowen, Meylan, Ross, Limpus, Balazs et al., 1992).
High utility	Species that are charismatic, attractive, or have another high use value (Hambler, 2004).	The African elephant (*Loxodonta africana).*
Threatened	Species with low populations considered at risk of extinction (Hambler, 2004).	The African wild dog (*Lycaon pictus*) is 'endangered' according to the IUCN Red List (Woodroffe & Ginsberg).
K-selected	Species with long life spans, low reproduction rates, and long time periods between generations (Doerksen et al., 1998)	The scalloped hammerhead, (*Sphyrna lewini*) (Klimley, Allen, Israel, & Kelly, 2006).
Keystone	Species that have a large impact on a community or ecosystem that is disproportionately large for their abundance or biomass (Hambler, 2004; Noss, 1999).	The southern ground hornbill (*Bucorvus leadbeateri*) in Africa (Trail, 2007).

Species Characteristic	Reason	Example
'Living fossils'	These species are of evolutionary and genetic interest (Hambler, 2004).	The tuatara (*Sphenodon punctatus*) found only in New Zealand (Hay, Subramanian, Millar, Mohandesan, & Lambert, 2008).
Migratory	Species that require networks of reserves and landscape linkages (Hambler, 2004). Some migratory species are protected under the Convention on Migratory Species (Bonn Convention).	The elk (*Cervus elaphus*) (Hebblewhite & Merrill, 2007).
Process limited	Species threatened by direct exploitation or harassment, or sensitive to the timing of ecological process such as flooding, fire, grazing, competition with exotics, or predation (Beazley & Cardinal, 2004; Lambeck, 1997; Noss, 1999).	The American moose (*Alces alces americana*) in Nova Scotia (Beazley & Cardinal, 2004).
Sensitive	Species that are easily disturbed, leading to low reproduction (Hambler, 2004).	The Eurasian bittern (*Botaurus stellaris*) (Puglisi, Adamo, & Baldaccini, 2005).
Slow maturation	Species with high risk of mortality before reaching reproducing age (Hambler, 2004).	The Australian grey nurse shark (*Carcharias taurus*) (Otway, Bradshaw, & Harcourt, 2004).
Social	Species at risk of the Allee effect (below a threshold density a population is no longer viable) (Hambler, 2004).	The Ethiopian wolf (*Canis simensis*) (Stephens & Sutherland, 1999).
Top carnivore	Often lost quickly from disturbed and managed ecosystems (Hambler, 2004).	The predatory sun star (*Heliaster kubiniji*) in the Gulf of California (Dungan, 1982).
Umbrella	An animal species with a large home range, usually large mammalian carnivores, herbivores, or birds (Roberge & Angelstam, 2004). The conservation of an umbrella species is expected to confer protection to a large number of naturally co-occurring species that need smaller areas and occur at higher densities (Hambler, 2004).	The grizzly bear (*Ursus arctos*) in the Rocky Mountains, North America (Noss, Quigley, Hornocker, Merrill, & Paquet, 1996).

Richness and Diversity

Measures of biological diversity have two components, the number of entities (individuals, species, or habitats) and the degree of difference or dissimilarity between those entities (the diversity) (The Business and Biodiversity Resource Centre, 2007). The iconic measure of biological diversity is species richness, which is the number of species of a given taxon in the chosen assemblage (Hambler, 2004; Magurran, 2002). Diversity is the variability of life within a defined area, which can be measured using a diversity index such as the Simpson or

Shannon Indices (Hambler, 2004; Whittaker, 1972). Ecologists also use measures of alpha, beta, and gamma diversity, where alpha diversity is the species richness at a site; beta diversity is the rate at which species replace one another between sites, based on comparison of the number of taxa that are unique to each site; and, gamma diversity is the overall diversity at a regional scale over multiple ecosystems (Spector, 2002).

Species richness is a relatively practical measure because different field workers will provide similar estimates of species numbers. It has wide application because the species-level is commonly seen as the unit of practical management, of legislation and political discourse. Species richness can also act as a surrogate measure for other kinds of variation in biodiversity because greater numbers of species are assumed to represent greater genetic diversity (in the form of a greater diversity of genes through to populations), more species diversity, and greater ecological diversity. However, species richness is a one-dimensional measure of biological diversity because it does not differentiate between assemblages with closely related species and those with more distantly related species (The Business and Biodiversity Resource Centre, 2007). It is also dependent on a high sampling intensity (Hambler, 2004). The richness per unit area is probably more informative than the total richness, because a large site generally supports more species and more habitats than small sites (Hambler, 2004). Species richness is similar to species presence.

Diversity measurement is based on three assumptions: that all species are equal, that all individuals are equal, and that species abundance has been recorded using appropriate units (Hambler, 2004; Magurran, 2002). The Simpson Index (Simpson, 1949) represents the probability that two randomly selected individuals in a habitat belong to the same species (see Equation 3.1). A high diversity index score suggests a stable site with high diversity, while a low diversity index score suggests low diversity. The Simpson Index is usually used in vegetation studies but can also be applied to animals. Results can be misleading for areas with low diversity (Brock & Xepapadeas, 2003; Groom et al., 2006).

Equation 3.1
The Simpson Index

$$D = \frac{\sum_{i=1}^{S} n_i(n_i - 1)}{N(N-1)}$$

Where:
D = Simpson's diversity index
S = number of species (species richness)
N = total percentage cover or total number of organisms
n = percentage cover of a species or number of organisms of a species

Source: Adapted from Bock and Xepapadeas (2003)

The Shannon Index (Shannon, 1948) provides a measure of the number of species present and the evenness of those species using categorical data (see Equation 3.2). It is similar to the Simpson Index in that a higher result indicates higher species diversity. The index is increased either by having additional unique species, or by having increased 'species evenness', the relative abundance or proportion of individuals among the species. This is the most widely used diversity index (Brock & Xepapadeas, 2003; Groom et al., 2006).

Equation 3.2
The Shannon Index

$$H = -\sum_{i=1}^{S} p_i \log p_i$$

Where:
H = Shannon's diversity index
S = number of species (species richness)
pi = relative abundance of each species (the fraction of individuals belonging to the i-th species)

Source: Adapted from Bock and Xepapadeas (2003)

It is difficult to map the distribution of flora and fauna in highly heterogeneous regions and all biological databases are likely to be incomplete. This means that physical habitats are a more practical coarse filter (Noss, 1996). Measures of diversity are criticised for being based on inventories stripped away of detail leaving only a single, dimensionless number behind. As a result, many conservation decision-makers are moving away from this concept in identifying areas for biodiversity protection (Perlman & Andelson, 1997).

Spector (2002) suggests targeting the areas where biogeographic assemblages intersect. These areas are known as biogeographic crossroads and present opportunities to achieve significant economy of effort. These intersections create regions of rapid turnover or a high beta diversity of species and habitats. This leads to exceptionally high species richness. These areas may also be important for evolutionary processes such as speciation and co-evolution. However, species at the edge of their ranges tend to be more fragmented, more variable, and more extinction-prone. This may mean that conserving species at the edges of the ranges may focus efforts on populations where persistence is uncertain. It is also not clear how large biogeographic crossroad areas need to be to function.

High diversity is one of the most popular reasons for conserving an area. However, it can be difficult to measure and misleading because sites that are diverse are not always important to conservation and vice versa (Hambler, 2004; Tisdell, 2002). For example, introducing exotic species to an area increases the species richness. Similarly, disturbance such as cutting a road often increases species richness and habitat diversity. Conversely, sites with relatively low species/habitat diversity can be significant for other reasons like naturalness, uniqueness, or the provision of ecosystem services. Such areas include the Antarctic, mangrove forests, reed beds, and deserts. Species quality is often more important than species or habitat diversity, although a diversity of high-quality species is generally desirable (Hambler, 2004). Furthermore, diversity measures are reliant on high sampling intensity and accurate data regarding the species present in an area. Such information is not always available.

3.1.4 GENETIC LEVEL

The Convention on Biological Diversity defines genetic material as “any material of plant, animal, or microbial or other origin containing functional units of heredity” (Convention on Biological Diversity, 1993, p. 146). Authors like Norton and Roper-Lindsay (2004) mention this level of organisation, but do not propose any criteria for assessing the genetic significance of an area. The most robust method for measuring genetic diversity is the analysis of the genetic code. Indirect methods are based on analysis of the physical features of taxa, assuming that these are genetic (The Business and Biodiversity Resource Centre, 2007). Not only is there little genetic data in existence to include in a national park-scale analysis, but there is considerable debate about meaningful measures at the genetic level, such as whether to conserve the evolutionary novelty revealed by adaptive process or evolutionary potential expressed by neutral genetic divergence (Diniz-Filho, 2004; Doerksen et al., 1998). It is not currently feasible to include the genetic level in decision-making, though this may change in the future.

The natural heritage criteria that have potential for use in the proposed model are summarised in Table 3.7.

Table 3.7

Summary of Potential Natural Heritage Criteria for Comparing National Parks

Level	Attribute	Potential Criteria	Information Source	Measurement and Units
Landscape	**Size**	The area of the park where a larger size is better.	Standard maps or satellite imagery in a GIS	Hectares (ha) or square kilometres (km^2) converted to a descriptive measure (e.g., 'Large' = 100,000-1,000,000 ha).
	Shape	Parks with irregular and elongated shapes (low area to perimeter ratios) are more susceptible to edge effects, so a circular-shaped park is best.	Standard maps or satellite imagery in a GIS	The boundary length is dived by the circumference of a circle of the same total area as the park. Values approaching the number one are best.
	Habitat continuity	The degree of structural connectivity of the landscape, facilitating the movement of organisms, where more natural land uses provide greater connectivity and greater connectivity is best.	Standard maps or satellite imagery in a GIS to identify corridors and stepping stones, and the type of land use adjacent to the park within a 50km radius from the boundary.	Landscape linkages are rated in terms of the irreplaceability, use, scale, condition and longevity, combined into a descriptive quality score. Alternatively, the naturalness of adjacent land uses could be rated, based on a buffer area radiating 50km from the park boundaries, and combined into a descriptive quality score.
	International recognition	If an area has been designated under an international environmental agreement due to its natural heritage importance, it has greater worth than areas that do not have international designations.	All or part of the area has been designated one or more of the following: World Heritage Site, wetland of international importance, important bird area or endemic bird area, global 200 eco-region, or a transboundary protected area. Other regional agreements may also apply.	The number of designations. Listed in relevant websites and reports.

Level	Attribute	Potential Criteria	Information Source	Measurement and Units
Ecosystem	**Representativeness**	The ecosystems represented in the park, where the more irreplaceable ecosystems are best.	Representation is calculated using a biogeographic classification at an appropriate scale based on satellite imagery, aerial photography, ecological survey, and gap analysis in a GIS. Areas found in no other national park will have an irreplaceability value of 100%.	Irreplaceability values for different biogeographic areas represented in a national park combined as weighted sums.
Species	**Presence**	Greater number of species present is best.	Species counts based on field measurements to-date. Alternatively, indicator species used to estimate the number of species present.	Number or conversion to descriptive categories.
	Rarity	The presence of rare species, in order of descending importance: globally rare; nationally rare; endemic species; species at a national distributional limit; and, although common elsewhere, particularly uncommon in the park.	Globally rarity according to the IUCN Red List. National rarity according to the country's national threat classification system. Endemic species, species at a national distributional limit, and species common elsewhere but particularly uncommon in the park based on knowledge of the distribution of species from books, reports, or expert opinion.	Number of species in each threat category, potentially converted to descriptive categories.
	Distinctiveness	The presence of focal species, where more focal species is best.	Based on information about species presence and the biology of the species from books, reports, or expert opinion, using a pre-determined list of species characteristics.	The number of focal species present in the park.
	Richness	Species abundance or alpha diversity, where greater abundance is best.	See species presence.	See species presence.
	Diversity	Beta diversity or the dissimilarity between species, where greater diversity is best.	Data intensive, the number of species present, total number of organisms of each species from field measurements.	Simpson Index or Shannon Index, where a higher value is best.
Genetic	**-**	-	-	-

3.2 ECONOMIC VALUE CRITERIA

The income generated from tourism provides economic justification for conservation (Green, 1992). National parks have the capacity to generate direct income from tourists or concessionaires. This is countered by the capital and maintenance costs associated with park management. The benefits and costs from tourism also influence regional and national economies (Page, Brunt, Busby, & Connell, 2001; WCPA-IUCN, 2000). Further, protected area systems generate marked economic benefits from ecosystem services, which underpin human economies and well-being (Balmford, Bruner, Cooper, Costanza, Farber et al., 2002; Dixon & Sherman, 1990,1991; Edwards & Abivardi, 1998; Munasinghe, 1994; Pearce, 1994; WCPA-IUCN, 1998).

3.2.1 ECONOMIC BENEFITS

The economic importance of a protected area is based on its combined market and non-market values. Its financial value is calculated from the perspective of the protected area as a business and is a subset of its economic value. Financial value is concerned with the balance of payments for the park, meaning revenue from commercial activities like tourism minus management costs. Economic value is calculated from the point of view of society and includes the financial value, regional economic growth, and contributions to net federal economic development (Dixon & Sherman, 1990; WCPA-IUCN, 1998). Protected areas provide benefits to different customers. These include neighbours and residents, commercial visitors (including tourists), regional customers, and global customers (WCPA-IUCN, 2000). This means that the economic benefits associated with a protected area are felt beyond the borders of the park, and even beyond the region or country in which the park is located.

The economic criteria that could be used in the proposed model are summarised in Table 3.9 at the end of this section.

Financial Benefits

Financial benefits are described by the WCPA-IUCN (2000) as ‘site-level mechanisms’ for funding protected areas. These include user fees, donations, and cause-related revenue (WCPA-IUCN, 2000). The financial accounting system of a protected area should involve the collection, recording, analysis, and presentation of income and expenditure data. This should include standard accounting practices such as inventories, reconciliations, balance sheets, and profit-and-loss reports (De Lacy et al., 2006).

User Fees

Use values such as recreation and tourism are primary objectives in national parks, and the provision of these services results in direct financial benefits (Dharmaratne, Sang, & Walling, 2000; Dixon & Sherman, 1991). User fees cover a broad spectrum of revenue possibilities, such as entry fees, fees for the use of facilities, fees charged to concessionaires who generate revenue through operating services in the park, and fees for permits (WCPA-IUCN, 2000).

Protected areas can provide recreational and aesthetic experiences satisfying subjective values which are traded for capital. Generally, this falls within the tourism industry in various forms (Murphee, 2004). Many national parks charge a fee for visitors to enter the site. However, admission fees for national parks are widely criticised for being decided upon arbitrarily, often below the market price (La Page, 1994; Mitchell & Carson, 1989). It is important that people of all ages, ethnic and cultural backgrounds have the opportunity to experience national parks meaning that if admission prices are charged or raised it must be well reasoned (Lovett, 1998).

Concessionaires pay for the right to provide facilities to visitors (WCPA-IUCN, 2000). For example, Ruapehu Alpine Lifts has a concession to provide skiing facilities on Mt Ruapehu in Tongariro National Park, New Zealand. Other facilities run by concessionaires may include accommodation, food and beverage conveniences, guiding, and equipment hire. Parts of a national park may also be leased to individuals or groups for a limited time period. Revenue could be generated by charging ‘publicity fees’ to corporations using the park as a location or backdrop for films, posters, or advertising. Fees can be charged for the installation and/or use of facilities like transmission towers, marine platforms, or research stations. Income may be earned by sales from book and gift/curio shops or through the provision of user pays services like guided hikes, lectures, museums, films, maps, guides, and equipment rental. Revenue may also be generated from fees for parking, camping and picnicking facilities, and yachting or cruise-ship visit permits (Page et al., 2001; WCPA-IUCN, 2000).

Donations

Donations to a park may be one-off or ongoing payments from corporations, individuals, or donor organisations. Corporations may be driven to donate by a sense of environmental responsibility, tax write-offs, or improved image. Individual charitable donations may also be made through a person's will or estate, or through insurance and annuities (WCPA-IUCN, 2000).

Cause-related Revenue

Cause-related revenue includes income from 'Friends of the Park' schemes, adoption programmes, sales of park-related books/curios, and special events. 'Friends' schemes involve the voluntary support of people that may not actually visit the protected area, usually arranged through a nature-NGO. Adoption programmes tend to focus on the sale of deeds to an acre/hectare of a protected area, involvement in special projects, or the adoption of a wild animal. Cause-related sales involve goods or services with the purchaser understanding that they have helped conservation by purchasing them. Examples of cause-related marketing include special events, sales, adoption schemes, and collection schemes (WCPA-IUCN, 2000).

Sales

Sometimes, flora and fauna may be sold to other parks or to zoos. This occurs in Africa where animals that are abundant in one park are sold to a park in the same or a neighbouring country where the species historically existed, but now is not present or exists in low numbers (David Cumming, personal communication, 10 September 2003).

Benefits to the Economy

Tourism is a demand-driven activity and is arguably the world's largest business (McKercher & du Cros, 2002). Tourists may pursue travel to satisfy personal wants, but destinations pursue tourism for economic benefits. Only a fraction of a tourist's money is spent on the attractions that draw the tourist to the region. The attraction – in the case of this research, the national park – entices the tourist to the region, but the benefits of a tourist's visit are accrued within the region and beyond (McKercher & du Cros, 2002). Tourism also stimulates employment and rural development in surrounding areas (Dixon & Sherman, 1991). Tourists spend money on transport, accommodation, food and drinks, tips, sightseeing and tour guides, and commissions to the travel industry (McKercher & du Cros, 2002). Other types of business that support and benefit from the travel and tourism industry include printers, publishers, wholesalers, utilities, administration, and computing and security firms (Page et al., 2001). Interestingly, Wescott (1994) found that tourism increased once the Grampians area was declared a national park, implying that the 'national park' label is important for drawing tourists to an area. These increases in tourism lead to increased economic activity in the surrounding area.

Balance of Payments

A country's balance of payments records all debit and credit transactions with foreign countries. Tourists act as 'invisible exports' and contribute to the balance of payments. For this reason, improving the balance of payments is probably the most significant justification governments use to promote tourism (Page et al., 2001).

Income and Gross Domestic Product

Tourism stimulates local economic activity and can lead to increases in gross domestic product (Page et al., 2001).

Employment

The provision of national parks initiates a wide spectrum of employment opportunities. Park staff include managers, bureaucrats, planners, rangers, and scientists. In areas that are popular with tourists the provision of supporting infrastructure stimulates employment (Murphee, 2004). According to Page et al. (2001), the types of employment created by tourism include:

- Direct – jobs that directly support tourism activity like hotels, guides, shuttle buses, equipment hire, and restaurants specific to a tourist destination;

- Indirect – jobs that are not a direct result of tourism activity, but are within the tourism supply sector; and,
- Induced – jobs created because local residents spend the money they earned from tourism.

Wildlife and nature-based tourism can become an important engine of economic growth and job creation in many developing countries. However, such industries are dependent upon adequately maintained roads and tourism infrastructure, the presence of wildlife, and effectively enforced laws against illegal logging, hunting, fishing, and settlement inside protected areas (Spergel, 2001). Not all jobs will necessarily go to the host community as employment is dependant on skills. If local people have little skill they will acquire the jobs requiring little skill that also tend to be menial, low paid and seasonal. The managerial jobs may go to well-qualified, experienced candidates that are often from other areas. Job creation is hard to measure, not least because tourism jobs can attract people from other sectors or those not normally part of the economic workforce (Page et al., 2001).

Cumming (2004) suggests the following indicators to measure the contribution of parks to local economies:

- The number of contracts awarded to local (that is on park borders or park neighbours) companies or bodies to provide services to the park (e.g. fence repairs, game drives, the number of people employed, jobs created);
- The area and extent of compatible land uses developed on land surrounding the park and into which animals from the park can disperse;
- The number of commercial lodges and other tourist facilities, which depend on the park for game viewing opportunities;
- The extent to which institutions are developed with local partners to involve them in wildlife conservation-based economic development, planning and resource management; and
- The number of jobs created and value added to local and national economies.

This list of indicators was developed with transitional southern African nations in mind. However, these criteria are applicable to most national parks worldwide.

Ecosystem Functions and Services

Ecosystems, and therefore national parks, provide essential services to humans known as 'ecosystem services' (Boumans, Costanza, Farley, Wilson, Portela et al., 2005; Costanza, 2000,2003; Costanza, d'Arge, deGroot, Farber, Grasso et al., 1997; Costanza & Folke, 1997; Curtis, 2004; de Groot, Wilson, & Boumans, 2002; Molnar et al., 2004; Pritchard, Folke, & Gunderson, 2000; Sutton & Costanza, 2002; Word Resources Institute, 1998). Ecosystem services include diverse and essential benefits including food and water, drought resistance, spiritual opportunities, the pollination of crops, and the cycling of minerals (Kareiva & Marvier, 2003; Spergel, 2001). In the past, these services were not recognised as having economic significance. However, it has become evident that human well-being is reliant on ecosystem services (Edwards & Abivardi, 1998). Ecosystem services challenge neoclassical market-based economics because they involve significant non-market values, meaning that it is often impossible to assign unambiguous property rights to them (Straton, 2005).

Ecosystem services are derived from natural structures and processes that perform ecosystem functions, which are divided by de Groot et al. (2002) into four primary categories: regulatory functions, habitat functions, production functions, and information functions. A clear conceptual framework and typology for describing and classifying ecosystem functions and services is presented in Table 3.8. This classification addresses the fullest possible range of 23 ecosystem functions that provide a much larger number of ecosystem services.

Regulatory functions relate to the capacity of ecosystems to regulate essential ecological processes and life-support systems through bio-geochemical cycles and other processes. These functions maintain ecosystem and biosphere health and provide services of direct benefit to humans, like clean air, water, and soil. Regulatory functions are essential to the proper functioning of all natural systems and should be part of every assessment of the economic benefits of protected areas (de Groot et al., 2002).

Table 3.8
Functions and Services of Natural and Semi-Natural Ecosystems

Ecosystem Functions		Ecosystem Processes and Components	Examples of Ecosystem Services
Regulatory functions: Maintenance of essential ecological processes and life support systems	**Gas regulation**	Role of ecosystems in bio-geochemical cycles (e.g. CO_2/O_2 balance, ozone layer)	UVB-protection by O_3 (preventing disease); maintenance of (good) air quality
	Climate regulation	Influence of land cover and biological mediated processes (e.g. DMS-production) on climate	Maintenance of a favourable climate including temperature, precipitation, and carbon sequestration (e.g. human habitation, health, cultivation)
	Disturbance prevention	Influence of ecosystem structure on dampening environmental disturbances	Storm protection (e.g. by coral reefs); flood prevention (e.g. by wetlands and forests)
	Water regulation	Role of land cover in regulating runoff and river discharge	Drainage and natural irrigation; medium for transport; timing and magnitude of runoff, flooding, aquifer recharge
	Water supply	Filtering, retention and storage of fresh water (e.g. in aquifers)	Provision of water for consumptive use (e.g. drinking, irrigation and industrial use)
	Soil retention	Role of vegetation root matrix and soil biota in soil retention	Maintenance of arable land; prevention of damage from erosion/siltation
	Soil formation	Weathering of rock, accumulation of organic matter	Maintenance of productivity on arable land; maintenance of natural productive soils
	Nutrient regulation	Role of biota in storage and re-cycling of nutrients (e.g. nitrates, phosphates, sulphates)	Maintenance of healthy soils and productive ecosystems
	Waste treatment	Role of vegetation and biota in removal or breakdown of xenic nutrients and compounds	Pollution control/detoxification; filtering of dust particles; abatement of noise pollution

Ecosystem Functions		Ecosystem Processes and Components	Examples of Ecosystem Services
	Pollination	Role of biota in movement of floral gametes	Pollination of wild plant species; pollination of crops
	Biological control	Population control through trophic-dynamic relations	Control of pests and diseases (including human pathogens); reduction of herbivory (crop damage)
Habitat functions: Providing habitat (suitable living space) for wild plant and animal species	**Refugium function**	Suitable living space for wild plants and animals	Maintenance of biological and genetic diversity (and thus the basis for most other functions); maintenance of commercially harvested species
	Nursery function	Suitable reproduction habitat	
Production functions: Provision of natural resources	**Food**	Conversion of solar energy into edible plants and animals	Hunting, gathering of fish, game, fruits, etc.; small-scale subsistence farming and aquaculture
	Raw materials	Conversion of solar energy into biomass for human construction and other uses	Building and manufacturing (e.g. lumber, skins); fuel and energy (e.g. fuel wood, organic matter); fodder and fertilizer (e.g. krill, leaves, litter)
	Genetic resources	Genetic material and evolution in wild plants and animals	Improve crop resistance to pathogens and pests; other applications (e.g. health care)
	Medicinal resources	Variety in (bio)chemical substances in, and other medicinal uses of, natural biota	Drugs and pharmaceuticals; chemical models and tools; test and essay organisms
	Ornamental resources	Variety of biota in natural ecosystems with (potential) ornamental use	Resources for fashion, handicraft, jewellery, pets, worship, decoration and souvenirs (e.g. furs, feathers, ivory, orchids, butterflies, aquarium fish, shells, etc)
Information functions: Providing opportunities for cognitive development	**Aesthetic information**	Attractive landscape features	Enjoyment of scenery (scenic roads, housing etc.)
	Recreation	Variety in landscapes with (potential) recreational uses	Travel to natural ecosystems for eco-tourism, outdoor sports etc.

Ecosystem Functions		Ecosystem Processes and Components	Examples of Ecosystem Services
	Cultural and artistic information	Variety in natural features with cultural and artistic value	Use of nature as motive in books, film, painting, folklore, national symbols, architecture, advertising etc.
	Spiritual and historic information	Variety in natural features with spiritual and historic value	Use of nature for religious or historic purposes (i.e. heritage value of natural ecosystems and features)
	Science and education	Variety in nature with scientific and educational value	Use of natural systems for school excursions etc; use of nature for scientific research

Source: Adapted from de Groot, Wilson, and Boumans (2002)

Habitat functions relate to the role of ecosystems in providing refuge and reproduction habitats to wild flora and fauna, thereby contributing to the *in situ* conservation of evolutionary processes, biological diversity, and genetic diversity. Along with regulation functions, habitat functions are essential to the maintenance of natural processes (de Groot et al., 2002).

Production functions relate to the benefits accruing from living biomass. Through photosynthesis and nutrient uptake autotrophs convert energy, carbon dioxide, water, and nutrients into carbohydrate structures which are used by secondary producers to create more biomass. This diversity provides goods for human consumption, ranging from food to energy resources and genetic material (de Groot et al., 2002).

Finally, information functions refer to the services that wilderness and natural areas play in the maintenance of human health through the provision of opportunities for reflection, spiritual enrichment, cognitive development, and recreation (de Groot et al., 2002). These functions overlap with those described in the section on social criteria (section 3.3).

The table only includes goods and services that can be used on a sustainable basis, excluding important non-renewable natural mineral resources like gold, iron, diamonds, and oil. In addition, energy sources that cannot be attributed to a particular ecosystem type, such as wind and solar-energy, have also been omitted.

Over the past few decades there has been increased interest regarding the valuation of ecosystem functions, goods, and services. Early references date back to the mid-1960s and 1970s, but widespread discussion regarding ecosystem services was initiated by Costanza et al.'s (1997) controversial essay. This article made a conservative estimate that the annual contribution of global ecosystem services is at least US$33 trillion dollars, more than three times greater than global GDP. While recognised as an important political document stimulating additional research and debate about ecosystem services, critics suggest that this estimate involved distorted price structures and double-counting. In addition, critics question whether it is reasonable to assume meaningful comparison with GDP (Toman, 1998).

The article has stimulated much debate and further valuation attempts (Boumans et al., 2005; Costanza, 2000,2003; Curtis, 2004; Pritchard et al., 2000), as well as Special Issues in the *Environmental Economics* Journal (issues 25 in 1998 and 41 in 2002). In a recent assessment Boumans et al. (2005) found the value of global ecosystem services to be about 4.5 times the value of Gross World Product in 2000. These values were estimated using economic valuation techniques (World Resources Institute, 2003).

Economic value relates to human well-being and changes in well-being are revealed by people's preferences (Pearce, 2006; Pritchard et al., 2000). For goods that are traded, preferences are revealed by the market value. For non-use or non-commercial goods, value is determined by calculating an individual's willingness to pay for the provision of the good, or willingness to accept compensation for loss of it. Techniques have been developed to reveal preferences and determine the dollar value of environmental elements (WCPA-IUCN, 1998). Valuation methods for measuring ecosystem services can be classified differently, but the primary distinction is between techniques that are based on observed behaviour and hypothetical behaviour. These can be divided into four categories: direct market valuation, indirect market valuation (observed), expressed preference methods, and benefit transfer (hypothetical) methods. Direct market valuation is based on market prices where goods are extracted from ecosystems and traded in functioning markets. Some regulation, information, and production function goods are exchanged in markets through trade. Indirect market valuation uses actual behaviour on a surrogate market to reveal preferences. Methods include hedonic pricing, were the price paid for a service is statistically broken down to the price of environmental attributes like clean air; the travel cost method, where demand functions are derived from the observed costs of travel to a recreational destination; and, cost-based methods, like the replacement cost method where environmental services are valued at the cost of replacing related infrastructure. Expressed preference methods use questions about hypothetical scenarios to infer value. Methods include contingent valuation, which asks respondents how much they are willing to pay for certain benefits or willing to accept for compensation for the loss of a benefit; and contingent ranking or conjoint analysis, which asks respondents to rank groups of goods. Benefits transfer occurs when estimates obtained for one context are used to estimate values from the same service in a different context. For example, the benefits from wildlife viewing tourism in one park could be applied to another park (Bateman, 1999; World Resources Institute, 2003).

Many intangible benefits are hard to translate into economic values. Some critics reject the notion that the feelings they have about a non-market good should be valued according to their willingness to pay (Barnes, 2003). Critics are concerned that valuing the environment is demeaning because the environment should be viewed as more than just another good or service. The economic counter-argument is that it is undemocratic to say that economic value should not count because economic valuation is based on people's preferences and it would be unfair to consider only the views of some people. All societies make environmental trade-offs and these decisions are better informed and more transparent when the economic values of environmental goods are known (Pearce, 2006). This does not mean that it is easy to derive economic value from environmental goods, nor are the methods for deriving value without criticism.

As a general rule, it is harder to get reliable measurements the further one moves from actual markets (Barnes, 2003). This means that an attempt to calculate the value of ecosystem services for a national park is likely to encounter problems of missing values, conflicting values and double counting. Critics of the approaches used to value ecosystem services claim that the inherent complexities and uncertainties associated with coupling dynamic human and natural systems are not accounted for by the valuation methods (Pritchard et al., 2000). In addition, non-market valuation is costly, time-consuming, and difficult (WCPA-IUCN, 1998).

In a study investigating the tourism value of rivers in Kruger National Park, South Africa, the value of the rivers was considered in terms of revenues to the park (on-site expenditure by visitors), contribution to the economy (on-site and off-site expenditure by visitors) and recreational value, including consumer surplus. The effect of a change in river quality was determined using contingent valuation and conjoint valuation where respondents were required to rate different scenarios. It was found that approximately 30% of tourism business to Kruger National Park would be lost if rivers were totally degraded (Turpie & Joubert, 2001).

Economic valuation methods have been used to derive the value of some of the world's wetlands. For example, the economic benefit of the Whangamarino Wetland in New Zealand was estimated to be US$9,881,392 (in 2003 dollars), derived from the flood control, recreation, commercial fishing, and non-use preservation benefits of the wetland. Similarly, the value of the Dutch Wadden Sea in the Netherlands was estimated to be US$2,329,614,000, and the Pantanel Wetland in Brazil to be worth US$15,644,090,000 (Schuyt & Brander, 2004). Dudley and Stolton (2003) list 33 cities that draw some or all of their water from a nearby protected area, illustrating that it pays to protect the watershed rather than build expensive water purification systems.

Slowly, markets for some ecosystem services are being created. Under the Kyoto Protocol of the UN Framework Convention on Climate Change, countries can credit their greenhouse gas inventory were carbon emissions are captured from afforestation or reforestation, creating a market for the carbon sequestration ecosystem service (WCPA-IUCN, 2000; Wilman & Mahendrarajah, 2002). Methods for accurately valuing ecosystem services will continue to be developed, but it is unlikely that ecosystem service values or qualities have been derived specific to national parks or at a scale appropriate for this research.

3.2.2 ECONOMIC COSTS

The costs associated with the establishment and management of protected areas include direct, indirect and opportunity costs. Direct costs are budgetary outlays to establish and manage a protected area. Indirect costs are beyond the day-to-day running of the park and include things like compensation for damages indirectly caused by the existence of the protected area such as damage to property by wildlife. Opportunity costs are the costs of lost economic development, including the resources currently on-site that could be harvested and the foregone benefits from a change in land use (Dharmaratne et al., 2000; Dixon & Sherman, 1990; Groom et al., 2006). Care must be taken to avoid double counting.

Financial Costs

Financial costs fall into two categories: capital costs, and operations and maintenance.

Capital Costs

The initial capital costs associated with establishing protected areas are not relevant to this research as it is concerned with protected areas that have already been established. However, capital costs for new facilities within existing national parks are relevant costs.

Operations and Maintenance

Ongoing direct costs to maintain and manage a protected area include:

- Staff salaries and general administration costs (Carret & Loyer, 2003; WCPA-IUCN, 2000);

- Maintenance of roads and facilities – visitor facilities may include walking tracks, visitor centres, camping areas, car parks, and signage. Other infrastructure that requires maintenance may include offices, staff accommodation, power supply equipment, transport systems and telecommunications facilities (De Lacy et al., 2006)

- Tourist education/conservation advocacy (WCPA-IUCN, 2000);

- Conservation management activities – including habitat restoration, pest control, monitoring, and research (Carret & Loyer, 2003; WCPA-IUCN, 2000); and,
- Enforcement – developing countries in particular need to enforce the protection of the area to prevent the poaching of wildlife and timber products, and the clearing of vegetation for agriculture (Dixon & Sherman, 1991).

Compensation

The PAMA may also be responsible for the following compensation costs:

- Compensation for damage – people need to be compensated for any damage occurring outside the protected area boundary that is caused by wildlife that live in the protected area. Damage could include harm to people, livestock or materials; or crops trampled or eaten by wildlife (Dixon & Sherman, 1991); and,
- Compensation for foregone rights – some protected areas may be associated with payments to local communities to prevent them from extracting resources from the park. Payments may also involve the provision of alternative sources of products, income, or social benefits like schools or clinics as a means of encouraging communities to cooperate with biodiversity objectives (Dixon & Sherman, 1991).

Compensation payments protect the park from resource extraction and poaching by local communities. The debate about the best incentives for changing behaviour has focused on the ‘directness’ of payments. Ferraro and Kiss (2002) argue that indirect payments, which have been used widely, prove inadequate in the majority of cases. People generally do what is in their own best interest, particularly in the short-term. If it is more beneficial in monetary terms to clear a habitat than it is to protect that habitat it will be cleared. Thus, biodiversity payments need to become more direct.

Costs to the Local Economy

The costs to the local economy may include inflationary effects, risk, or dependency on one industry, leakage, and opportunity costs.

Inflation

Development for the purposes of tourism can create inflationary effects on local economies, increasing the cost of land, property, and goods. Increased land prices benefit sellers, but can disadvantage local people who find it difficult to purchase property. In comparison, tourism development interests are often capable of paying higher prices (Page et al., 2001).

Risk/Dependency

It is risky in the long-term for a region to rely heavily on a single industry. International tourism is a fickle business that is influenced by fashions, the economy of the visitor's country, the economy, and political stability of the host country, the cost of travel, and perceptions about the pristine condition of a destination. These variables are impossible for a host destination to control and potentially have large impacts on a destination. It is best if a destination attracts a diverse range of tourists so if a market in a particular country experiences a downturn, the risk is spread and the consequences are less severe (Page et al., 2001).

Leakage

If tourist infrastructure like accommodation, restaurants, and tour organisation are owned by foreign investors, the local economy will not benefit from tourist activity. Instead, tourist spending is leaked to foreign investors (Page et al., 2001). However, the benefits accruing to the local economy will depend far more on the level of integration between the park and local economy, and benefits to the local community are likely to depend more on the amount of local values added, than on the ownership of the enterprise.

Opportunity Costs

The opportunity costs associated with a protected area are the foregone benefits from the area under the best alternative land use. If the area was not protected its resources could be harvested and it could be converted to a land use such as agricultural production. Opportunity costs are area specific and dependant on the nature of potential alternative land uses and the restrictions on allowable uses (Dixon & Sherman, 1991). For example, Norton-Griffiths and Southey (1995) estimated the opportunity costs of foregone revenue from agriculture and livestock production on conservation land in Kenya to be US$203 million in 1989 dollars. These opportunity costs were found to far exceed the direct[1] benefits from tourism and forestry on conservation land (net revenues of US$42 million), giving an indication of the extent to which the Kenyan government subsidises conservation. The paper indicates that Kenya, at considerable cost to itself, is providing wildlife services with high existence values to the rest of the world (including developed economies), little of which accrues to Kenyans.

A summary of economic criteria that could be used in the proposed model is given in Table 3.9.

3.3 SOCIAL BENEFIT CRITERIA

Utilitarian arguments for the provision of protected areas focus on economic values and protection of biodiversity. However, the general public tends to place greater importance on the intangible attributes of protected areas, which may be perceived in personal, cultural, or societal terms (Putney, 2003). Intangible attributes can be defined as those that enrich "the intellectual, psychological, emotional, spiritual, cultural, and/or creative aspects of human existence and well being" (WCPA 2000 cited in Putney, 2003, p. 4).

The IUCN definition of national park stipulates that social attributes are imperative to the purpose of national parks, involving the provision of "… a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible." In addition, the objectives for national park management specify that nature and scenery should be protected for "spiritual, scientific, educational, and recreational or tourist purposes", and visitor use should be managed "for inspirational, educational, cultural, and recreational

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[1] Only direct use benefits from conservation were used in this analysis because it was hard to source accurate estimates of indirect use and non use benefits.

Table 3.9

Summary of Potential Economic Criteria for Comparing National Parks

Level	Attribute	Potential Criteria	Information Source	Measurement and Units
Financial Benefits	**User Fees**	Revenue to the park from entrance fees, fees for the use of facilities, and concessionaire fees.	National park accounts.	Currency.
	Donations	Payments from corporations, individuals, or donor organisations to the park.	National park accounts.	Currency.
	Cause-related revenue	Income to the park from 'Friends of the Park' schemes, adoption programmes, sales of park-related books/curios, and special events.	National park accounts.	Currency.
Economic Benefits	**Balance of payments**	Tourist expenditure contributes to a country's balance of payments.	The reserve bank quarterly bulletin or government statistics may give some indication.	Currency.
	Contribution to GDP	Tourist expenditure contributes to a country's gross domestic product.	Government statistics may give some indication.	Currency.
	Contribution to the local economy	Tourist expenditure contributes to economic development in nearby towns.	Government (national, regional or local) statistics or surveys of local businesses.	Currency.
	Employment	The provision of a national park initiates direct, indirect, and induced employment opportunities.	Government (national, regional or local) statistics, or surveys of local businesses (e.g., questionnaires, interviews, and focus groups).	Currency.
	Ecosystem functions and services	Ecosystems provide diverse and essential benefits that underpin human economies, including regulation, habitat, and production functions.	Academic journals with conversion formulae used in conjunction with GIS and spatial data; economic valuation approaches, namely non-market valuation methods. Data is not yet readily available for fine scale ecosystem services.	Many units (e.g. tons of carbon, cubic metres of clean water), that could potentially be converted to units of currency.

Level	Attribute	Potential Criteria	Information Source	Measurement and Units
Financial Costs	**Capital**	Expenditure on new facilities.	National park accounts.	Currency.
	Operations and Maintenance	Expenditure to maintain and manage the protected area including staff salaries, administration cots, maintenance of roads and visitor facilities, tourist education/conservation advocacy, conservation management, and enforcement.	National park accounts.	Currency.
	Compensation	Expenditure on compensation for damage to property outside the park or compensation for foregone right to extract resources from the park.	National park accounts.	Currency.
Economic Costs	**Inflation**	Tourism can have inflationary effects on local economies, increasing the cost of land, property, and goods.	Government (national, regional or local) statistics, or surveys of local businesses and people (e.g., questionnaires, interviews, and focus groups).	Currency.
	Risk/dependency	It is risky in the long-term to rely heavily on a single industry. It is best if a tourist destination attracts a diverse range of tourists so if a particular country experiences a downturn the risk is spread.	Government (national, regional or local) statistics, park records of visitor origin, hotel records of visitor origin. Also, if local economies depend on other industries as well as tourism.	Visitor origin statistics converted into descriptive categories of risk.
	Leakage	If tourist infrastructure is owned by foreign investors, tourist spending will be leaked to other countries.	Possibly government (national, regional or local) statistics.	Percentage of local income leaked.
	Opportunity costs	-	-	-

purposes". Emphasis is also placed on the "sacred or aesthetic" attributes of national parks and the "needs of indigenous people" (IUCN-WCMC, 1994, p. 4).

International policy frameworks on the protection and management of biological diversity give increasing attention to the need for greater community involvement and participation in the management of protected areas. This is particularly true for the traditional owners of a protected area who were excluded from the land when the protected area was established. Management practice has moved to include local communities, neighbours and other stakeholders in planning and decision-making. Further, there are increasing numbers of PAMAs entering co-management arrangements with the traditional, usually indigenous, owners of protected areas (Hockings, 2000). These sentiments are in line with the position expressed in the Convention on Biological Diversity. In addition, the intangible values associated with protected areas – which include those outlined in the aforementioned IUCN guidelines – have gained more prominence in the protected area literature through the IUCN WCPA Task Force on Non-Material Values (established in 1998). Where possible, the social benefits discussed in this section are linked to the definitions agreed upon by the Task Force as outlined in Table 3.10 below.

The social attributes of national parks are difficult to define and quantify, and as a result, they are often ignored or given less weight than more easily quantified scientific and economic attributes (Brooks, Balmford, Burgess, Fjeldsa, Hansen et al., 2001; Jope & Dunstan, 1996; Tranel & Hall, 2003). It is hard to make 'soft' attributes explicit in decision-making, but they are vital to the future of protected areas and an attempt should be made to do so. The structure of this section is based on the aforementioned social attributes from the IUCN Guidelines for Protected Area Management and pertinent literature. At the end of the section, a summary of potential social criteria for the proposed model is given in Table 3.20.

Table 3.10
Intangible Attributes of Protected Areas as Defined by the WCPA Task Force on Non-Material Values

Intangible Attributes	Definition
Recreational	The intrinsic qualities of natural areas that interact with humans to restore, refresh, or create anew through stimulation and exercise of the mind, body, and soul (i.e., re-creation).
Spiritual	Those qualities, both positive and negative, ascribed to natural, cultural, and mixed sites by different social groups, traditions, beliefs, or value systems that fulfil humankind's need to understand, and connect in meaningful ways, to the environment of its origin and the rest of nature.
Cultural	The qualities, both positive and negative, ascribed to natural, cultural, and mixed sites by different social groups, traditions, beliefs, or value systems that fulfil humankind's need to understand, and connect in meaningful ways, to the environment of its origin and the rest of nature.
Identity	Those natural sites that link people to their landscape through myth, legend, or history.
Existence	The satisfaction, symbolic importance, and even willingness to pay, derived from knowing that outstanding natural and cultural landscapes have been protected and exist as physical and conceptual spaces where all forms of life and culture are valued and held sacred.
Artistic	The qualities of nature that inspire human imagination in creative expression.
Aesthetic	Appreciation of the harmony, beauty, and profound meaning found in nature.
Educational	The qualities of nature that enlighten the careful observer with respect to human relationships with the natural environment, and by extension, people's relationships with one another, thereby creating respect and understanding.
Research and monitoring	The function of natural areas as refuges, benchmarks, and baselines that provide scientists and interested individuals with relatively natural sites less influenced by human-induced change or conversion.
Peace	The function of protected areas in fostering regional peace and stability through cooperative management across international land or sea boundaries (transfrontier conservation areas) or as 'intercultural spaces' for the development of understanding between traditional and modern societies, or between distinct cultures.
Therapeutic	The relationship between people and natural environments in protected areas that creates the potential for healing and for enhancing physical and psychological well-being.

Source: Adapted from Putney (2003)

3.3.1 SPIRITUAL SIGNIFICANCE

The provision of spiritual opportunities relates to the feelings of individuals or groups of individuals about a national park. Spiritual associations can be defined as "those qualities of protected areas that inspire humans to relate with reverence to the sacredness of nature" (Putney, 2003, p. 7). Spiritual significance is strongly linked to cultural associations with an area. For example, the Māori people of New Zealand believe they are born of the land and do not 'own' it (Patterson, 2000). They regard the mountains of Tongariro National Park as places of spiritual force that command and give life to the natural world. In pre-European times, Mount Tongariro was treated with such respect and humility that it disrespectful to look directly at the mountain (Department of Conservation, 2006).

Spiritual opportunities are provided to people that visit the protected area, as well as those that gain spiritual fulfilment through the knowledge that a natural area exists and is protected. Spiritual experiences may be associated with aesthetic beauty, specific resources, cultural beliefs, or historical events that occurred at a specific location. Spiritual significance is personal and defies measurement for the comparative purposes of this research.

3.3.2 SCIENTIFIC SIGNIFICANCE

National parks provide important, and sometimes unique, sites for research (Hockings et al., 2000). They can be of great importance to science because their features are relatively uninfluenced by human activities. This means that national parks are excellent resources for better understanding elements of ecology and can function as baselines or benchmarks against which to measure change in ecosystems at other locations (Davis, Graber, & Acker, 2003). Under the Burra Charter[2] the scientific importance of a place is described as dependant upon the importance, rarity, quality or representativeness of the data involved, and the degree to which further substantial information may be derived from the area (Hall & McArthur, 1996b). Research is often linked closely to education because

[2] The Burra Charter was declared under the Australian International Council on Monuments and Sites (ICOMOS) Charter for the Conservation of Places of Cultural Significance, adopted in 1979 and revised in 1988.

national parks can be used for field study by students of all levels (Dixon & Sherman, 1991).

Cumming (2004) suggests the following indicators to determine the scientific significance of a protected area:

- The number of academic publications that involve the scientific study of the park;
- The number of visiting scientists to the park;
- Research agreements with universities; and,
- Professional comparative assessment by a team of scientists.

Each of these indicators is problematic. In particular, there is a danger that the most accessible or interesting/charismatic parks will attract the most scientists, leading to more publications, visits, and research agreements with universities. It is apparent that scientific significance is complicated by the location and preferences of researchers. Research builds on itself and researchers go to areas where data and historic measurements are abundant. A team of scientists may also be influenced by these factors. There is a danger that historic spending patterns on research will influence the outcome of a decision model if research outputs are used to measure scientific worth. However, according to the IUCN definition, national parks should be managed for scientific benefits, amongst others. This means that some measure of scientific significance should be incorporated in resource allocation decisions, and the indicators suggested by Cumming, albeit limited, are practical. Further research is required to produce a robust and fair method for the comprehensive assessment of the scientific worth of different areas.

3.3.3 EDUCATIONAL SIGNIFICANCE

The educational properties of protected areas can be defined as:

> The qualities of nature that enlighten the careful observer with respect to human relationships with the natural environment, and by extension, people’s relationships with one another, thereby creating respect and understanding. (Putney, 2003, p. 8)

National parks can be a vehicle to instil understanding and appreciation of the natural environment (Dixon & Sherman, 1991). In some ways, educational opportunities are related more to the management activities carried out in a national park than the inherent significance of the park itself. The creation of a park implies that the park has worth and that the community should become aware of that worth through education provided by the national park managers. If visitors are not actively educated they are effectively mis-educated, incorrectly understanding that the park's significance is limited to whatever enjoyment they happen to get out of it (Lovett, 1998). Thus, it is the duty of national park managers to provide interpretive information to educate visitors.

Some outside educational institutions, such as schools and organisations focussed on aspects of nature conservation, recognise the educational value of fieldtrips to national parks and may educate participants without relying on the provision of information by park managers. Potential indicators for determining the educational importance of a national park are the number of participants in educational or interpretive programmes (Hockings et al., 2000), whether there is an educational visitor centre associated with the park and the frequency with which educational institutions and organisations take fieldtrips to the national park for educational purposes.

3.3.4 SIGNIFICANCE FOR RECREATION AND TOURISM

For many people, national parks are associated with the use of leisure time (Hockings et al., 2000). Leisure is discretionary time that excludes the time spent at work or on essential tasks like eating or sleeping. To make leisure time more enjoyable and satisfying people engage in recreational activities (Taylor, 1993). The recreational attributes of national parks can be defined as:

> The intrinsic qualities of natural areas that interact with humans to restore, refresh, or create anew through stimulation and exercise of the mind, body, and soul (i.e., re-creation). (Putney, 2003, p. 7)

Tourism is a form of entertainment that involves the consumption of experiences (McKercher & du Cros, 2002). Following the Second World War there was a dramatic worldwide increase in tourism and this has influenced national park management (Payne & Graham, 1993). Visitor activities in national parks may include hiking, horseback riding, cycling, fishing, boating, rafting, swimming, snow sports, camping, appreciation of nature/wildlife/scenery/history, and research.

The objectives of national park management include “to manage visitor use for inspirational, educational, cultural and recreational purposes at a level that will maintain the area in a natural or near natural state” (IUCN-WCMC, 1994, p. 4). Researchers are increasingly able to identify and better understand the many benefits gained through recreation in protected areas, yet are unable to incorporate this knowledge into mainstream economic and political systems. The benefits of recreation in protected areas have clear significance in the lives of individuals (Shultis, 2003). By undertaking recreational activities in national parks, visitors gain a range of psychological and physiological benefits that manifest themselves throughout wider society (Putney, 2003; Shultis, 2003). Personal benefits from leisure in a national park include improved psychological and physiological health, such as improvements in cognitive efficiency, the development of leadership skills, stress management, improved neuropsychological functioning, increased life expectancy, and better management of health problems (Table 3.11).

Recreation may also bring social and cultural benefits to society, through such things as community/regional/national pride, social mobility, ethnic/cultural identity, reciprocity and sharing, and family bonding. These benefits can transfer to economic benefits such as: reduced health costs, increased productivity, reduced work absenteeism, fewer on-the-job accidents, and decreased job turnover (Table 3.12). However, these benefits become intangible in socio-political decision-making (Shultis, 2003).

Tourism is a commercial, demand-driven activity that is difficult to control. Tourist-oriented businesses provide goods and services at or near attractive destinations and social benefits arise from the generation of wealth. Attractions drive tourism, but not all natural or cultural tourist attractions have equal demand-generation potential. A number of factors influence the popularity of a park with visitors, namely the ease of access, proximity to major centres, and the types of experience that tourists are motivated to seek. Attractions located close to a large population base, a major tourist centre, or a gateway attract more visitors than those attractions that are more distant. For an attraction to triumph over distance decay and poor market access it must motivate people to visit regardless of the time, effort, cost or the distance involved (McKercher & du Cros, 2002).

Table 3.11
Personal Benefits of Leisure

Psychological benefits (mental health)	
Holistic sense of wellness	Prevention and reduction of depression, anxiety, and anger
Stress management (prevention, mediation, and restoration)	Positive changes in mood and emotion
Catharsis	
Personal development and growth	
Self-confidence, self-reliance, self-competence, self-assurance	Adaptability
Belief clarification	Cognitive efficiency
Improved academic/cognitive performance	Improved problem-solving ability
Independence and autonomy	Nature learning
Sense of control over one's life	Cultural and historical awareness, learning, and appreciation
Humility	Environmental awareness and understanding
Leadership	Tolerance
Aesthetic and creativity enhancement	Balanced competitiveness
Spiritual growth	Balanced living
Prevention of problems with at-risk youth	Acceptance of responsibility
Psychophysiological benefits	
Cardiovascular benefits	Increased muscle strength and better connective tissue
Reduction and prevention of hypertension	Reduced incidence of disease
Reduced serum cholesterol/triglycerides	Improved bladder control for the elderly
Improved control or prevention of diabetes	Increased life expectancy
Prevention of colon cancer	Management of menstrual cycles
Reduced spinal problems	Management of arthritis
Decreased body fat and obesity/weight control	Improved functioning of immune system
Improved neuropsychological functioning	Reduced consumption of alcohol and use of tobacco
Increased bone mass and strength in children	
Respiratory benefit	

Source: Adapted from Driver and Bruns (1999) and Shultis (2003)

Table 3.12
Benefits to Society from an Individual's Leisure

Social and cultural benefits of leisure	
Community satisfaction	Family bonding
Community, regional and national pride	Reciprocity and sharing
Cultural/historical awareness and appreciation	Social mobility
Reduced social alienation	Community integration
Community and political involvement	Nurturing of others
Ethnic and cultural identity	Understanding and tolerance of others
Social bonding, cohesion, and cooperation	Environmental awareness and sensitivity
Conflict resolution and harmony	Support for democratic ideals of freedom
Greater community involvement in environmental decision-making	Enhanced world view
Social support	Socialisation and acculturation
Developmental benefits of children	Prevention of social problems by at-risk youth
Economic benefits of leisure	
Reduced health costs	Decreased job turnover
Increased productivity	Balance of payments (tourism)
Reduced work absenteeism	Local and regional economic growth
Fewer on-the-job accidents	Contributions to net federal economic development
Environmental benefits of leisure	
Maintenance of physical facilities	Environmental protection
Stewardship/preservation of options	Ecosystem sustainability
Improved relationships with nature	Preservation of species diversity
Awareness of dependency on natural world	Maintenance of natural scientific laboratories
Development of environmental ethic	Preservation of particular natural and cultural sites
Public involvement in environmental issues	

Source: Adapted from Driver and Bruns (1999) and Shultis (2003)

The type of recreation that tourists undertake in a protected area is dependant on their motivations for visiting. Tourists can be grouped according to their motivations for recreation in protected areas as follows:

1. Nature Escapists appreciate nature and want to learn about it. They also desire to escape from everyday life;

2. Eco-tourists have a strong motivation to learn about nature, are interested in physical fitness and adventure, want to escape everyday life, and are interested in associating with others;

3. Comfortable Naturalists are interested in nature and escaping from everyday life, but want to do so in comfort; and,

4. Passive Players desire escape, adventure, and social activity but have little interest in nature (De Lacy & Whitmore, 2006).

The type and quality of facilities and experiences offered by a protected area will determine the type of tourists. Another factor that influences tourist numbers at a site is civil order because tourists are unlikely to visit a protected area that they perceive as unsafe (Sachida, 2005).

Traditionally, visitor monitoring in national parks is focused on assessing the number of tourists who visit a site. In addition to counting visitors, more in-depth observations of, and questionnaires about, visitor behaviour are periodically undertaken. This information is used by managers to estimate the environmental impacts from visitor use and determine the appropriate carrying capacity for a park, to assist with infrastructure investment decisions, to calculate the regional economic benefit of a park, and to monitor visitor satisfaction (De Lacy et al., 2006; Hockings et al., 2000). A summary of the advantages and disadvantages of different visitor monitoring techniques is given in Table 3.13.

Recreation benefits are typically assessed through visitor numbers, which are difficult to accurately collect and are vulnerable to managerial meddling (Shultis, 2003). Questionnaires and interviews provide more detailed information about tourist behaviour, but are time-consuming and expensive to undertake and analyse. Surveys can reveal information about visitor use and satisfaction levels (Hockings et al., 2000).

Visitor planning frameworks have taken the motivations of different tourist groups into account and focussed on the concept of 'recreational opportunity', which can be defined as "the availability of a real choice for a user to participate in a preferred activity within a preferred setting in order to achieve a satisfying experience" (Taylor, 1993, p. 2). Of the visitor planning frameworks developed, the most prominent and rational is the Recreation Opportunity Spectrum (ROS) framework (Payne & Graham, 1993). The ROS concept was developed by the U.S. Forest Service in the late 1970s and focuses on providing a diversity of outdoor recreation opportunities in each park. Six recreation opportunity classes are suggested that range from developed to undeveloped: urban, rural, roaded natural, semi-primitive motorized, semi-primitive non-motorized, and primitive.

Table 3.13
Summary of Visitor Monitoring Techniques

Visitor monitoring technique	Advantages	Disadvantages	Application
Counting visitors (including automated counters, entrance records – e.g. ticket sales – manual counts, visitor books, tour records and aerial photos)	Provides a simple measure of the extent of use of a natural area; automated counters are one of the most reliable ways of estimating numbers	Most methods provide estimates only; automated counters are expensive to purchase and some may have significant margins of error	Traffic counters can be employed on most roads used by vehicles; aerial photos are useful for marine areas and difficult-to-access locations, such as beach dunes
Questionnaires and personal interviews (including site-based, main and/or telephone data collection)	Questionnaires provide comprehensive information on visitors, their activities and expectations; they are widely used, making results comparable with those obtained elsewhere	Can be expensive to design, administer and analyse	Best used where detailed information on visitors and their visit characteristics, preferences and expectations are required for planning and impact management
Observing visitors (including counting numbers and observing behaviour)	Useful for counting numbers when other means are not available; observing behaviour can be correlated with other techniques, especially self-reporting by visitors	Counts of numbers are approximate only, observing behaviour is expensive and training of observers is essential	Best used where information on numbers and behaviour is unavailable via other means
Focus groups and other interactive techniques (where users are brought together to provide data, often on more than one occasion)	Efficient means of accessing a range of ideas at one time (focus group) or seeking determination and agreement over time on indicators and standards (task force)	Extremely time consuming to organise and administer; data may be difficult to analyse if consensus is not reached	Using task forces only warranted for large, complex natural areas with multiple stakeholders

Source: Newsome et al. (2002, p. 286) cited in De Lacy and Whitmore (2006, p. 517)

These classes are characterised by different recreation activities, management needs, levels of human modification, types, and frequency of user interaction, and ease of access. The ROS classes adopted by the New Zealand Department of Conservation ranging from ‘Drive-in’ to ‘Wilderness’ are shown in Table 3.14 below. Areas are described in regard to these factors and an area can be mapped into opportunity classes for zoning decisions (Payne & Graham, 1993).

Other visitor planning methods derived from the ROS framework include:

- Limits of Acceptable Change, U. S. Forest Service (Stankey, 1973);
- Visitor Impact Management, U.S. National Park Service (Graefe, 1990);
- Visitor Activity Management Process, Canadian Parks Service (Graham, 1990); and,
- Visitor Service Levels Framework, Parks Victoria (Australia) (Parks Victoria, c.2000).

Of these frameworks, the Visitor Service Levels Framework developed by Parks Victoria is the most relevant to the purposes of this research. Historically, the extent to which visitation sites in Victoria’s protected areas were serviced was dependant on historical decisions and varying degrees of strategic planning. To improve visitor satisfaction and safety, the protection of natural and cultural values, and cost efficiency, Parks Victoria developed a comprehensive planning framework to improve visitor services throughout the state.

Table 3.14
Activity and Management Characteristics Associated with Recreation Opportunity Spectrum Classes in New Zealand's National Parks

Characteristics	**Back Country**			**Remote**	**Wilderness**
	Drive in	**4x4 Drive in**	**Walk in**		
Land activities	Resort stays, driving for pleasure, touring (road/rail), campervaning, caravanning, 4x4 driving, trail biking, cycling, camping, caving, rock climbing, sight seeing, multi-sport eventing, walking, picnicking/BBQ, outdoor play, nature study/appreciation, nature tours, art, photography, skiing (downhill/cross country), ice skating, ice and snowcraft, snow play, general outdoor play	4x4 driving, trail biking, mountain biking, camping, caving, rock climbing, tramping, skiing (downhill/cross country), ice and snowcraft, snow play, multi-sport eventing, sight seeing, picnicking/BBQ, walking, nature tours, big game hunting, small game hunting, game bird hunting, horse trekking	Camping, caving, big game hunting, rock climbing, mountain biking, tramping, skiing cross country, ice and snowcraft, multi-sport eventing, photography, nature study, nature tours, horse trekking	Caving, big game hunting, tramping, rock climbing, skiing (cross country), ice and snowcraft, mountaineering, nature study/appreciation, nature tours	Tramping, big game hunting, mountaineering, nature tours
River and Lake activities	Boat tours, pleasure boating, jetboating, jetskiing, waterskiing, sailing, wind surfing, canoeing, rafting, floating (tube, pack), fishing, swimming, sun bathing, water play	Jetboating, canoeing, rafting, floating (tube, pack), fishing (fly/spinner), nature study/appreciation	Canoeing, rafting, floating (tube, pack), fishing (fly/spinner), general water play, nature study/appreciation	Canoeing, rafting, floating (tube, pack), fishing (fly/spinner)	Canoeing, rafting, fishing
Air activities	Flight seeing, flying (general), gliding, hang gliding/paragliding	Flight seeing, flying (general), gliding, hang gliding/paragliding	Flight seeing, flying (helicopter), hang gliding/paragliding	Flight seeing, flying (helicopter)	None
Degree of regulation of activities	Moderate to high	Moderate	Some	Little	None
Facilities and services	Road side and road end facilities, campgrounds, car parks, picnic areas, visitor centres, ski fields, nature trails, high standard walking tracks, jetties, wharves, boat ramps	Few facilities, some camping areas, informal car parks, tracks	Well signposted, surfaced and benched tracks, huts may be basic and unserviced or may be serviced with gas, running water etc.	Some facilities such as tacks, bridges, and huts	No discernible management presence
Maintenance operations	Regular, frequent, often visible	Operations to maintain facilities may be visible	Operations to maintain facilities may be visible	Operations to service and manage facilities and the environment may occasionally be present	No discernible management presence

Source: Adapted from Taylor (1993)

The Visitor Service Levels Framework is concerned with the provision of visitor services at visitor sites, where a visitor site is defined as “an area of several hectares or less where approximately four or more different visitor services or facilities are provided” (Parks Victoria, c.2000, p. 4). Visitor services range from basic amenities such as toilets and picnic tables to more complex facilities like information centres and ski trails. Parks Victoria determined generic visitor needs and corporate standards of service, evaluated the existing level of service provision at different sites, and identified the ideal provision of services at those sites based on the importance of the site and service requirements (Parks Victoria, c.2000). Most relevant to this research is the process Parks Victoria followed to determine Site Importance.

The strategic importance of each visitor site is rated to asses the relative merit of capital and recurrent investment amongst sites. The site importance rating is based on four criteria:

1. The importance of the site for activity-based recreation – based on the extent to which visitors travel long distances to get to the site; the proximity of alternative sites for similar recreational experiences; and, whether the site is a destination on its own, part of a wider touring route, or is a stopping point to another site of greater significance;

2. The importance of the site for tourism and general sightseeing and enjoyment of natural and cultural features – based on the extent to which visitors travel long distances to get to the site; the proximity of alternative sites for similar scenic experiences; and, whether the site is a destination on its own, part of a wider touring route, or is a stopping point to another site of greater significance;

3. The importance of the site for education – based on current use and frequency of use of the site by schools/colleges; and,

4. Projected annual visitor numbers—indicators of importance as well as service requirement.

The criteria were scored using a 1 to 5 scale as shown in Table 3.15. The final Site Importance score was calculated by adding the scores for the first three criteria to the square of the annual visit days score, giving a maximum score of 40 for each site (Parks Victoria, c.2000).

The Site Importance criterion brings the recreational, aesthetic, and educational aspects of social benefits into one score. However, a national park is likely to have a number of visitation sites, and scores will have to be normalised for each park to ensure fair comparison.

The following visitor-related indicators are suggested by Cumming (2004):

- The number of national, continental, and foreign visitors per year;
- The facilities and infrastructure available for visitors (e.g. lodges, restaurants, shops, camping sites, hides, types and state of roads);
- The diversity of recreational activities available (e.g. hiking, horse riding, canoeing);
- The area of the park available to visitors and types of access (length and types of road access);
- Cultural sites, their preservation and associated interpretive displays and information; and,
- Interpretive services and the range of information available to visitors and the public (maps, information sheets, books, scientific reports, annual reports and performance statistics).

Cumming (2004) acknowledges that many of these indicators need to be linked to carrying capacity or planned levels of service delivery. This means that the highest score for each suggested criterion is not necessarily best.

Table 3.15
Scoring for Site Importance criteria used in the Visitor Service Levels Framework by Parks Victoria

Level of Importance	Importance for recreational activity	Importance for general sightseeing and tourism	Importance for education	Annual visit-days[3]
1	There are many similar and therefore alternative sites in the region for recreational activities. The site draws all or most of its visitors from the local area.	There are many similar and therefore alternative sites in the region for visitors. People are not usually prepared to travel beyond their local area to visit the site.	Very low: Little or no use for education.	0– 5,000pa
2	The site is of regional importance and people are often prepared to travel for up to 1.5 hours to visit the site.	The site is of local/regional importance and people are often prepared to travel for up to 1.5 hours to visit the site.	Low: occasional but infrequent use by schools/colleges.	5,000–10,000pa
3	The site is of regional importance and people are often prepared to travel for up to 3 hours to visit the site.	The site is of regional importance and people are often prepared to travel for up to 3 hours to visit the site.	Moderate: Regular use by moderate number of schools/colleges.	10,000–50,000pa
4	The site is of importance to the State because of the recreational activities it provides. It is one of only a few sites offering a particular activity and attracts people from throughout the state and nearby interstate areas.	The site is of importance to the State for tourism because of the unique opportunities for the enjoyment of natural and cultural features. It is one of only a few sites offering a particular experience and attracts people from throughout the State and nearby interstate areas.	High: Important regional destination for schools/colleges.	50,000–200,000pa
5	The site is of national importance because of the recreational opportunities it provides. There are few or no other substitute sties. It attracts many interstate and international visitors.	The site is of national importance for tourism because of the opportunities it provides. There are no other substitute sites. It attracts many interstate and international visitors.	Very High: Major destination for schools/colleges from across the State.	Over 200,000pa

Source: Adapted from Parks Victoria (c.2000)

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[3] Where a visit-day is the number of day visitors plus the number of overnights stays. A day visitor is a person entering the park for the first time on any given day and staying in the park for one day or less.

3.3.5 CULTURAL SIGNIFICANCE

The cultural attributes of protected areas are defined as:

> The qualities, both positive and negative, ascribed to natural, cultural, and mixed sites by different social groups, traditions, beliefs, or value systems that fulfil humankind's need to understand, and connect in meaningful ways, to the environment of its origin and the rest of nature. (Putney, 2003, p. 7)

Culture is constantly evolving and no one set of cultural standards is inherently superior or will apply in perpetuity (Hay-Edie, 2003; Lennon, 2006). The modern concept of cultural heritage embraces all the signs that document human activities over time (Lennon, 2006). The concept of 'identity', where natural sites link people to their landscape through myth, legend, or history is also relevant (Putney, 2003).

The Convention Concerning the Protection of the World Cultural and Natural Heritage (commonly known as the World Heritage Convention) was adopted by UNESCO in 1972, where elements of cultural heritage were defined as:

> monuments: architectural works, woks of monumental sculpture and painting, elements or structures of an archaeological nature, inscriptions, cave dwellings, and combinations of features, which are of outstanding universal value from the point of view of history, art, or science;
>
> groups of buildings: groups of separate or connected buildings which, because of their architecture, their homogeneity, or their place in the landscape, are of outstanding universal value from the point of view of history, art, or science;
>
> sites: works of man (sic) or the combined works of nature and of man (sic), and areas including archaeological sites which are of outstanding universal value from the historical, aesthetic, ethnological, or anthropological points of view. (UNESCO, 1972, p. 2)

In 1992, the World Heritage Convention was modified to recognise and protect 'cultural landscapes' of outstanding universal value. Cultural landscapes are places where people and the natural environment interact (Rössler, 2003). Cultural landscape properties are inscribed on the World Heritage List on the basis of one or more of the following criteria. The property shall:

(i) represent a masterpiece of human creative genius;

(ii) exhibit an important interchange of human values, over a span of time or within a cultural area of the world, on developments in architecture or technology, monumental arts, town-planning or landscape design;

(ii) bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared;

(iv) be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history;

(v) be an outstanding example of a traditional human settlement, land-use, or sea-use which is representative of a culture (or cultures), or human interaction with the environment especially when it has become vulnerable under the impact of irreversible change;

(vi) be directly or tangibly associated with events or living traditions, with ideas, or with beliefs, with artistic and literary works of outstanding universal significance. (UNESCO, 2005, pp. 19-20)

The U.S. National Park Service expanded on the above definitions to classify the historical components of the landscape and cultural landscape categories, as shown in Table 3.16. These definitions provide clear categories for landscape inventory.

For some societies, historic buildings are closely linked to cultural associations. However, for many traditional societies characterised by hunting and gathering, built heritage plays a lesser role. For such societies it is stories, songs, and dances passed down by oral tradition through the generations that characterise cultural heritage (Seale, 1996). In 2003, the Convention on Intangible Cultural Heritage was adopted recognising that cultural landscapes exist for cultures that do not create monuments, but have beliefs and rituals associated with landscape features (Lennon, 2006).

Protected areas are designated on cultural as well as natural grounds, so protected area managers should maintain datasets on cultural artefacts, sites, beliefs, practices and rituals. Ideally, maps indicating sites of significance will be maintained to assist in planning activities to ensure that cultural sites are not unsuitably intruded upon. In addition, cultural and social history information is often provided for visitor groups (De Lacy et al., 2006; Hockings et al., 2000).

Table 3.16

Definitions for Cultural Landscape Elements

Landscape Component		**Definition**
Historical Components of the Landscape	**Structures**	The physical remains of a deliberately constructed feature associated with human activity, such as a house, garden or water race.
	Complexes	A number of features that are related to each other in some way – for example, through use or function, such as structures associated with a farm or military barracks.
	Sites	The location of an event, structure, earthwork or complex where no above-ground evidence remains.
	Features	Components or elements of landscapes, including structures, sites or complexes and field boundaries, as well as natural features such as an avenue of exotic trees or alluvial streamside deposits containing minerals.
	Linear networks	Long, narrow landscape or landscape components, such as a river, canal/aqueduct, or transport route and its associated elements.
Cultural Landscape Categories	**Historic vernacular landscape**	A landscape that evolved through use by people whose activities or occupancy shared it. Through social or cultural attitudes of an individual, a family, or a community, the landscape reflects the physical, biosocial, and cultural character of everyday lives. Function plays a significant role in vernacular landscapes. This can be a farm complex or district of historic farmsteads along a river valley – rural historic districts or agricultural landscapes.
	Historic site	A landscape significant for its association with a historic event, activity, or person.
	Historic designed landscape	A landscape that was consciously designed or laid out by a landscape gardener, architect, engineer, or horticulturalist according to design principles, or an amateur gardener working in a recognized style or tradition. The landscape may be associated with a significant person, trend or even in landscape architecture, or illustrate an important development in the theory and practice of landscape architecture. Aesthetic values play a significant role in designed landscapes.
	Ethnographic landscapes	A landscape containing a variety of natural and cultural resources that associated people define as heritage resources – contemporary settlements, sacred religious sites, massive geological structures with small plant communities, animals, and subsistence and ceremonial grounds.

Source: Adapted from the U.S. National Park Service (1990; 1994)

Cultural tourism is often linked to built heritage like religious buildings, the ruins of past civilisations, or examples of architecture (Seale, 1996). The conservation of cultural heritage has focussed on the management of individual structures. The 1964 International Charter for the Conservation and Restoration of Monuments and Sites (also known as the Charter of Venice) was drawn up following floods that damaged many historical buildings in Venice. It has been the fundamental reference for conservation policies dealing with cultural heritage management. Conservation practice has now moved away from marking cultural sites as points on maps to considering the connections and spatial context of sites (Lennon, 2006).

World Heritage status is a good indication of cultural importance. However, subtleties between sites that are not World Heritage Sites could also be differentiated based on the number and quality of historic and cultural landscape components. This would involve a qualitative scale for rating the significance of individual sites. Historical experts and descendants of the area may be the most appropriate people to rank the landscape components.

3.3.6 SCENIC/AESTHETIC SIGNIFICANCE

Scenic beauty has long played an important role in the selection of areas for protection. However, it is difficult to compare aesthetic importance across different sites. Aesthetic attributes are defined by Putney (2003, p. 8) as “appreciation of the harmony, beauty, and profound meaning found in nature”. One does not have to visit a national park to receive aesthetic benefits from it. Views from a distance or vistas on films, calendars and paintings can represent aesthetic benefits (Dixon & Sherman, 1991).

Hockings, Stolton and Dudley (2000) suggest the artistic interpretation of sites as a potential indicator for aesthetic importance. Scenic images from national parks are reproduced as photographs, drawings, and paintings, and sold as postcards, posters, advertisements, calendars, books, art, and logos. Even if it were simple to ascertain how many images from different national parks are produced or sold, many biases are inherent to this criterion. National parks with a higher visitor base and/or accessible sales facilities like a visitor centre are likely to sell more images than those parks with fewer visitors or less suitable sales facilities. Questions also arise with regard to the uniqueness of artworks, for example, is the sale of a unique painting equivalent to the sale of one mass-produced poster? It would be near impossible to require artists and photographers to log every publication with the country's PAMA. For these reasons, it is unlikely that artistic interpretations of a national park would be a practical or robust indicator of aesthetic importance.

Research on the aesthetic preferences of visitors to protected areas finds a positive relationship between the appreciation of aesthetic attributes and the greater degree of direct experience and intellectual knowledge of an area (de Nogueira & Flores, 2003). The number of visitors to a national park provides a more practical indicator of aesthetic importance than artistic interpretation because visitor numbers are recorded for most national parks already. Distortions may be inherent with visitor numbers as an indicator of aesthetic importance, because visitors may be influenced more by accessibility and advertising, than by a well balanced investigation of the scenic beauty offered by each of a country's national parks. Importance for general sightseeing and tourism could be used as a surrogate for aesthetic value based on a subjective scale such as the one presented in Table 3.15, section 3.3.4.

The significance of an area can also be found in the uniqueness of form in terms of geology and aesthetic beauty. The World Heritage criteria for natural sites include "outstanding examples representing major stages of the Earth's evolutionary history" and "outstanding examples representing significant ongoing ecological and biological evolution" (Worboys & Winkler, 2006b). Thus, World Heritage status indicates that a national park has outstanding aesthetic importance. In the Conservation Priority Scoring System presented by Bell and Martin (1987) the criteria for amenity value are based on qualitative scales for special geological features and scenic attractions (Table 3.17). This priority-setting framework was developed for southern Africa where landscape types are grasslands, woodlands, water, and mountains. In other countries, more landscapes may be present and the scenic attractions scale can be modified accordingly.

Table 3.17
Descriptive Criteria for Amenity Value

Importance	Special Geological Features	Scenic Attractions
Low	Nothing of unusual interest	One type of landscape
	Some exposure of rock/fossil/geomorphological interest	Two types of landscape
	Good exposure of rock/fossil/geomorphological interest	Three types of landscape
	Sole representative of geological feature in country	Four types of landscape
High	Sole representative of geological feature in world	

Source: Adapted from Bell and Martin (1987)

3.3.7 STAKEHOLDER NEEDS AND PARTICIPATION

Many protected areas around the world were established without the agreement of the traditional owners/users of the lands and seas. This means that the key stakeholders have not been fully involved in decision-making regarding these protected areas. In addition to the general acceptance of the rights of indigenous peoples, it is now widely recognised that the long-term sustainability of the protected areas they inhabit or have a traditional interest in is dependant on their involvement (Beltran, 2000). Furthermore, the IUCN objectives for national park management include taking "… into account the needs of indigenous people, including subsistence resource use, in so far as these will not adversely affect the other objectives of management" (IUCN-WCMC, 1994, p. 4).

In accordance with current understanding of the concept of sustainable development, as well as the Convention on Biological Diversity, Agenda 21, and the Rio Declaration on Environment and Development, protected areas will survive best if they are of value to the nation as a whole and to local people in particular. The knowledge and practices of indigenous and other traditional peoples can contribute positively to the management of protected areas. Further, the territorial and resource rights of indigenous and other traditional peoples inhabiting protected areas should be recognised through their participation in the co-management of resources, without compromising the objectives in the protected area management plan (Beltran, 2000). Local communities have the closest physical contact with conservation and are the most affected economically. The idea that those living closest to nature will know what is best for it, is fundamentally flawed (Nicholls, 2004). However, if all that can be seen is economic loss, political unrest may arise, resulting in the sabotage of conservation efforts and disregard of the rules or laws for conservation (Tisdell, 2002).

It is now standard practice to include stakeholders in protected area management planning processes. Stakeholders are people that have an interest in a protected area and include local communities, user groups, interested individuals, and local government officials, representatives of nature-NGOs, commercial interests, many other groups, and the staff of the protected area (Thomas & Middleton, 2003). It can be time-consuming to involve stakeholders in the planning process, but the involvement of various interest groups is essential if there is to be consensus around the aims of the protected area management plan. The benefits of stakeholder involvement include an increased sense of ownership for all users, greater support for the protected area, and a new mechanism for communication (Thomas & Middleton, 2003).

The term 'participation' is used to describe the involvement of groups and individuals in the decision-making process. There are many types of participation possible, from limited to more inclusive levels. Many organisations are embracing the more inclusive levels of participation, but some are bound by their legislative or political mandate and are unable to deviate from this (Thomas & Middleton, 2003). Levels of participation have been defined in many ways (for example, Arnstein, 1969; Donaldson, 1994; Howard, Baker, & Forest, 1984; Mitchell, 1997). Thomas and Middleton (2003) present the following categories, ranging from least to most inclusive:

- Informing – groups and individuals are informed about proposed actions but have no opportunities to change them. Informing is a 'top-down' approach, usually employed to persuade others to the project leader's point of view;
- Consulting – information is disseminated to local communities, key stakeholders and organisations and their views are sought. The views of those consulted are usually taken account of, but not necessarily acted upon;

- Deciding together – those affected by an issue are invited to learn about it, discuss it, and become part of the final decision-making process. Those initiating the discussion usually set boundaries on how much influence the other stakeholders have in the final discussion;
- Acting together – this occurs when there is both a shared decision-making process, and shared responsibility for implementing decisions; and
- Supporting independent community interests – communities become responsible for setting their own agendas and implementing the decisions which they take in a completely 'bottom-up' approach to conservation. The role of experts and other agents or investors is to support the community with information and expertise and perhaps resources to help them make informed decisions.

Another way of presenting the levels of participation is shown in Table 3.18 below. Here the levels are divided into education, advisory committee, and co-management arrangements, the terms more commonly used in protected area management in countries like New Zealand and Canada. National park management is moving away from merely educating stakeholders about management decisions to advisory committee and even co-management arrangements.

Co-management arrangements between PAMAs and indigenous or traditional peoples offer the potential for developing the notion of parks as intercultural spaces. In a co-management arrangement differing cultural perspectives are considered equally important (Putney, 2003). Many co-management arrangements do fall short of the ideal, but conflicts are less likely to occur if indigenous peoples/traditional owners are involved in all aspects of management (Beltran, 2000). In principle, all of the decisions passed by co-management organisations should maintain the ecological integrity of protected areas as the highest priority. Co-management partnerships between indigenous peoples/ traditional owners and protected area management agencies should be based on a sound understanding of the social and economic needs of individuals and communities (Beltran, 2000).

Through co-management arrangements, protected area management agencies gain enhanced opportunities to protect and interpret the cultural values of protected areas. They may also benefit by expanding and enhancing the conservation estate in a cost-effective manner and enjoy improved opportunities for eco-tourism and cultural tourism, and development of an improved tourism product. Furthermore, co-management will offer enhanced opportunity to contribute to reconciliation with indigenous peoples. Co-management arrangements, however, are demanding to initiate and may require more complex management structures in the long run. There are likely to be additional demands for financial and other resources to implement co-management arrangements and additional requirements to train and supervise staff. Existing legislation will need to be amended or new legislation introduced, to implement changed management arrangements. There may also be new restrictions on accessing some parts of the protected area (Smyth, 1998).

The traditional owners benefit from co-management arrangements through recognition of traditional ownership and participation in managerial decision-making for the protected area. There is job creation and training in contemporary management techniques (e.g. weeds, feral animals, tourism), along with resources for infrastructure and support services. Income derived from lease payments and/or a percentage of entrance fees can filter into the community. In addition, co-management arrangements bring enhanced opportunities to protect cultural sites and landscapes, and opportunities to educate people about traditional culture. However, disadvantages of co-management arrangements may include sharing management of traditional land with a Government agency and allowing increased numbers of people to visit traditional land. The options for development and use of traditional land are also limited to the purposes of the protected area (Smyth, 1998).

For visitors, co-management may bring enhanced opportunities to appreciate cultural values of protected areas and to interact directly with traditional owners or their employees (often indigenous people). In doing so they are participating in the process of reconciliation. There may be additional costs associated with use of protected areas by visitors, either via taxation or entrance fees and there may be restrictions on destinations and/or activities within protected areas because of cultural site protection (Smyth, 1998).

Table 3.18
Participation Levels: Education, Advisory Committee and Co-management

Level of Participation		**Characteristics Sought**	**Strengths**	**Weaknesses**
Education	**Awareness Raising**	Alerts people to programmes/actions	Directs attention to projects Interpretive enforcement	Information flows in one direction
	Education	Allows people to act Provides information for effective discussion	Important stage in capacity building	Whoever provides information has a degree of power
Advisory Committee		Public representation Communication Information sharing Consensus building Feedback on success of committee	Community contact with government officials Informs government of community views and concerns Increases government accountability Government open to input for strategy and policy development	General public not usually involved Government retains control of finances Low frequency of meetings Committee has little or no decision making power/ responsibility Volunteer burnout Little contact with local authorities Communication skills required
Co-management		Begins at conceptual stage Long-term process Traditional and/or indigenous knowledge Power and risk sharing Democratic process Partnership Co-operation Integration Institutional arrangements Governance Accountability All interested parties	Long-term solutions Democratic Interactive Co-operation Legitimacy Sense of ownership Monitoring Increased compliance Reduces monitoring/ enforcement costs Multiple information sources/wider knowledge base Information sharing Different types of knowledge used Dynamic	People skills needed Power differences Sector focus retained Not enough detailed research - need to know which practices have been successful Caution: cannot consider resource users and communities as homogeneous groups

Source: Uunila (2002, p. 23)

The characteristics of four co-management models used in Australian national parks are outlined in Table 3.19 below.

Table 3.19
Selected Co-Management Models from Australia

Details	**Garig Gunak Barlu National Park model**	**Uluru model**	**Queensland model**	**Witjira National Park model**
Ownership	Aboriginal	Aboriginal	Aboriginal	Government
Structure of Board of Management	Equal representation of traditional owners and government representatives	Aboriginal majority	No guarantee of Aboriginal majority	Aboriginal majority
Lease-back Details	No lease-back to government agency	Lease-back to government agency for long period	Lease-back to government agency in perpetuity	Lease of the national park to traditional owners
Fees	Annual fee to traditional owners	Annual fee to traditional owners, community council or board	No annual fee paid	Unknown
Examples	Garig Gunak Barlu National Park	Uluṟu-Kata Tjuṯa, Kakadu, Nitmiluk, Booderee and Mutawintji National Parks	None finalised	Witjira National Park

Source: Adapted from Kothari (2006) and Smyth (2001)

The Witjira National Park model differs from the others in that the government retains ownership of the park and leases it to the traditional owners. In the other three co-management models ownership is restored to the traditional Aboriginal owners. The Uluru and Queensland models involve a lease-back arrangement with the government PAMA for a long period.

Co-management may bring enhanced recognition of cultural values associated with the biodiversity of protected areas and improved protection and management of biodiversity values through the application of traditional knowledge and practices. Depleted populations who are culturally and ecologically important may also be reintroduced to the area. Pressures on biodiversity may be increased through increased tourist numbers, the establishment of traditional living areas within the protected area, and traditional hunting and gathering (Smyth, 1998).

Potential criteria to measure stakeholder participation in park policy, planning, and decisions include formal structures and social institutions, legal and customary instruments and rules that facilitate public participation and accountability (Cumming, 2004). Land ownership restitution may also be relevant (Bell & Martin, 1987; IUCN-SA, 2003). There is a danger that the level of participation for a national park is more a measure of management effectiveness/progress, than the significance of a park. Some measure of potential stakeholder participation would be better.

3.3.8 PEACE PARKS

Protected areas can play an important role in

> … fostering regional peace and stability through cooperative management across international land or sea boundaries (transfrontier conservation areas) or as “intercultural spaces” for the development of understanding between traditional and modern societies, or between distinct cultures. (Putney, 2003, p. 8)

National parks that are part of transboundary protected area arrangements have increased political significance. There are many examples of long-standing interaction and co-operation between two or more adjoining protected areas divided by international or sub-national boundaries. These transboundary protected areas have symbolic value for peaceful co-operation between nations and also have practical benefits for co-ordinated or joint conservation management. These areas have a potential role in sustainable regional development and conflict prevention, resolution and reconciliation (Sandwith et al., 2001). A comprehensive discussion of the benefits associated with transboundary protected areas is provided by Hamilton et al. (1996).

In particular, benefits may include:

- The promotion of international co-operation at different levels in different fora;
- Greater possibilities for the free movement of people, goods, services, and money between nations;
- Enhanced protection of natural heritage across ecosystems;

- The facilitation of more effective research;
- Greater economic benefits for local and national economies; and,
- Increased cross-border control of problems like fire, pests, poaching, pollution, and smuggling (Griffen, Cumming, Metcalfe, t' Sas-Rolfes, Singh et al., 1999; Hamilton et al., 1996; Sandwith et al., 2001).

Transboundary protected area arrangements can also enhance local communities. The IUCN South Africa developed an indicator based Transboundary Conservation Area Development Effectiveness Toolkit that focuses on measuring progress towards five outcomes: improved local and regional livelihoods, enhanced capacity for conservation, positive contribution to stability peace and security, long-term sustainability of the transboundary conservation area, and positive contribution to regional economic developments taking into account external factors (IUCN-SA, 2003). These criteria give a beyond park border perspective on the success of transboundary arrangements for local people. A more crude and simple measure of success is the mere presence of a transboundary protected area arrangement, on the assumption that it enhances political relationships with neighbouring countries and benefits local communities.

Most intangible values defy measurement and it is hard to make intuitive worth explicit without destroying their meaning. However, the political reality is that only calculable values ‘count’ (Putney & Harmon, 2003). Potential social criteria for the proposed model are summarised in Table 3.20.

Table 3.20
Summary of Potential Social Benefit Criteria for Comparing National Parks

Attribute	Potential Criteria	Information Sources	Measurement and Units
Spiritual significance	-	-	-
Scientific significance	National parks provide important sites for research. Criteria could include: - The number of academic publications that involve the scientific study of the park - The number of visiting scientists to the park - The number or presence of research agreements with universities - Professional comparative assessment by a team of scientists.	Records kept by the PAMA, visitor statistics, expert scientists.	Number or descriptive categories
Educational significance	Visitors can gain understanding and appreciation for the natural environment. Criteria could include: - The number of participants in educational or interpretive programmes - The presence of an educational visitor centre directly associated with the park - The frequency with which educational institutions and organisations take fieldtrips to the national park for educational purposes	Records kept by the PAMA, visitor statistics	The number of participants, visitor centres, and/or fieldtrips.
Cultural significance	UNESCO Cultural World Heritage Site status The number of historical components of the landscape and cultural landscape categories present	National park management plan or http://whc.unesco.org for World Heritage status. The number of historical components of the landscape and cultural landscape categories present may be determined from the management plan, interviews with local people and traditional owners, or from maps or spatial information in a GIS. The importance of importance of these could then be ranked on a descriptive scale by historical experts or people descended from those that created the cultural/historical components	The number of sites combined into descriptive categories of park importance.

Attribute	Potential Criteria	Information Sources	Measurement and Units
Significance for recreation and tourism	Visitors take part in recreational activities in national parks. Potential criteria include: - The number of national, continental, and foreign visitors per year; - The facilities and infrastructure available for visitors (e.g. lodges, restaurants, shops, camping sites, hides, types and state of roads); - The diversity of recreational activities available (e.g. hiking, horse riding, canoeing etc); - The area of the park available to visitors and types of access (length and types of road access); - Cultural sites, their preservation and associated interpretive displays and information; and, - Interpretive services and the range of information available to visitors and the public - Site importance based on the importance of a site for activity-based recreation, general sightseeing, and education; and annual visitor numbers	Visitor statistics collected by the PAMA and information presented in the national park management plan. The availability of maps, information sheets, books, scientific reports, annual reports and performance statistics from the PAMA.	Numbers and/or descriptive categories.
Scenic/Aesthetic significance	Potential criteria include: - Artistic impressions of the national park - Number of visitors (surrogate) - The uniqueness of geological features and number of landscape types present	Surveys of stores that sell photographs, calendars, postcards, and paintings of features from the national park. Visitor statistics collected by the PAMA. The management plan for geological features and types of landscape.	Number or type converted into a descriptive category for scenic importance.
Stakeholder participation	Potential criteria include: - Level of participation - Land ownership restitution - Formal structures and social institutions, legal and customary instruments and rules that facilitate public participation and accountability	The park management plan or staff of the PAMA.	Descriptive categories.
Peace parks	Transboundary protected area agreements with neighbouring countries may improve relations between countries.	The park management plan or staff of the PAMA.	Yes/No

3.4 THREAT ASSESSMENT CRITERIA

The IUCN objectives for national park management (IUCN-WCMC, 1994) advise managers to “eliminate and thereafter prevent exploitation or occupation inimical to the purposes of designation”. The pressures threatening national parks are not all contained within the park’s boundaries. Threats that are external to the park, like climate change, pose great management challenges. Much of the day-to-day work by conservation managers involves action to counter threats and understanding threats is a critical part of priority setting in conservation (Salafsky, Salzer, Ervin, Boucher, & Ostlie, 2003).

A national park may be subjected to a range of threats, but the severity of their impact is dependant on the extent to which it can withstand them (Hockings et al., 2000; Pressey, 1996). Threats to a national park include plant and animal pests, human activities within the park, and human activities surrounding the park. Processes like encroachment by exotic plants and modified fire regimes are difficult to exclude from protected areas without intensive management. Other impacts like air pollution and the destruction of complementary habitats cannot be offset through management of the protected areas themselves (Pressey, 1996). The most significant threatening factors are habitat destruction, habitat fragmentation, alien species, pollution, development on protected area boundaries, illegal use or collection of resources, and human-induced climate change (Halvorson, 1996; O'Riordan & Stoll-Kleemann, 2002). Habitat destruction is the single greatest threat to biological diversity in both terrestrial and marine environments (O'Riordan & Stoll-Kleemann, 2002).

In the past, conservation strategies were based on beliefs about fire, predators, and the static nature of a ‘climax’ ecosystem. Today, however, management needs to be based on information about park ecosystems and threats to their resources that is scientifically reliable (Halvorson, 1996). Threats to the integrity of a protected area should be documented by the PAMA. These are likely to include the degree of pest and weed invasion, fire fuel load, water quality and quantity, watershed condition, and the health of flora and fauna. Further, new developments within or adjacent to the protected area will have impacts that need to be assessed and monitored (De Lacy et al., 2006).

3.4.1 SELECTED THREATS FACING NATIONAL PARKS

Climate Change

Climate change is one of the threats facing national parks and protected areas around the globe. Under climate change scenarios, some species may no longer be able to survive within current protected areas. Some parks that are on the edges of habitat zones such as coastal areas and mountainous regions may change to a completely different type of habitat (Dudley, 2003). For example, a protected area that consists of a narrow coastal strip where there is no option to expand landwards will be susceptible the so-called 'coastal squeeze' effect, as the sea-level rises (Hockings et al., 2000). Some habitats and ecosystems will disappear altogether, while other changes will be long-term and catastrophic. Some changes may be short term, and others focused on individual species and local food webs. Protected area management agencies may have to shift protected area boundaries to protect moving habitats and ecosystems. This will be no simple task because protected areas do not exist in an empty landscape and replacement land or water may not be available. This will have enormous implications for protected area infrastructure, surrounding human communities, and the businesses that exist because of the protected area (Dudley, 2003).

Scott et al. (2002) modelled biome representation in Canada's national park system under multiple climate change scenarios. The equilibrium process-based global vegetation models BIOME3 and MAPSS were used to model vegetation change under multiple double-CO_2 climate change scenarios. Vegetation distribution scenarios were calculated at 0.5° latitude-longitude resolution and the boundaries of Canada's 39 national parks were superimposed on this in a geographic information system. The modelling results suggested substantial changes in biome representation in Canada's national parks. Greater than 50% of all vegetation group boxes changed biome type. The authors concluded that climate change represents an unprecedented challenge to Parks Canada.

Invasive Species

Historically, human commensals like rats and cats have caused extinctions around the world (Donlan, Tershy, Campbell, & Cruz, 2003). Many alien organisms "… have been introduced to areas outside their natural distribution ranges by human activities" (Macdonald, 1994, p. 199). Where naturally-occurring plants and animals have not evolved adequate defence mechanisms these organisms become invasive.

The introduction of foreign plant and animal species can have devastating impacts on natural ecosystems. Up to 40% of extinctions in the last four centuries may have resulted from introduced pests (Hambler, 2004). The adverse impacts of introduced animals are the greatest threat to the biodiversity of New Zealand, a country were protected areas account for over 30% of its terrestrial area. The ongoing process of biological invasion has rendered many bird species extinct and greater than 40% of remaining bird species threatened along with many endemic reptiles, invertebrates and plants. Thus, the focus of conservation management in New Zealand is the control and eradication of invasive species both within and outside of protected areas (Clout, 2001).

Visitor Use

From the 1980s a rising demand for wildlife and nature viewing has been observed. The principal reasons for this trend appear to be rising incomes in industrialised countries and cheaper travel costs, along with a shift in tastes towards nature-based tourism. In Third World national parks, where there is a limited supply of parks and entrance fees are low, the result has been overcrowding in the more popular national parks (Shah, 1995). Overcrowding does not apply to the Third World national parks alone, for example overcrowding by tourists is considered one of the two greatest threats to the national parks of the Czech Republic (Správa Krkonošského Národního parku, 2006; Správa Národního parku a chránené krajinné oblasti Šumava, 2006). The threats associated with increased visitor number in parks include environmental damage by large numbers of visitors and interactions between animals and people.

Tourist behaviour that is thoughtless, poorly informed, or irresponsible puts pressure on local ecosystems, but other problems arise when cumulative impacts exceed the local carrying capacity (Mowforth, Charlton, & Munt, 2008; Weaver & Lawton, 2005). Natural habitat can be lost through seemingly harmless activities such as walking, mountain-biking, or horse riding. These activities can disturb vegetation and soil, often leading to wider, muddier trails through soil erosion or compaction. Further vegetation changes may occur at the edges of tracks where tourists have inadvertently introduced alien plant species via seeds that are attached to their shoes/clothing/equipment. Sensitive environments like sand dunes, peat moorlands, and geothermal areas are more vulnerable to serious damage (Page et al., 2001). Waterborne visitors can cause riverbank erosion, and divers and boaters can disturb aquatic sediments (Page et al., 2001; Weaver & Lawton, 2005). Tourists can also damage historic buildings and cave paintings through wear by foot traffic, increased humidity, light, and dust (Page et al., 2001). Further, elevated numbers of tourists bring greater quantities of litter and pollution, and require more guidance, facilities, water, and waste disposal (Mowforth et al., 2008).

Depending on the number of tourists observing an animal and their behaviour, the animal is likely to modify its natural course of action (Shah, 1995). In particular, charismatic megafauna, like lions (*Panthera leo*) in Kenyan national parks, tend to be harassed by tourists, disrupting the animals' usual habits and behaviour (Page et al., 2001). In a study of the influence of human presence on wintering wildfowl behaviour in a wetland of international importance in Southern France Guillemain et al. (2007) found that birds would always feed after disturbance, disrupting their normal resting patterns.

The idea of a carrying capacity for tourists is based on the notion of the highest and best use of an area or the most desirable set of ecological and social conditions (Ryan, 1991). According to Fennell (2003) the carrying capacity of an area is reliant on four interrelated elements: (1) the quantity of a given type of use (2) an ecosystem can tolerate (3) over time (4) without degradation making it unsuitable for that use. Carrying capacity can provide a guiding framework for tourist development, particularly when used with other approaches such as zoning (Mexa & Coccossis, 2004; Ryan, 1991).

Poaching

Poaching is a significant threat to wildlife across the world, particularly in the tropics. Much of this hunting is for commercial gain as opposed to subsistence living (Wato, Wahungu, & Okello, 2006). The international trade in wildlife ranges from live animals and plants to wildlife products including foods, leather goods, tourist curios, and medicines (CITES Secretariat, n.d.). Poaching is considered the greatest threat to biodiversity conservation in the protected areas of the Central African Republic in the short to medium-term (Blom, Yamindou, & Prins, 2004). Poaching pressure has severely impacted the population of Sumatran tiger (*Panthera tigris sumatrae*) in Kerici Seblat National Park (Sumatra); elephants in Kideppo Valley National Park (Uganda); Chimpanzees (*Pan troglodytes*) in Gombe National Park (Tanzania); and African buffalo (*Syncerus caffer*), elephant and black rhino (*Diceros bicornis*) in Serengeti National Park (Tanzania) (Aleper & Moe, 2006; Hillborn, Arcese, Borner, Hando, Hopcraft et al., 2006; Linkie, Martyr, Holden, Yanuar, Hartana et al., 2003; Pusey, Pintea, Wilson, Kamenya, & Goodall, 2007).

Buffer Zone/Border Conflict

Conflict with people on reserve borders is a major cause of mortality in large carnivores inhabiting protected areas. Thus, species that range widely and therefore are most exposed to threats on reserve borders are most likely to disappear from small parks (Woodroffe & Ginsberg, 1998).

Third World national parks are under increasing pressure from economic activity in the buffer zones, such as farming, grazing, grass gathering, tree harvesting for firewood and timber, and wildlife poaching. Rural communities are generally poor and often have a direct dependence on natural resources. If day-to-day survival becomes a reality for a community for reasons such as an increase in population or decrease in land availability, people may be tempted to exploit the national park (Shah, 1995). If the buffer area is exploited and becomes desertified, the flora and fauna at the boundary of the park will retreat into the interior of the park, making the edges vulnerable to erosion (Shah, 1995).

3.4.2 THREAT TAXONOMY

Until recently, threat assessment frameworks lacked standardised terminology and therefore direct comparability. There was also no standardised system for measuring the strength, extent, and magnitude of threats (Salafsky et al., 2003). A standardised framework for naming, measuring, and comparing threats in conservation is presented by Salafsky et al. (2003). This is the most practical and comprehensive framework for threat assessment in which the terminology is clear (relationships are unambiguous and definitions are precise) and compatible with the existing terminology used in conservation. Terms and definitions to describe different threat components include:

> Threats – any human activity or process that has caused, is causing or may cause the destruction, degradation, and/or impairment of biodiversity and natural processes. There is often a fine line between a naturally occurring event such as a fire lit by lightening and human-caused threats such as fires set by a match or even increased intensity of fires due to forest management practices. In general, we would regard the latter two threats whereas the former is not. In systems that depend on human actions to maintain biodiversity such as the use of prescribed burnings, the removal or alteration of these management activities may also constitute a threat. It includes both *direct threats* and *underlying causes*. Synonymous with *pressures.*
>
> Direct Threats – factors that immediately cause stress to conservation targets by physically causing their destruction or degrading their integrity.
>
> Underlying Causes – a condition or environment, usually social, economic, political, institutional, or cultural in nature, that enables or otherwise contributes to the occurrence and/or persistence of a direct threat. There is typically a chain of underlying causes behind any given direct threat. In a situation analysis, underlying causes can be subdivided into *indirect threats* (factors with a negative effect) and *opportunities* (factors with a positive effect). Synonymous with *drivers*.
>
> Past Threats – threats that have occurred in the past, but are no longer active (although their effects on targets may still persist).
>
> Current Threats – threats that are actively occurring.
>
> Future Threats – threats that are not actively occurring, but have some probability of occurring in the future.
>
> Targets – the biological entities (species, communities, or ecosystems) that the project is trying to conserve. Synonymous with conservation targets, biodiversity targets, and local targets. (Salafsky et al., 2003, p. 5)

Decisions about where to allocate resources occur annually, so future threats and past threats are not within the scope of this research. Instead, current direct threats are most relevant to the ranking model because they indicate what is happening ‘now’.

The following conventions for describing direct threats are proposed by Salafsy et al. (2003) on the assumption that human activities cause all threats:

> Habitat conversion – total loss or destruction of natural habitat.
>
> Transportation infrastructure – development of long narrow corridors for transporting people, goods, and energy.
>
> Abiotic resource use – human extraction of non-biological resources.
>
> Consumptive biological resource use – human harvesting or use of biological resources from an ecosystem that removes the resources from the system.
>
> Non-consumptive biological resource use – human use of biological resources in an ecosystem in a way that does not remove the resources from the system.
>
> Pollution – human caused introduction and spread of unwanted matter and energy into ecosystems. Includes chemical, biochemical, thermal radiation, and noise pollution. Can include both point source and non-point source pollution.
>
> Invasive species – human linked introduction and spread of species from one ecosystem into another. Includes alien or exotic species as well as escaped native ones. Also includes plants and animals as well as disease causing organisms.
>
> Modification of natural processes/ecological drivers/disturbance regimes – human caused changes in natural systems. Threats in this category often bleed over into "stresses" within a system. In managed systems, removal or alteration of human management activities such as grazing or prescribed burns may also constitute a threat. (Salafsky et al., 2003, p. 8)

The full taxonomy of direct threats is shown in Table 3.21, were specific examples of each type of threat are given for various biome types.

This taxonomy was developed to guide practitioners to develop a model of the threats affecting their project site. For each direct threat there are two components: the 'what' and the 'who'. For example, if the action is logging (the what), different threats are posed if the actor is a multinational company or a local community (the who). The taxonomy presented in the table is restricted to the actions being taken, but practitioners are cautioned not to ignore the underlying causes and actors responsible for direct threats (Salafsky et al., 2003).

Table 3.21
An Initial Taxonomy of Direct Threats

Threat category	**Generic threats in different biome types**				
	Forests	**Grasslands/ Savannah**	**Desert**	**Fresh water**	**Marine**
Habitat conversion	Housing Industrial development Farms Plantations Ski areas	Housing Industrial development Farms Dam construction Golf courses	Housing Industrial development Farms Golf courses	Docks Farms (e.g. rice) Channelization Dam construction Shipyards	Aquaculture Destructive fishing
Transportation infrastructure	Utility lines Roads Railroads	Utility lines Roads Railroads	Utility lines Roads Railroads	Levees and dikes Dredging	Dredging Shipping lanes
Abiotic resource use	Mining Oil and gas drilling Geothermal energy Water withdrawal	Mining Oil and gas drilling Geothermal energy Water withdrawal Wind farms	Mining Oil and gas drilling Geothermal energy Water withdrawal Wind farms	Mining Oil and gas drilling Water withdrawal	Mining Oil and gas drilling Coral mining Desalizanation plants Wind farms
Consumptive biological resource use	Hunting/ harvesting Grazing Logging	Grazing Hunting / gathering	Grazing	Fishing	Fishing Trawling
Non-consumptive biological resource use	ATVs / Snowmobiles Hiking / biking Scientific research Military manoeuvres	ATVs / Snowmobiles Hiking / biking Scientific research Military manoeuvres	ATVs / Snowmobiles Hiking / biking Scientific research Military manoeuvres	Jet skis Boating Scientific research Military manoeuvres	Jet skis Boating Scuba / snorkelling Military manoeuvres
Pollution	Acid rain Solid waste Toxins Radio active fallout	Solid waste Toxins Radio active fallout Agricultural run-off	Salizanation Toxins Solid waste	Municipal waste Solid waste Toxins Agricultural run-off Thermal pollution	Solid waste Toxins Agricultural run-off Municipal waste Sonic pollution
Invasive species (alien and native)	Plants Animals Diseases and pathogens	Plants Animals Diseases and pathogens	Plants Animals Diseases and pathogens	Plants Animals Diseases and pathogens	Plants Animals Diseases and pathogens
Modification of natural processes / ecological drivers / disturbance regimes	Climate change Loss of key predators Grazing patterns Fire regimes	Climate change Desertification Grazing patterns Fire regimes	Climate change Grazing patterns	Climate change Sea-level rise Fragmentation Sedimentation Loss of key predators Flow regimes (dams) Shoreline stabilisation	Climate change Sea-level rise Coral bleaching Loss of key predators

Source: Salafsky *et al* (2003, p. 28).

3.4.3 MEASURING INDIVIDUAL DIRECT THREATS

Some nature-NGOs have developed frameworks to prioritise conservation areas (see Chapter 4) that incorporate an assessment of the threats facing the area. Both the WWF's Rapid Assessment and Prioritisation of Protected Area Management (RAPPAM) framework (Ervin, 2003c) and The Nature Conservancy's Five-S Framework for Site Conservation (The Nature Conservancy, 2000a) provide good examples. Salafsky et al. (2003) also propose a standard system for measuring threats in conservation.

The RAPPAM framework focuses on the state of biodiversity expressed in biodiversity objectives, rather than specific biodiversity elements. These objectives are linked to pressures and threats to the protected area. Pressures are forces, activities, or events that have already had a detrimental impact on the integrity of the protected area, while threats are potential or impending pressures that are likely to have a detrimental impact on the protected area in the future. Pressures are noted in regard to changes in their severity over the past five years, and the severity of the pressure over the last five years based on the extent of the park in which the pressure is present, its impact, and the permanence of the pressure. Similarly, the extent, impact, and permanence of a threat over the next five years is predicted, along with the probability of that threat occurring. The scorecard questionnaire for pressures and threats is shown in Figure 3.3 below. Each threat is scored for each variable using a 1-4 ranking and the scores are multiplied to give an overall score for each threat (Ervin, 2003c).

The Nature Conservancy's Five-S Framework for Site Conservation was developed as part of its 'conservation by design' strategy to address strategic conservation planning and assessment of conservation success. Each conservation area project is focussed on specific conservation targets, be they ecological communities, ecological systems, or species. Conservation targets can be affected by threats which impair or degrade their key ecological attributes. The Five-S Framework assesses threats by differentiating between stresses and sources of stress, later combining the measurements for each. A stress is an "… impairment or degradation of the size, condition, and landscape context of a conservation target, and results in reduced viability of the target" (The Nature

Conservancy, 2000, p. V-1). In comparison, a source of stress is “… an extraneous factor, either human (e.g. policies and land uses) or biological (e.g. non-native species), that infringes upon a conservation target in a way that results in stress” (The Nature Conservancy, 2000, p. V-1).

Figure 3.3
RAPPAM Scorecard for Pressures and Threats

2 PRESSURES AND THREATS

Pressure: ____________________

○ Has ○ Has not been a pressure in the last 5 years

In the past 5 years this activity has:	The overall severity of this pressure over the past 5 years has been:		
	Extent	Impact	Permanence
○ Increased sharply	○ Throughout (>50%)	○ Severe	○ Permanent (>100 years)
○ Increased slightly	○ Widespread (15–50%)	○ High	○ Long term (20–100 years)
○ Remained constant	○ Scattered (5–15%)	○ Moderate	○ Medium term (5–20 years)
○ Decreased slightly	○ Localized (<5%)	○ Mild	○ Short term (<5 years)
○ Decreased sharply			

Threat: ____________________

○ Will ○ Will not be a threat in the next 5 years

The probability of the threat occurring is:	The overall severity of this threat over the next 5 years is likely to be:		
	Extent	Impact	Permanence
○ Very high	○ Throughout (>50%)	○ Severe	○ Permanent (>100 years)
○ High	○ Widespread (15–50%)	○ High	○ Long term (20–100 years)
○ Medium	○ Scattered (5–15%)	○ Moderate	○ Medium term (5–20 years)
○ Low	○ Localized (<5%)	○ Mild	○ Short term (<5 years)
○ Very low			

Source: Ervin (2003c, p. 43c)

Two illustrative lists of stresses and sources of stress were developed to prompt the managers undertaking the assessment. Once identified, both stresses and sources of stress are ranked on a scale of very high–high–moderate–low. The stresses are ranked against the:

- Severity of damage – given current circumstances, the level of damage to the conservation targets expected within 10 years; and
- Scope of damage – given current circumstances, the geographic scope of impact to the conservation targets expected within 10 years.

The sources of stress are ranked against the:

- Degree of contribution to the stress – the contribution of the single source to the full expression of stress; and,
- Irreversibility of the stress – the ease by which the stress caused by the source of stress can be reversed.

The scores are then combined via a series of rules to give an overall score for each threat and a threat status for the site (The Nature Conservancy, 2000). This method of assessing threat status for a conservation target is cumbersome for practitioners to use.

Salafsky et al. (1999) propose a standard system for measuring the magnitude of threats in conservation that is more precise and practical than the RAPPAM and 5-S frameworks. In developing the system they sought to make it measurable using both continuous data or impact categories, consistent at different spatial and temporal scales, consistent across different types of threats to allow comparison, combinable into an overall score for an area, and easy for practitioners to use. The proposed measurement system is presented in Table 3.22. Different steps in the conservation process require the assessment of different threat variables. The authors suggest the scope, severity, and timing variables are most pertinent for a comparison of conservation areas in order to determine where resources should be invested (the purpose of this research). Depending on the decision-making framework employed, the likelihood and reversibility variables may also be relevant.

3.4.4 COMBINING THREATS

Depending on the purpose of a threat assessment, threats may need to be combined in different ways. This may be the significance of a single threat to a single target, the impact of multiple threats on a single target, the impact of one threat across multiple targets, or combined threat status for a project (Salafsky et al., 2003). Determining a threat score for a single target (one national park), termed a 'Type II roll-up' is most appropriate for this research. Salafsky et al. (2003) advocate processes used in The Nature Conservancy's 5-S framework for combining threat measures because this method has proved robust over hundreds of conservation projects.

Table 3.22

Proposed Continuous and Categorical Measurements for Threat Variables

Variable	Continuous Measurement	Categorical Measurement	Comment
Scope (spatial) the area of the project site (or target occurrence) affected by a threat within 10 years	Area threatened expressed in hectares or as a percentage of the total possible area	4 = Throughout (>50%) 3 = Widespread (16–50%) 2 = Scattered (5–15%) 1 = Localized (<5%)	Calculated as a percentage of possible area (i.e., pollution as percentage of aquatic habitat at a site, not entire site)
Scope (% of targets) the number of target occurrences affected by a threat within 10 years	Absolute number of targets or percentage of targets within a protected area affected	4 = Most or all (>50%) 3 = Many (26-50%) 2 = Some (5-25%) 1 = Few (<5%)	Is an alternative way of measuring scope
Severity the degree to which a threat has an impact on the viability/integrity of targets within the protected area within 10 years	Actual measure of reduced target viability/integrity (e.g., nesting success, stream temperature)	4 = Serious damage or loss 3 = significant damage 2 = moderate damage 1 = little or no damage	Independent of area; different continuous measures needed for each target type
Timing time until a threat will start having an impact on targets	Years	4 = Current (< 1 year) 3 = Imminent (1-3 years) 2 = Near-term (3-10 years) 1 = Long-term (>10 years)	Refers to onset of the impact, not the duration of threat
Likelihood the probability that a threat will occur within the next 10 years	The fraction between 0 and 1 or percent between 0 and 100	4 = Existing threat (100%) 3 = High probability (50-99%) 2 = Moderate probability (10-49%) 1 = Low probability (0-9%)	May not be included in most calculations; it can also be applied to other variables
Reversibility degree to which effects of a threat on target occurrences can be restored	Resources (money, time, ecological capital, etc.) required to reverse a threat	4 = irreversible (e.g. extinction) 3 = reversible with difficulty 2 = reversible with some difficultly 1 = easily reversible	Distinguish between technical versus economic or practical reversibility
Contribution the degree to which a threats causes multiple and cascading threats and/or has widespread ecological impacts	Number of targets and/or target occurrences affected by threat	4 = Very high 3 = High 2 = Moderate 1 = Low	Has some potential overlap with scope

Source: Salafsky et al. (2003, p. 18)

The first step is to calculate threat magnitude by combining the scope and severity measures derived from Table 3.22 above. The rules for combining scope and severity measures are presented in Figure 3.4 below. It is not clear why, for example, the threat magnitude is the same (low) for low severity and very high scope, and for low severity and low scope.

Figure 3.4

Rule-Based Procedure for Calculating Threat Magnitude

		Scope			
		4-Very High	3-High	2-Medium	1-Low
Severity	4-Very High	4-Very High	3-High	2-Medium	1-Low
	3-High	3-High	3-High	2-Medium	1-Low
	2-Medium	2-Medium	2-Medium	2-Medium	1-Low
	1-Low	1-Low	1-Low	1-Low	1-Low

Source: Salafsky et al. (2003, p. 20)

Magnitude measures for each threat are then combined for a target site following the three-five-seven rule where:

- Three High threats are equivalent to one Very High threat;
- Five Medium threats are equivalent to one High threat; and,
- Seven Low threats are equivalent to one Medium threat.

The rule-based calculation of threat magnitude is considered meaningful, simple, and transparent. The three-five-seven rule for combining threats to a site is also meaningful and simple, but lacks transparency (Salafsky et al., 2003)

The system for naming, measuring, and comparing threats in conservation presented by Salafsky et al. (2003) represents the most practical option for threat assessment across multiple sites. It does involve considerable simplification in reducing specific threat to an overall threat rating. However, this system is the most appropriate for deriving threat information for comparative purposes. The steps for determining the threat status of a national park using this system are as follows:

1. Identify the direct threats to the national park using the threat taxonomy as a prompt;

2. Score the scope and severity of each threat using descriptive categories;

3. Combine the scope and severity scores into a threat magnitude measure following the scoring method used in The Nature Conservancy's 5-S framework (The Nature Conservancy, 2000); and,

4. Combine all of the threat magnitude measures for a site into a threat status following the three-five-seven rule.

3.5 CONCLUSION

The natural heritage, economic, social, and threat assessment criteria that could be used to rank national parks are outlined in this chapter. Natural heritage criteria at the landscape, ecosystem, and species level have generated considerable attention in the conservation biology, park management, and international conservation literature. These criteria are clearly what conservation has always been about. Debate about the different ways of categorising and measuring different aspects of this natural heritage exists, but the body of literature is generally well-understood and consensus exists on many aspects. The importance of genetic-level attributes has been recognised in the international literature, but this is a relatively young area of research and it is currently not clear how to measure a conservation area in terms of genetic significance. Methods for comparing the magnitude of threats facing protected areas appear simplistic, but offer practical options for including threats in significance assessment and decision-making.

The fields of natural resource economics and ecological economics are less well-established than the conservation sciences, but the types of financial and economic costs and benefits associated with national parks can generally be easily identified. The financial costs and benefits and many of the economic benefits are measurable. The major exception is ecosystem services benefits, for which standards and valuation methods are still under development.

The social benefits associated with natural areas are the hardest to define and measure. There is considerable overlap with these intangible attributes, and a general indication in the park management and social sciences that it is unethical to draw comparisons on a cultural or spiritual basis. However, these benefits are increasingly recognised as important and vital to the success of national parks in the eyes of the public, if not in an explicit manner. It is hard to address equity issues in devising a system to measure an intangible benefit because the recognition of social benefits is dependant on the extent of cultural and historical knowledge and the assertiveness of associated stakeholder groups in expressing intangible relationships with an area. All of the social criteria identified have limitations, but it is important that social aspects are included in significance assessment.

The proposed model will incorporate some of the criteria identified in this chapter. Decision-making frameworks that are used in conservation are reviewed in the Chapter Four, with the intention of selecting a framework that can incorporate the breadth of criteria discussed here. The process for choosing the final set of criteria for the decision-making model is described in Chapter Five.

4 SELECTING A DECISION-MAKING FRAMEWORK

The preceding chapter presented a review of the biological, social, and economic criteria that could be employed to compare national parks. The aim of this chapter is to identify a suitable rational decision-making framework in which to incorporate these criteria to assist decision-makers with the annual allocation of funds amongst national parks. Frameworks used to set priorities in conservation were identified and reviewed in the context of the key objectives for the proposed model. The decision-making frameworks reviewed in this chapter have been divided into four groups (Table 4.1), which are discussed separately.

Table 4.1

Groups of Decision-Making Frameworks Reviewed in this Chapter

Type of Decision-Making Framework	Overall Purpose	Criteria/Analysis Involved	Framework Specifically Developed for Protected Areas?
Methods for identifying new protected areas	Prioritising conservation effort	A range of predominantly biological and landscape criteria	Yes
Methods for evaluating management effectiveness		Analysis of existing protected area characteristics and management capacity	Yes
Cost-based methods	Deciding which actions to implement	Economic analysis of project costs and outcomes	Sometimes – usually project-level analyses; used in many disciplines
Multiple Criteria Decision Making methods	Making better decisions	Consideration of a wide range of criteria	No – used in many disciplines; rarely applied to protected areas

The first two groups of methods were developed in response to the problem of resource scarcity in conservation (Weitzman, 1998). Many decision-making frameworks have been developed to prioritise areas for conservation effort. These frameworks arise from diverse disciplines including conservation biology, ecology, economics, political science, and sociology (Hughey, Cullen, & Moran, 2003). The first group of frameworks was developed to identify areas to be designated as protected areas, while the second group of frameworks was developed to prioritise conservation efforts based on the evaluation of the effectiveness of protected area management in existing protected areas.

Frameworks belonging to the third group were developed in the environmental economics discipline. These relate to the selection of conservation projects based on the analysis of costs and benefits/outcomes. The fourth group of frameworks belongs to the Multiple Criteria Decision Making literature, and was initially developed through operations research. These are formal decision-making frameworks that employ computer software to model decisions.

Following the review of decision-making frameworks, the most appropriate decision-making framework to address the problem posed in this thesis is selected. The selection is based on the characteristics identified in Chapter Three; that is, the framework selected must: accommodate incommensurate data, it must provide a transparent mechanism for dealing with data that may be subjective, and it should incorporate a transparent procedure for subjectively weighting criteria. Of the frameworks reviewed, Multiple Criteria Analysis, a framework belonging to the Multiple Criteria Decision Making group of frameworks, is identified as the most appropriate decision-making framework for a model to assist decision-makers with the allocation of funds amongst national parks. The chapter concludes with an in-depth discussion of the Multiple Criteria Analysis process.

4.1 FRAMEWORKS DEVELOPED TO IDENTIFY AREAS FOR PROTECTED AREA DESIGNATION

Decision-making frameworks to identify areas for protected area designation were developed to address the question "What and where are the priority areas or species that require conservation management?" (Hughey et al., 2003, p. 93). Frameworks belonging to this group are based on the premise that because conservation funding is limited, it should be concentrated on the areas richest in biodiversity; therefore, the best way to do this is to identify the most biologically important areas and ensure their conservation by giving them protected area status (Olson & Dinerstein, 1998).

The historical selection of sites for national parks was largely unscientific and *ad hoc*. Consequently, many national parks are located in mountainous or other regions with low economic potential for timber extraction or agricultural development, and ecosystems in areas suitable for economic activities are poorly represented in the world's protected areas (Norton & Roper-Lindsay, 2004). Scientific interest in national park selection and design was stimulated in the 1970s by island biogeography theory, and from the late 1980s has developed into a large literature on the systematic methods to evaluate and choose terrestrial areas for protection (Norton & Roper-Lindsay, 2004). Prominent contributions to the literature about prioritising terrestrial areas for protection include Bell *et al.* (1987), Bonn *et al.* (2005), Cavieres *et al.* (2002), Dinerstein *et al.* (1993), Fjeldsa (2000), Heath *et al.* (2000a), Margules and Pressey (2000), Moilanen (2005), Moore *et al.* (2003), Moran *et al.* (1997), Polasky *et al.* (2000), Pressey *et al.* (1996), Pressey *et al.* (1994), Pressey *et al.* (1993), Spector (2002), Woinarski *et al.* (1996), and Woodhouse *et al.* (2000). Frameworks for selecting aquatic areas for protection have been considered by other authors, including Leslie (2005), Lourie *et al.* (2004), Raven *et al.* (1998), and Turpie *et al.* (2002).

Priority-setting frameworks consider criteria according to one central goal. Perlman and Andelson (1997) identify four central goals used in priority-setting decisions:

1. *All* biodiversity must be protected
2. The *most* biodiversity must be protected;
3. The *most diverse subset* of biodiversity must be protected; or
4. The *most valuable* biodiversity must be protected.

An example of how goals can influence priority-setting decisions is outlined by Perlman and Andelson (1997). During a three day workshop, experts were given biological information about Latin America and the Carribean and asked to select priority areas for conservation. As a group, the experts divided the area into seven major habitat types and thirty-five regional habitat units and gave each regional habitat unit a 'biological value' score and a 'landscape integrity and conservation status' score. The 'biological value' score for each habitat unit was based on species richness, phyletic diversity, the number of endemic species present, beta diversity, and presence of rare/endangered species. The 'landscape integrity and conservation status' score was based on the presence or absence of large blocks of original habitat, the percentage of remaining original habitat, rate of conversion, degree of degradation and fragmentation, and the degree of protection. The experts were later divided into four groups and instructed to identify priority areas for conservation. All four groups gave the highest and lowest priority to areas with the most and least ‘biological value’ respectively. Three of the groups considered biological value and threat alone, giving the highest priority to the most threatened areas. However, the fourth group gave the highest priority to the relatively intact areas, as well as those considered critical (Perlman & Andelson, 1997).

Many decision-making frameworks to identify areas for protected area designation are data intensive, and rely on the expertise and resources of academic institutions and nature-NGOs. These priority-setting frameworks focus primarily on criteria that indicate the biological importance of the area. Some frameworks focus on a single species, while others consider multiple biological criteria (Davis, Heywood, & Hamilton, 1995). Other criteria included in some frameworks include those indicating the degree of threat faced by the area, the economic costs and benefits of conservation and management actions, and social benefits associated with the area. In the following discussion, the frameworks are divided into those based on species-related criteria, those based on habitat-related criteria, and those incorporating economic and/or social criteria.

4.1.1 FRAMEWORKS BASED ON SPECIES CRITERIA

Species-based frameworks prioritise areas for conservation based on the distribution of one or multiple species (usually fauna). An analysis of priorities may involve a single umbrella species, the presence of threatened or flagship species, or a large number of species. The most prominent species-based frameworks for prioritising areas for protected area designation are detailed in Table 4.2.

Roberge and Angelstam (2004) reviewed 18 research papers that employ the umbrella species concept as a priority setting tool. They conclude that single-species umbrellas cannot ensure the protection of all co-occurring species, because some species are limited by factors irrelevant to the umbrella species. The authors advocate multi-species approaches that consider a range of habitat types and landscape attributes as a better approach for rapid assessment.

Birds are considered good indicators for identifying potential protected areas because they have dispersed to, and diversified in, all regions of the world; they occur in virtually all habitat types and altitudinal zones; and avian taxonomy and the geographical distribution of individual bird species are well-known so comprehensive global analysis is possible (Fishpool & Evans, 2001). However, while indicator taxa are considered a pragmatic method for assessing priorities, they cannot ensure complete and efficient representation (Moore et al., 2003).

Birds, large mammals, reptiles, flowering plants, and some invertebrates have been categorised by the IUCN according to their risk of extinction, with this risk being based on measures of rarity, rates of decline, and population fragmentation. Most quantitative measures of these concepts are sensitive to the scale at which they are made (Hartley & Kunin, 2003). Nevertheless, threatened species are listed on the IUCN's Red List and are published in Red Data Books, and the closer a species is to extinction, the higher the priority placed on it by the IUCN. Some authors have criticised such methods because most assume a high degree of threat is sufficient for intervention (Moran et al., 1997). For example, Myers (1983) suggests that species conservation be approached in the same manner that doctors prioritise patients in an emergency situation. This 'triage approach' to species conservation would mean withholding or delaying funding for those species that will survive only if allocated considerable funding and for those that can survive without immediate access to financial resources. Using this approach, the greatest share of resources should be allocated to species that can survive if given a reasonable amount of attention. The merits of triage approach continue to be highlighted in the conservation literature (see Hambler, 2004).

Approaches based on species distribution data include those focusing on tropical species (Balmford & Long, 1995; Barrett, Brandon, Gibson, & Gjertsen, 2001; Bruner, Hanks, & Hannah, 2003) and avian species in Africa (Brooks, Balmford, Burgess, Hansen, Moore et al., 2001; Brooks, Balmford, Burgess, Fjeldsa, Hansen et al., 2001; Brooks & Thompson, 2001). The WWF uses flagship species as 'ambassadors', icons, or symbols for defined habitats, campaigns, or environmental cause. By successfully conserving that species, other species

Table 4.2

Selected Species-Based Frameworks for Selecting Areas for Protected Area Designation

Framework	Description	Scale	Biological Criteria	Threat Criteria	Strengths	Weaknesses
Endemic Bird Areas **BirdLife International (Stattersfield, Crosby, Long, & Wege, 1998)**	Identifies 218 regions of the world where the distributions of two or more restricted-range species overlap (BirdLife International, 2006a).	Global	Presence of endemic bird species having a restricted global breeding range of less than 50,000 km^2.	None.	Most EBAs are also important for the conservation of restricted-range species from other animal and plant groups. Globally, EBAs amount to just 4.5% of the Earth's land surface (BirdLife International, 2006a).	Does not incorporate threats, or social or economic criteria. Limitations of using birds as umbrella species. Data limitations.
Flagship Species **World Wide Fund for Nature (WWF)**	Assumes that by protecting charismatic megafauna (e.g., giant panda, Bengal tiger, black rhinoceros, mountain gorilla), which appeal to the general public, many other species in the same area are also protected (WWF, 2006).	Global/ National	The presence of at least one species of charismatic megafauna.	None.	Easy to gain public support, simple to implement (Hughey et al., 2003).	Does not incorporate threats, or social or economic criteria. Potentially huge opportunity costs for areas without these species (Hughey et al., 2003). Data limitations.
Important Bird Areas (IBAs) **BirdLife International (BirdLife International, 2006b)**	Areas amenable to conservation action and management that are key habitats for bird species vulnerable to extinction or whose populations are otherwise irreplaceable. Comprehensive books are available for Europe (Heath et al., 2000a; Heath, Evans, Hoccom, Payne, & Peet, 2000b), Asia (Chan, Crosby, Islam, & Tordoff, 2004), the Middle East (Evans, 1994), Tropical Asia (Boyla & Estrada, 2005), and Africa (Fishpool & Evans, 2001).	Global/ Regional/ National	Largely determined using ornithological data. Four IBA categories: (1) Globally Threatened Species; (2) Restricted-Range Species (Endemic Bird Areas - EBAs); (3) Biome-restricted Assemblages; and (4) Congregations (Fishpool & Evans, 2001; Vreugdenhil, Terborgh, Cleef, Sinitsyn, Boere et al., 2003). Also incorporates existing international legal instruments, e.g., Ramsar sites.	Considers key land-use threats to the area and the seriousness of threats.	Criteria are internationally agreed, standardised, quantified, and scientifically defensible (BirdLife International, 2006b).	Does not incorporate social or economic criteria. Limitations of using distribution patterns of a better known taxon (with relatively good data coverage) as a proxy for the patterns of all taxa.

Framework	Description	Scale	Biological Criteria	Threat Criteria	Strengths	Weaknesses
Red List of Threatened Species **IUCN (Goodwin & Holloway, 1972; IUCN, 2001)**	Establishes criteria for threatened species to determine endangered species priorities. Species are allocated to a category that represents the likelihood of extinction. The Red List is published online at www.iucnredlist.org/.	Global/ National	Degree of rarity or threat determined for birds, mammals, reptiles, flowering plants, and some invertebrates (Hambler, 2004).	None.	Helps to identify international and national priorities (Hughey et al., 2003). Threat categories and criteria have been revised several times and are considered helpful in policy-making (Hambler, 2004).	Does not incorporate threats, or social or economic criteria. Only concerned with the rarity of species and does not specifically assess areas for protection. Data limitations.
Species-By-Species Approach to Prioritise Reaches in a Catchment **(Filipe, Marques, Seabra, Tiago, Ribeiro et al., 2004)**	Estimates the conservation value of individual stream reaches by summing the predicted probability of occurrence of fish species multiplied by the corresponding conservation value of each species. Applied to native freshwater fishes of the Guadina River Basin (southern Iberian Peninsula) which are threatened by the construction of two major dams (Filipe et al., 2004).	Local/ National	Occurrence (based on landscape variables), abundance, endemicity, and rarity of native fishes.	Human presence variables.	A practical way of ranking watercourses for conservation based on the probability of species occurrence (Filipe et al., 2004).	Does not incorporate social or economic criteria. Limitations of aggregating criteria estimates (Filipe et al., 2004). Data limitations.

sharing its habitat and/or vulnerable to the same threats may also be conserved (WWF, 2005b).

Some authors have suggested basing priorities on genetic distinctness by analysing phylogenetic diversity (e.g. Woinarski et al., 1996). However, the time and expertise involved in this sort of analysis make it impractical.

Approaches based on the distribution patterns of a better known taxon as a proxy for the patterns of all taxa (like BirdLife International's Important Bird Areas method) are criticised by Vreugdenhil *et al.* (2003) for the following reasons:

1. Sampling bias caused by centres of investigation and access;
2. Sampling bias caused by the frequency of sampling, so that seasonal fluctuations or non-residence of recorded species is not noted;
3. Dependence on intensive fieldwork, which is time-consuming and involves expensive transportation to places not easy to access;
4. Problems in defining categories for species assemblages;
5. Data do not provide delineation of territories;
6. Dependence on highly skilled, and expensive, taxonomists; and,
7. Failure of one taxon to adequately represent other taxa.

Consequently, Vreugdenhil *et al.* (2003) suggest that the primary use of data about a specific taxon should be to verify that the taxon is represented in the protected area network.

4.1.2 FRAMEWORKS BASED ON HABITAT CRITERIA

Habitat-based approaches recognise that to achieve maximum conservation, limited resources should be focused on areas with important habitat characteristics. However, habitats are harder to define than species. Criteria for prioritising habitats include: diversity (of habitats and/or species), endemism, area, threat, amenity value, education value, representativeness, scientific value, typicalness, fragility, archaeological interest, importance for migratory wildfowl, replaceability, and management factors (Hambler, 2004). Prominent frameworks for prioritising areas for protected area designation are shown in Table 4.3.

Global-scale methods include Conservation International's Major Tropical Wilderness Areas and Megadiversity Countries (Conservation International, 1990; Mittermeier, Gil, & Mittermeier, 1997; Myers, 1988), WWF's Global 200 Ecoregions, BirdLife International's Important Bird Areas and Endemic Bird Areas (BirdLife International, 2006a,2006b; Stattersfield et al., 1998), and WWF/IUCN's Centres of Plant Diversity (Davis, Heywood, & Hamilton, 1994; Davis et al., 1995). These have centred around Conservation International's Biodiversity Hotspots model, first proposed by Myers (1988). Broadly speaking, the term 'hotspot' applies to an area with high concentrations of naturally occurring species, and/or high levels of threat to species diversity (Earthwatch Europe, IUCN, & World Business Council for Sustainable Development, 2002; Mittermeier, Myers, Thomsen, da Fonseca, & Olivieri, 1998; Myers, Mittermeier, Mittermeier, da Fonseca, & Kent, 2000).

The Biodiversity Hotspots approach, Major Tropical Wilderness Areas, and Megadiversity Countries approaches are centred on five principles:

1. The biodiversity of each nation is important to its survival and must be part of the national strategies;
2. Some areas are richer in biodiversity than others;
3. Many biodiversity-rich areas have high levels of endemism;
4. Many biodiversity-rich areas face serious threats; and,
5. Areas highest in biodiversity and endemism and that are most seriously threatened should receive most (but not exclusive) attention to achieve the maximum conservation impacts with limited resources.

The duplication of global-scale prioritisation efforts by nature-NGOs has been criticised because many of the global-scale approaches identify the same regions and give them similar importance rankings (Mace, Balmford, Boitani, Cowlishaw, Dobson et al., 2000). Furthermore, analyses are expensive. The focus of the hotspots approach on areas of high biodiversity raises controversy in conservation circles because only areas of high biodiversity value are considered important, and the value of biodiversity to people in social and economic terms is not addressed (Earthwatch Europe et al., 2002).

A structured approach to choosing protected area systems has been developed to meet two primary objectives for all protected areas: representativeness and persistence. Ideally, protected area systems should represent the full variety of biodiversity at all levels of organisation. This means maintaining natural process and viable populations and excluding threats in order to promote the persistence of species in the long term (Margules & Pressey, 2000). Systematic conservation planning is based on principles of complementarity, flexibility, and irreplaceability (Pressey et al., 1993). Margules and Pressey (2000) comprehensively reviewed the process of systematic conservation planning. Many studies from the systematic conservation planning literature have concentrated on algorithms to tackle the problem of maximising the total number of species represented in a cost-constrained protected area network. Unfortunately, these methods rely on complete knowledge of the distribution of each species in the region, and because this is usually not available, surrogate values are used instead (Trakhtenbrot & Kadmon, 2005).

Systematic techniques for conservation planning have been developed since the late 1970s, employing computer software selection packages and geographic information systems (GIS) (Margules & Pressey, 2000). Complementarity-based techniques involve selecting networks of sites that complement each other in their species composition (Trakhtenbrot & Kadmon, 2005). They are concerned with species representation, focusing on maximising biological diversity in minimal land area by considering species distribution and richness. Analyses include Gap and Network techniques. Gap Analysis uses maps (often in a Geographic Information System) to identify gaps in the protected area network (Kiester, Scott, Csuti, Noss, Butterfield et al., 1996; Rodrigues, Andelman, Bakarr, Boitani, Brooks et al., 2004; Rodrigues, Andelman, Bakarr, Boitani, Brooks et al., 2003; Wright & Scott, 1996). Network Analysis involves identifying taxa for representation, identifying sites with the most endemic species, and iterating until all the wanted taxa are represented.

Table 4.3

Selected Habitat-Based Frameworks for Selecting Areas for Protected Area Designation

Framework	Description	Scale	Biological Criteria	Threat Criteria	Strengths	Weaknesses
Benefit-to-Cost Ratio **(Williams, Moore, Toham, Brooks, Strand et al., 2003)**	Selects conservation areas by minimising potential conflicts between conservation and other socio-economic pressures based on benefit-to-cost ratios. Applied to the Guinean-Congolian forest region (Williams et al., 2003).	Regional	Representation of forest mammal and bird species in a network of protected areas.	Factors thought to increase the costs of conservation because of conflict, including: current and future land use patterns, human population density, and distribution of infrastructure.	An explicit, repeatable, and accountable process. Considering socio-economic information improves the efficiency of uptake of conservation opportunities (Myers, 1988). A good way to look at threats with limited data.	Does not incorporate social or economic criteria. Data limitations.
Biodiversity Hotspots **Conservation International (Hambler, 2004; Mittermeier et al., 1998; Myers et al., 2000; Sechrest, Brooks, da Fonseca, Konstant, Mittermeier et al., 2002)**	Identifies funding priorities to reduce the extinction rate most efficiently by protecting the largest possible number of species in the smallest possible area (Conservation International, 2007). Since 1989, further analyses have been run as better data and spatial processing systems have become available. Conservation International still uses the Biodiversity Hotspots concept as an institutional blueprint (Hambler, 2004; Mittermeier et al., 1998; Myers et al., 2000).	Global	Endemicity – hotspots must contain at least 0.5% of the world's 300,000 vascular plant species (Hambler, 2004; Mittermeier et al., 1998; Myers et al., 2000).	Hotspots have lost at least 70% of original habitat (Veech, 2003). In a modified hotspots approach future threats are incorporated based on surrogate criteria including governmental debt, human population size, rural population density, and population growth rate (Hughey et al., 2003; Myers et al., 2000).	A rigorous approach for setting international priorities (Hambler, 2004). Hotspots stimulated productive debate and to date represent the nearest to a consensus on global priorities (Hambler, 2004).	Excludes areas of high endemicity that have experienced low rates of habitat loss, and does not adequately represent the world's biomes (Hughey et al., 2003). Does not consider the costs of conserving these areas (Turpie et al., 2002). Does not incorporate social or economic criteria. Data limitations.
Complementarity Analysis to Prioritise Estuaries **(Turpie et al., 2002)**	Method to determine the conservation importance of estuaries, and prioritise a network of estuarine protected areas that includes all known species of plants, invertebrates, fishes, and birds. Applied to the estuaries of South Africa (Turpie et al., 2002).	National	Existence and abundance information for estuarine plants, invertebrates, fishes and birds.	None.	The estuary importance index was determined using weightings agreed at a meeting of estuary specialists. Results may improve estuary management actions and decision-making in South Africa (Rodrigues et al., 2004; Rodrigues et al., 2003).	Does not incorporate threats, or social or economic criteria. Data limitations.

Framework	Description	Scale	Biological Criteria	Threat Criteria	Strengths	Weaknesses
Global Gap Analysis Programme **Conservation International (e.g. Kiester et al., 1996)**	An analysis of terrestrial vertebrate coverage in protected areas using GIS. Prioritises both existing protected areas for strengthening, and unprotected sites for protection. Gap analysis has been applied by other authors (Olson & Dinerstein, 1998) at a range of spatial scales.	Global/ Regional/ National/ Local	Presence and range of threatened species, and species endemism.	None.	Useful for identifying areas for further research and conservation planning.	Limitations of protected area and taxonomic data – omission and commission errors. Does not incorporate social or economic criteria.
Global 200 Ecoregions **WWF (Olson & Dinerstein, 1998)**	Identifies the world's 233 most biologically distinctive ecoregions in each major habitat type.	Global	Species richness, endemism, taxonomic uniqueness, unusual ecological or evolutionary phenomena, and global rarity of major habitat types.	None.	Integrates the goals of maintaining species diversity and the preservation of distinct ecosystems and ecological processes. The first attempt to achieve representation of habitat types on a global scale (Olson & Dinerstein, 1998).	Does not include phenomena like migration (Kareiva & Marvier, 2003). Ecoregions span political boundaries making projects hard to implement (Conservation International, 1990; Myers, 1988). Does not incorporate social or economic criteria. Data limitations.
Major Tropical Wilderness Areas **(Mittermeier et al., 1998)**	Tropical areas that are largely intact and have a low human population density are important storehouses of biodiversity, harbour watersheds, stabilise climate, and contain many endemics (Hambler, 2004).	Global	Biodiversity-rich tropical ecosystems retaining at least 75% of their primary vegetation.	Fewer than 5 people per km^2.	Selected by a large team of specialists and intended to complement the Biodiversity Hotspots approach (Hambler, 2004).	Not sufficient to include all the species absent from the biodiversity hotspots (Mittermeier et al., 1997). Ignores other biomes. Does not incorporate social or economic criteria. Data limitations.
Megadiversity Countries **Conservation International (Baldus, Hahn, Mpanduji, & Siege, 2003; Mittermeier et al., 1997; Mittermeier et al., 1998)**	Identifies 17 'Megadiverse Countries' that support up to 70% of the world's terrestrial species. Most of these countries are in the tropics (Mittermeier et al., 1997).	Global	Species richness, endemism, presence of charismatic mammals.	None.	A method developed to better market the conservation of biological diversity in the 17 countries having the greatest species diversity and endemism in the world (Kelly & Park, 1986).	Does not incorporate social or economic criteria. By targeting mammal species, the world's biomes are poorly represented. Data limitations.
Protected Natural Areas Programme **(Hughey et al., 2003)**	Applied in New Zealand to establish a network of protected natural areas which represents the full range of natural diversity in the country by dividing the country into Ecological Regions and Districts.	National	Representativeness, diversity and pattern, rarity and special features, naturalness, long-term ecological viability, size and shape, buffering, surrounding landscape and boundaries.	None.	Useful for identifying national priority areas (Hughey et al., 2003).	Does not incorporate threats, or social or economic criteria. Labour and data intensive (The Ramsar Convention Bureau, 2001). ata limitations.

Framework	Description	Scale	Biological Criteria	Threat Criteria	Strengths	Weaknesses
Wetlands of International Importance **The Ramsar Convention Bureau under the Ramsar Convention on Wetlands (UNESCO, 2006)**	Wetlands of International Importance are proposed on a voluntary basis by Contracting Parties (nations) to the Ramsar Convention on Wetlands (Ramsar, Iran, 1971).	Global	Significance in terms of ecology, botany, zoology, limnology, or hydrology. Wetlands on the Ramsar List contain representative, rare, or unique wetland types and/or are of international importance for conserving biodiversity, particularly for waterfowl and fish.	None.	Sites are managed by the sovereign nation, but there is strong international help and support to manage them.	Does not incorporate threats, or social or economic criteria. Sites are nominated by the sovereign nations, so the approach is not a rigorous method for identifying important wetland sites. Data limitations.
World Heritage Sites – Natural Properties **The United Nations Educational, Scientific and Cultural Organisation (UNESCO, 2006)**	Natural World Heritage Sites are Designated under the World Heritage Convention to protect the world's natural wonders.	Global	Natural Properties are defined as 'natural sites or precisely delimited natural areas of outstanding universal value from the point of view of science, conservation, or natural beauty'.	None.	Designation is an explicit, repeatable, and accountable process. Sites remain part of the sovereign nation, but there is strong international help and pressure to protect them (Hambler, 2004).	Once designated, sites are not ranked.

Abiotic conditions may be substituted for taxa, and the technique can be combined with other analyses like richness and hotspot analysis (Williams et al., 2003). Applications of complementarity techniques include a determination of the minimum set of estuaries that includes all known species of plants, invertebrates, fishes and birds in South Africa (Turpie et al., 2002). Reyers *et al.* (2002) expanded the principle of complementarity to include, for example, maintenance of natural processes, turnover of feature diversity, and the need to minimise threats. Das *et al.* (2006) undertook the first fine scale prioritisation effort within a tropical biodiversity hotspot using systematic conservation planning, employing a combination of species and habitat surrogates in the Western Ghats, India, to identify areas of high conservation value.

Many systematic conservation planning approaches have been criticised for using only presence/absence data at the expense of considering the probability of biodiversity persistence and constraints on practical implementation (Cowling, Pressey, Sims-Castley, le Roux, Baard et al., 2003). Complementarity techniques are limited by unequal sampling effort across all sites, and, if applied without other criteria, these techniques often select widely scattered areas that may be too small to retain viable populations of species (Vreugdenhil et al., 2003). Computer methods are most often used at large scales, but Lindh and Martin (2004) applied GIS and selection software at the small scale of a mountain resort community in Canada (12,630 ha). They found reserve selection procedures may be unsuitable for small scale conservation planning because there are fewer alternative solutions than for larger areas. Furthermore, if data must be digitised, the procedure can be time-consuming; data are often out of date; the scale of data is usually coarser than the scale of planning; and general limitations are amplified by the scale of planning (Lindh & Martin, 2004).

4.1.3 FRAMEWORKS INCORPORATING ECONOMIC AND/OR SOCIAL CRITERIA

Methodologies that determine conservation priority are often biased towards biological criteria. While these methods are useful for identifying areas of important biological value and for gaining programme support, few incorporate economic and social concerns (Hughey et al., 2003; Moran et al., 1997). Areas selected for conservation should maximise social welfare, taking into consideration both the opportunity costs of alternative uses and the ecological benefits from protection (Groeneveld, 2004). Decision-making frameworks that incorporate economic and/or social criteria are shown in Table 4.4.

Where economic aspects are incorporated, they are mostly limited to the context of opportunity costs, economic incentives for conservation, and the reasons why species are endangered (Hughey et al., 2003). The Stochastic Dynamic Programming for Optimal Resource Allocation framework (Wilson, McBride, Bode, & Possingham, 2006) considers land costs using statistical models. Similarly, the Socially Optimal Reserve Selection framework (Groeneveld, 2004) includes opportunity costs associated with loss of agricultural production. The Cost-Effective Priority Investment Index (Moran et al., 1997) addresses the success of intervention (as a probability) and also considers the probability that an area will be threatened by deforestation. Furthermore, the Department of Conservation's Measuring Conservation Achievement framework (Stephens, 1999; Stephens, Brown, & Thornley, 2000) incorporates cost utility analysis in its evaluation of New Zealand's natural heritage assets. This methodology also considers threats such as those from alien species, habitat modification, and fragmentation.

Other frameworks include limited social criteria, such as the World Heritage (UNESCO, 2006) and Natura 2000 (EUROPA, 2006) sites. Both these frameworks recognise the importance of landscapes that have been modified by humans. For example, World Heritage Sites can include ‘mixed properties’, which are works of both man and nature considered to be of outstanding historical, aesthetic, ethnological, or anthropological importance (UNESCO, 2006). Neither method addresses economic criteria nor considers threats associated with the area.

Three decision-making frameworks that include a more comprehensive range of criteria are the Centres of Plant Diversity (Davis et al., 1994,1995), MICOSYS (Minimum Conservation System) (Vreugdenhil et al., 2003), and Conservation Priority Scoring System (Cumming, 1984).

Table 4.4

Selected Frameworks for Selecting Areas for Protected Area Designation that incorporate Economic and/or Social Criteria

Framework	**Description**	**Scale**	**Criteria Relating to the Importance of Potential Conservation Areas**				**Strengths**	**Limitations**
			Biological	**Threats**	**Economic**	**Social**		
Centres of Plant Diversity **WWF & IUCN (Davis et al., 1995)**	Identifies sites of global botanical importance. A large team of botanists reached consensus on the location of 20 Centres of Plant Diversity.	Global	Richness, endemicity, and habitat diversity. Mainland centres must contain at least 1,000 vascular plant species and at least 10 percent endemism; island centres must contain at least 50 endemics or at least 10 percent endemic flora.	Sites are threatened or under imminent threat of large-scale devastation.	Richness of useful species.	Richness of useful species.	The significance of plants as determinants of conservation priority is unrivalled by animal species (Cumming, 1984). Consideration of useful species incorporates socio-economic dimensions.	Limited economic and social criteria. Only selects areas under significant threat. Data limitations.
Conservation Priority Scoring System **(Cumming & Jackson, 1984)**	Systematically prioritises parks. The method was developed for Africa over a series of workshops at Wankie/Hwange in 1981 (Cumming, 1984), Victoria Falls in 1983 (Bell & Martin, 1987), and Lifupa in 1984 (Bell & Martin, 1987).	Regional/ National	Biological value relating to: land area, plant diversity, presence of endemic and/or threatened plant and animal species, morphological features, and ecosystem type.	Vulnerability of the area to other forms of development, legal status, staffing resources, motivation and technical competence of staff, adequacy of funding and equipment, level of planning, law enforcement capability, civil security, and land pressure.	Economic potential of wildlife resources, national conservation importance and investment, international interest in the area, potential for conservation-related development.	Landscape and amenity values relating to special floristic, faunal, recreational, and scenic attractions; geological features; accessibility; and, public awareness of the area.	Explores amenity values. Considers a wide range of biological, economic, and social criteria, including threatening aspects.	No clear distinction between actual and potential value, and the grouping of factors could be confusing (Moran et al., 1997). Hard to assess some factors fairly across all parks. Data limitations.

Framework	Description	Scale	Criteria Relating to the Importance of Potential Conservation Areas				Strengths	Limitations
			Biological	Threats	Economic	Social		
Cost-Effective Priority Investment Index **(Stephens, 1999; Stephens et al., 2000)**	An index that balances biodiversity 'cost' and biodiversity 'benefit' to rank biodiversity investments on the premise that the success of an investment intervention depends on the probability of success and degree of threat. Applied to the Asia-Pacific region.	Global/ Regional	Endemism, species richness.	Deforestation used as a probability of threat.	Success of intervention is integrated as a probability.	None.	Incorporates scientific and some economic criteria into global priority-setting. Open to adaptation as better surrogates arise. Normalises measures of richness and endemism.	Data limitations. Limited economic criteria. Does not incorporate social criteria. Simple and subjective choice of success and threat surrogates.
Measuring Conservation Achievement **Department of Conservation, New Zealand (Stephens, 1999)**	A framework for catalogued inventory of natural heritage assets to define goals, develop models for reporting on the status of natural heritage, for measuring conservation achievement, and for cost-utility evaluation of conservation projects.	Special priority sites/ Local/ National	Distinctiveness (endemism and landform), importance, size, and natural character of an area. The latter is the degree to which the pre-human condition of a habitat or ecosystem remains, measured on a scale from 0–1.	Plant and animal removal, pest pressure, weed pressure, resource modification, fragmentation.	Cost utility analysis.	None.	Can determine the 'biodiversity value' of a site, demonstrate the difference conservation management is making, and has potential to assess the cost-effectiveness of different projects (Department of Conservation, 2005).	Complex, data-hungry, numerous assumptions, struggles to capture the flow of predicted future benefits (Vreugdenhil & House, 2002; Vreugdenhil et al., 2003). Does not incorporate social criteria. Data limitations.
MICOSYS (Minimum Conservation System) **DHV Consultants for the World Bank (Vreugdenhil, 1992)**	A spread-sheet based programme. Finds gaps in biodiversity representation across an existing protected area system; models the composition of a new, representative protected area system; and estimates the investment and operational costs of the selected system. Applied to Costa Rica (Vreugdenhil, House, Cerrato, Martinez, & Pereira, 2002) and Honduras (Vreugdenhil et al., 2003).	National	Size of the reserves, ecosystem representation, and species of special concern.	None.	Costs per area, tourism value, simple incorporation of ecosystem services delivery, and use of watersheds.	Outstanding environmental education opportunities, archaeological remains, and extraordinarily scenic landscapes.	Simple spreadsheet that does not require special software and can be used by technicians without GIS experience; potentially useful to a range of organisations/ stakeholders; incorporates weightings on appropriate criteria; adaptable as more information arises (EUROPA, 2006; Eurosite, 2006).	Does not incorporate threat criteria. Time-consuming. Only available in Spanish. Data limitations.

Framework	Description	Scale	Criteria Relating to the Importance of Potential Conservation Areas				Strengths	Limitations
			Biological	Threats	Economic	Social		
Natura 2000 Sites **The European Commission under the Habitats Directive and Birds Directive (Scottish Natural Heritage, 1992)**	Natura 2000 is a network of protected areas designated under European Union legislation. The two types of protected area are Special Protection Areas under the Birds Directive (1979) and Special Areas of Conservation under the Habitats Directive (1990).	Regional	Special Protection Areas are designated for threatened bird species and regularly occurring migratory species. Special Areas of Conservation are designated to support rare, endangered, or vulnerable natural habitats and species of plants or animals other than birds (Groeneveld, 2004).	None.	None.	Some semi-natural habitats are protected.	Europe-wide partnership with European Union support. Covers both terrestrial and marine areas. Areas managed on a case-by-case basis by member states.	Does not incorporate threat or economic criteria. Data limitations.
Socially Optimal Reserve Selection **(Groeneveld, 2004)**	An integrated analytical framework for the Single Large or Several Small reserves (SLOSS) problem that determines the socially optimal number of reserve sites to be allocated in a farming area under a fixed total reserve area, taking the opportunity costs of conservation into account.	Local	Species richness, time to extinction of a metapopulation or expected metapopulation size.	None.	Opportunity cost of loss of agricultural production, diminishing returns to farm area, and land trade transaction cost with reserve establishment.	None.	Shows that the opportunity costs of nature conservation and land transactions are important factors determining the optimal number of reserve sites under a fixed total reserve area, as well as metapopulation dynamics. Integrates economic and ecological insights into the metapopulation SLOSS debate (Groeneveld, 2004)	Assumes homogenous habitat quality, excludes the spatial configuration of reserve sites and the existence of corridors/ stepping stones (Wilson et al., 2006). Does not incorporate threat or social criteria. Data limitations.

Framework	Description	Scale	Criteria Relating to the Importance of Potential Conservation Areas				Strengths	Limitations
			Biological	**Threats**	**Economic**	**Social**		
Stochastic Dynamic Programming for Optimal Resource Allocation **(Wilson et al., 2006)**	Employs heuristics to 'maximise short-term gain' and 'minimise short-term loss' and compares these heuristics to priority-setting approaches based on simple rankings and a fixed annual budget for reservation using a case study from South East Asia.	Local/ National/ Regional/ Global	Species richness, endemic species.	Forest conversion rates represented as stochastic processes with a binomial distribution.	Land cost using statistical models.	None.	Can be applied at any spatial scale, incorporates threat and costs into priority-setting, performs well (Wilson et al., 2006).	Does not incorporate threat or social criteria. Limited economic criteria. Incorporates many simplifications of reality (UNESCO, 2006). Data limitations.
World Heritage Sites – Cultural/Mixed **The United Nations Educational, Scientific and Cultural Organisation (UNESCO, 2006)**	World Heritage Sites are Designated under the World Heritage Convention to protect the world's natural and cultural wonders. Most sites with Cultural Property recognition are designated as Mixed Properties as they also have outstanding natural values (UNESCO, 2006).	Global	Natural Properties are defined as 'natural sites or precisely delimited natural areas of outstanding universal value from the point of view of science, conservation, or natural beauty'.	None.	None.	Mixed Properties are defined as 'works of man or the combined works of man and nature which are of outstanding universal value from the historical, aesthetic, ethnological, or anthropological point of view'.	Designation is an explicit, repeatable, and accountable process. Sites remain part of the sovereign nation, but there is strong international help and pressure to protect them (Davis et al., 1994).	Does not incorporate threat or economic criteria. Once designated, sites are not ranked.

The Centres of Plant Diversity framework was developed to identify areas of global botanical importance based on biological criteria, the degree of threat faced by an area, and the presence of species useful to humans from an economic or cultural perspective. It specifically selects areas of high biological importance and that face serious threats. This framework is also biologically biased because simply considering the presence of economically or socially importance species is far from a comprehensive analysis of the economic and social significance of an area.

The MICOSYS framework includes a far more comprehensive analysis of the social and economic importance of an area. Economic considerations include the tourism value of the area, the ecosystem services provided by the area, and the cost of the establishing and operating the site. Social considerations include the value of the area as an educational resource, the presence of archaeological remains, and scenic benefits. This is a computer-based spreadsheet and geographic information system model that can be used to find gaps in representation in an existing protected areas system, identify new protected areas, and estimate the investment in operational costs of a system (Vreugdenhil et al., 2003). The predominant limitations of this framework are that it does not explicitly analyse the threats faced by an area, and it is time consuming and data intensive.

The Conservation Priority Scoring System (Cumming & Jackson, 1984) was developed in Southern Africa during the early 1980s. Despite being one of the earliest priority-setting methods developed for protected areas, it provides the most comprehensive and administratively elegant approach to prioritising areas for conservation management action. The system was initially suggested for prioritising spending among populations of elephant (*Loxodonta africana* and *Loxodonta cyclotis*) and rhinoceros (*Ceratotherium simum* and *Diceros bicornis*). Because prospective donors and funding organisations were presented with a plethora of conservation plans and projects with no clear way of weighing one against another, the system was further refined to prioritise a core conservation estate for the African continent (Bell & Martin, 1987). The first step was to define a minimum set of National parks for Africa based on vegetation types. These national parks were then ranked based on four sets of criteria:

1. Biological value – intended to assess whether an area deserves conservation effort on purely biological considerations, based on the objectives of preventing extinction and preserving examples of biological communities. Criteria include: land area; diversity and rarity of flora and fauna; geological features; and ecosystem type.

2. Conservation status – intended to assess the current state of conservation activity and the requirements and probable costs of improving that status. Criteria include: legal status; historical status; labour resources; motivation and technical competence of staff; funds and equipment; development and planning; research and monitoring; law enforcement capability; identification of illegal activities; poaching threat; land pressure; and civil security.

3. Socio-economic factors – intended to assess socio-economic factors that would affect the ease and costs of conservation action in an area, given that the more closely conservation action corresponds with short-term economic interests, the easier and cheaper it is. Criteria include: conservation awareness, conflicting land use (vulnerability of the PA to other forms of development), national conservation importance; economic potential of wildlife (tourist or cropping potential); international involvement in the area; and potential for conservation-related developments.

4. Landscape and amenity value – intended to assess the potential appeal of an area to visitors apart from its strictly biological value. Based on the question "how many people would miss the area if no attempts were made to conserve the area?" Criteria include: special geological features; floristic and faunal attractions; scenic attractions, cultural attractions, recreational attractions; and accessibility (communications, road condition).

Each national park was described in relation to each criterion using a subjective scoring system. For example, labour resources were ranked from none (rank score = 0) to fully staffed (rank score = 4). The Conservation Priority Scoring System was reviewed by Bell and Martin (1987) who suggested improving the logic and layout of the system to set up three criteria categories:

1. Area Value – including factors that help prevent extinction, maintain selected communities, and preserve landscape aesthetics;

2. Problems and Costs of Conservation – including costs, threats, and other factors relating to the costs of conserving the area; and,

3. Mitigating Factors – approximately equivalent to the existing Conservation Status category.

The robustness of the Conservation Priority Scoring System remains unknown because the methodology has not been applied in practice by academics or protected area management agencies (David Cumming, personal communication, 10 September 2003).

4.2 FRAMEWORKS FOR EVALUATING THE EFFECTIVENESS OF PROTECTED AREA MANAGEMENT

Methods developed to assess the effectiveness with which protected areas are managed address the question "How effective are different management interventions and techniques in the conservation of areas and species?" (Hughey et al., 2003, p. 93). Protected areas can only deliver their environmental, social, and economic benefits if they are effectively managed, so conservation agencies (governments, management agencies, and international aid and nature-NGOs) have addressed the question of how to assess the effectiveness of management (Dudley & Stolton, 1999; Hockings & Phillips, 1999). Assessments of management effectiveness seek to help managers improve protected area management and project planning, as well as promoting the accountability of management actions (Hockings, Stolton, & Dudley, 2000). Management assessments have focused on three areas of protected area management: design, management processes, and the ecological integrity of protected areas or protected area networks (Ervin, 2003b; Hockings et al., 2000).

Recognising that all protected area contexts differ, Hockings and Phillips (1999) identified the need to develop a toolbox of approaches, derived from one broad conceptual framework, for evaluating protected area management. The IUCN-

WCPA Management Effectiveness Task Force published a framework model for assessing the effectiveness of protected area management (Hockings et al., 2000). The management framework and associated assessment tools can be used by protected area managers to build an evaluation methodology for either an individual protected area or a system of related protected areas. The primary objective of protected area evaluation is "to improve conservation and management effectiveness of protected areas – both for protected area systems and individual protected sites" (Hockings et al., 2000, p. 15). Evaluation should be part of adaptive management, allowing information to feed into the management cycle and improve future management (Hockings et al., 2000).

The framework model recognises different phases in the protected area management cycle (Table 4.5). These linked, interactive phases are: planning, resource allocation, implementation, monitoring and evaluation, and feedback. Management is also influenced by contextual issues such as the uniqueness of the area and the threats and opportunities that it faces. These contextual issues can be divided into three categories: protected area design (context and planning), appropriateness of management systems and processes (input and process), and delivery of protected area objectives (outputs and outcomes) (Hockings et al., 2000).

Design issues relate to the buffer zones, the shape of the protected area, and connectivity to other protected areas. If protected areas are too small to meet their conservation objectives, threats may continue despite management efforts. Many project areas are inadequately managed and lack resources, jeopardising the ability of the protected area to meet its objectives. Legislation may be adequate to stop the exploitation of wildlife and habitat in some countries, but in others hunting, encroachment, and timber harvesting threaten legally protected areas (Groom, Meffe, & Carroll, 2006).

Table 4.5

Evaluation and the Protected Area Management Cycle

Management Activity	Planning	Resourcing	Implementation	Outputs	Impacts
Things evaluated	Reserve design	Staff Funds Equipment	Management systems Management processes	Services & facilities Results of management actions	Effects of management in relation to objectives
Type of evaluation	Design	Input	Process	Output	Outcome
Focus of evaluation	Appropriateness	Economy	Efficiency	Effectiveness	Effectiveness and appropriateness

Source: Adapted from Hockings (1998, p. 338)

The conceptual framework developed by Hockings et al. (2000) is outlined in Table 4.6. The elements of an assessment of management effectiveness include:

- Context – where are we now? This question considers the significance of the area and the threats and opportunities it faces. It does not analyse management activities, but helps put management decisions into context. When the objective of evaluation is to identify management priorities within a protected area network, or to make resource allocation decisions, this may be the main question to answer.

- Planning – where do we want to be and how are we going to get there? This question focuses on the vision for a protected area. This involves the appropriateness of legislation, policies and plans, protected area design, and management plans. The indicators selected for this evaluation may include ecological representativeness and connectivity, shape, size, location, management objectives, and management plans.

- Inputs – what do we need? This question is based on staff, funds, equipment and facilities required at either the site level or at agency level.

- Process – how do we go about it? This question investigates the adequacy of management processes in relation to the management objectives for a societal system. Indicators may relate to day to day maintenance, involvement of local communities, and types of natural and cultural resource management.

- Outputs – what did we do and what products or services were produced? This examines the extent to which targets, work programmes and plans have been implemented, and focuses on whether activities have been carried out according to schedule.

- Outcomes – what did we achieve? This assesses how well programmes have achieved the desired objectives. Good outcome valuation relies on solid objectives set out in national legislation, policies, or site-specific plans, and on significant monitoring. Outcome evaluation is considered the most challenging element of a management effectiveness assessment.

Each type of evaluation has a different focus, so they are complementary, rather than alternative approaches to management evaluation. Hockings (2003) observed that few established methodologies assess all six of the elements outlined in the WCPA framework, and suggested that more useful information for adaptive management will be achieved through methods that address all six elements.

The framework's guidelines explain the level of assessment needed, how the assessment should be reported and presented, the indicators needed, how to apply the framework at a site or system scale, and who should carry out the assessment. The framework identifies three possible levels of evaluation, each with differing requirements for data, time, and financial inputs. A level one evaluation relies on available data to assess the context, appropriateness of planning, inputs, and processes of management. It may also include limited assessment of outputs and outcomes. Assessment will rely primarily on the available literature and the informed opinions of managers and/or independent assessors, and little or no additional data will be collected.

Table 4.6

Framework for Assessing Management Effectiveness of Protected Areas and Protected Area Systems

Elements of evaluation	**Context**	**Planning**	**Input**	**Process**	**Output**	**Outcome**
Explanation	*Where are we now?* Assessment of importance, threats and policy environment	*Where do we want to be?* Assessment of PA design and planning	*What do we need?* Assessment of resources needed to carry out management	*How do we go about it?* Assessment of way in which management is conducted	*What were the results?* An assessment of the implementation of management programs and actions; Delivery of products and services	*What did we achieve?* An assessment of the outcomes and the extent to which they achieved objectives
Criteria that are assessed	Significance Threats Vulnerability National context	Protected area legislation and policy Protected area system design Reserve design Management planning	Resourcing of agency Resourcing of site Partners	Suitability of management processes	Results of management actions Services and products	Impacts: effects of management in relation to objectives
Focus of evaluation	Status	Appropriateness	Resources	Efficiency Appropriateness	Effectiveness	Effectiveness Appropriateness

Source: Hockings, Stolton, & Dudley (2000, p. 13)

A level two evaluation combines the information gathered in level one with additional monitoring of outputs and outcomes. Indicators may be more tailored to suit local conditions. Level three incorporates the information gathered in the level two assessment and emphasises detailed evaluations of outputs and outcomes at the site level. The appropriate level for evaluating management effectiveness of the individual sites can be determined based on significance, vulnerability, the extent of threats, and the status of the national economy (Hockings et al., 2000).

The framework discussed above has been the basis of several tools for assessing management effectiveness (for example, Ervin, 2003c; Staub & Hatziolos, 2003; Stolton, Hocking, Dudley, MacKinnon, & Whitten, 2003; WWF, 2004). The framework suggests using checklists and scorecards to assess indicators, particularly for process and output indicators (Table 4.7). Most methodologies developed to evaluate protected area management effectiveness, including those developed prior to the development of the WCPA framework, evaluate management processes through a similar qualitative scoring system. The more general systems set a single standard for management and do not allow for regional differences, while systems that focus on scorecards tend to focus on the area being assessed, by developing a generic template to reflect locally relevant standards for management (Hockings, 2000).

Table 4.7

Example of a Simple Scoring System

Issue	Criteria	Score
Maintenance	a. Little or no maintenance of equipment/facilities is undertaken	0
	b. Maintenance is only undertaken when equipment/facilities are in need of repair	1
	c. Most equipment/facilities are regularly maintained	2
	d. All equipment/facilities are regularly maintained	3

Source: Hockings, Stolton & Dudley (2000, p. 63)

Some methods have been developed to evaluate a special type of protected area such as the Natura 2000 Special Areas of Conservation in Crete, with a focus on the representativeness of plant biodiversity (Dimitrakopoulos, Memtsas, &

Troumbis, 2004), and the Frazer Island World Heritage Area in Australia (Hockings, 1998). Among the organisations that have developed methods to evaluate the management effectiveness of protected areas, The Nature Conservancy and WWF have played prominent roles (Table 4.8). While methods for the evaluation of management effectiveness have focused on terrestrial protected areas, some methods have been developed to evaluate marine protected areas, (for example, Alder, Zeller, Pitcher, & Sumaila, 2002; Staub & Hatziolos, 2003). Two examples of a simple scorecard evaluation method include The Nature Conservancy's PROARCA/CAPAS project (Courrau, 1999a), which was developed to monitor protected area management in Central America; and the Site-level Management Effectiveness Tracking Tool developed by the World Bank/WWF Alliance for Forest Conservation and Sustainable Use (Stolton et al., 2003).

Table 4.8

Frameworks for Evaluating the Effectiveness of Protected Area Management Developed by The Nature Conservancy and WWF

Organisation	Management Effectiveness Evaluation Methods
The Nature Conservancy	Measures of Conservation Success 1998. Parks in Peril Scorecard 1990 (Brandon, Redford, & Sanderson, 1998; The Nature Conservancy, 1999). PROARCA/CAPAS Monitoring Strategy for Protected Areas in Central America 1997 (Courrau, 1999a) Five-S Framework for Site Conservation (The Nature Conservancy, 2000a,2000b)..
WWF	Endangered Spaces Progress Report 1988 (WWF Canada, 1998). Management Effectiveness Assessment Methodology 1993 (Cifuentes, Izurieta, & de Faria, 2000). Evaluation of Protected Area Management in Cameroon 1997 (Culverwell, 1997). Protected Areas or Endangered Spaces 1998 (Ferreira, Lemos de Sá, Bushbacher, Batmanian, Bensusan et al., 1999), Forest Innovations Project – Central African Case Study 1999 (Hakizumwami, 2000). WWF-World Bank Alliance ‘Paper Parks’ study 1999 (Dudley & Stolton, 1999) Rapid Assessment and Prioritisation of Protected Area Management (RAPPAM) Methodology 2000 (Ervin, 2003c). Site-Level Management Effectiveness Tracking Tool (Stolton et al., 2003).

The PROARCA/CAPAS project incorporated indicators for five areas: social, administrative, natural resources management, political-legal, and economic-financial, which relate to input and process indicators in the WCPA framework (Hockings, 2000). The indicators were developed because the existing information needed for assessing management effectiveness was limited, fragmented, outdated, and lacking in scientific rigour. First, the optimal scenario for a protected area was developed for each of the five areas. Indicators were then identified to measure progress towards each objective. Monitoring sessions were conducted every six months at which time the staff and stakeholder representatives met to evaluate the status of the indicators based on the current situation in the protected area. The group agreed on a five-point rating scale for each criterion based on evidence from reports, maps, letters, and other material. This approach is simple because it requires neither special technology nor training and can be applied by most protected area staff, it is low-cost because it does not require investments in equipment or time, and it has the capacity to improve and adapt to local needs because new criteria and indicators can be developed to cover gaps (Courrau, 1999a,1999b; Hockings, 2000).

The Site-level Management Effectiveness Tracking Tool developed by the World Bank/WWF Alliance for Forest Conservation and Sustainable Use (Stolton et al., 2003) is a score-card approach that has been widely applied. The tool aims to report progress on management effectiveness in forested areas (Stolton et al., 2003). Developed in accordance with the WCPA Framework, this simple, site-based survey relies largely on multiple-choice questions about constraints to good management, addressed to managers. The methodology has been applied to over 200 forest protected areas in 37 countries and has proved more effective for tracking progress at one site than for comparing sites (WWF, 2004).

The aspect of the WCPA framework most relevant to this thesis is context, which relates to park significance. Consequently, the following review focuses on frameworks for evaluating management effectiveness that have a comprehensive assessment of context. The Rapid Assessment And Prioritisation of Protected Area Management Methodology (RAPPAM) developed by WWF (Ervin, 2003c) is one of the most comprehensive methods for assessing management effectiveness.

The World Wide Fund for Nature (WWF) Forests for Life Programme developed the Rapid Assessment and Prioritisation of Protected Area Management (RAPPAM) methodology to assess the effectiveness of protected areas to help park managers and policy makers identify management steps needed to ensure a fully functioning system of protected areas at a national or regional level. It is a comprehensive system-wide assessment developed in accordance with the WCPA Framework using a scorecard approach (Ervin, 2003c). The RAPPAM methodology is designed for broad-level comparisons among multiple protected areas. It can answer important questions regarding threats, infrastructure and management capacity, the urgency for taking actions, the overall level of integrity and degradation of each protected area, and the most strategic interventions for improving the entire system. Although it can be applied to a single protected area, the RAPPAM methodology is not designed to provide detailed, site-level adaptive management guidance to protected area managers (Ervin, 2003c; Vreugdenhil et al., 2003). The methodology was developed between 1999 and 2002, and involved field-testing in France, Cameroon, Gabon, China, and Algeria (Ervin, 2003a,2003b). It has been implemented in selected protected areas in Bhutan (Tshering, 2003), China (Diqiang, Jianhua, Ke, Bo, & Chunquan, 2003), Russia (Tyrlyshkin, Blagovidov, & Belokurov, 2003), and South Africa (Goodman, 2003a,2003b) and these studies are summarised in Ervin (2003a; 2003b).

While the methodology was developed for forest protected areas, modifications to some questions allowed it to be applied successfully to other biomes including grasslands and wetlands. The significance or ‘context’ aspects relate to pressures and threats, biological importance, socio-economic importance, and vulnerability (Ervin, 2003b,2003c).

Criteria for pressures and threats have been covered in Chapter 3. The other criteria relating to biological importance, socio-economic importance, and vulnerability (Figure 4.1) are addressed as statements to which respondents react by choosing one of four options: ‘yes’, ‘mostly yes’, ‘mostly no’, or ‘no’. This format was chosen to detect general trends, rather than ascertaining the exact degree to which the protected area performs.

Figure 4.1
RAPPAM Scorecard for Biological Importance, Vulnerability, and Socio-Economic Importance

3 BIOLOGICAL IMPORTANCE

y	m/y	m/n	n	
○	○	○	○	a) The PA contains a relatively high number of rare, threatened, or endangered species.
○	○	○	○	b) The PA has relatively high levels of biodiversity.
○	○	○	○	c) The PA has a relatively high degree of endemism.
○	○	○	○	d) The PA provides a critical landscape function.
○	○	○	○	e) The PA contains the full range of plant and animal diversity.
○	○	○	○	f) The PA significantly contributes to the representativeness of the PA system.
○	○	○	○	g) The PA sustains minimum viable populations of key species.
○	○	○	○	h) The structural diversity of the PA is consistent with historic norms.
○	○	○	○	i) The PA includes ecosystems whose historic range has been greatly diminished.
○	○	○	○	j) The PA maintains the full range of natural processes and disturbance regimes.

5 VULNERABILITY

y	m/y	m/n	n	
○	○	○	○	a) Illegal activities within the PA are difficult to monitor.
○	○	○	○	b) Law enforcement is low in the region.
○	○	○	○	c) Bribery and corruption is common throughout the region.
○	○	○	○	d) The area is experiencing civil unrest and/or political instability.
○	○	○	○	e) Cultural practices, beliefs, and traditional uses conflict with the PA objectives.
○	○	○	○	f) The market value of the PA resources is high.
○	○	○	○	g) The area is easily accessible for illegal activities.
○	○	○	○	h) There is a strong demand for vulnerable PA resources.
○	○	○	○	i) The PA manager is under pressure to unduly exploit the PA resources.
○	○	○	○	j) Recruitment and retention of employees is difficult.

4 SOCIO-ECONOMIC IMPORTANCE

y	m/y	m/n	n	
○	○	○	○	a) The PA is an important source of employment for local communities.
○	○	○	○	b) Local communities depend upon the PA resources for their subsistence.
○	○	○	○	c) The PA provides community development opportunities through sustainable resource use.
○	○	○	○	d) The PA has religious or spiritual significance.
○	○	○	○	e) The PA has unusual features of aesthetic importance.
○	○	○	○	f) The PA contains plant species of high social, cultural, or economic importance.
○	○	○	○	g) The PA contains animal species of high social, cultural, or economic importance.
○	○	○	○	h) The PA has a high recreational value.
○	○	○	○	i) The PA contributes significant ecosystem services and benefits to communities.
○	○	○	○	j) The PA has a high educational and/or scientific value.

Where y = yes, m/y = mostly yes, m/n = mostly no, and n = no

Source: Ervin (2003c, p. 44)

Respondents are encouraged to provide notes explaining why their choice was ‘mostly yes’ or ‘mostly no’ rather than an unqualified ‘yes’ or ‘no’. Given the nature of the available responses, the statements are worded non-specifically; for example, one statement about biological importance is: “the protected area contains a relatively high number of rare, threatened, or endangered species" (Ervin, 2003b).

In the analysis of pressures and threats, the extent, impact, and permanence values are combined to develop an overall degree of pressure and threat for each activity. This score can be used to identify systemic pressures and threats and to help formulate appropriate management strategies and policies. A single threat can also be assessed system-wide, to determine which protected areas face the highest and lowest overall degree of pressure/threat, and which activities are most serious in each protected area. From the questionnaire responses, a numerical index is allocated for biological importance, socio-economic importance, and vulnerability. Specific indicators within each category can also be analysed either individually or in combination with other indicators, then compared with other protected areas. This provides more detailed information about the protected area system (Ervin, 2003c).

Overall, the RAPPAM method is practical to implement and robust, assuming that one person’s answers are directly comparable with another’s. The pressure and threats assessments are of particular interest, albeit broad and non-specific regarding activities. The questions about biological importance, socio-economic importance, and vulnerability could be more accurately addressed using quantitative data. In addition, there is no facility for weighting criteria. Nevertheless, the RAPPAM method is the most appropriate decision-making framework within the management effectiveness group.

4.3 COST-BASED ASSESSMENT

Cost-based assessment methods are formal economic techniques based on analysis of costs and benefits/outcomes. Each of the four frameworks reviewed here – Cost-Benefit Analysis, Cost Effectiveness Analysis, Cost Utility Analysis, and Opportunity Cost Analysis – has been applied to conservation management decisions.

4.3.1 COST BENEFIT ANALYSIS

Cost Benefit Analysis (CBA) is a well-established decision-making framework that weighs the costs of an action against its benefits. It asks the question "are the gains to society greater than the sacrifices required of society?" (Hughey et al., 2003, p. 95). The primary objective of CBA is economic efficiency. Future costs and benefits are discounted to present values for direct comparison and if the net present value is positive for a project/course of action, that project should go ahead. The CBA framework can be used to optimise, prioritise, rank, and decide whether to implement a course of action (Broersma, 2003). Cost-Benefit Ratios are a standard ranking tool that can be used to compare the costs of conservation implementation with the benefits expected to arise from conservation action.

The benefits of CBA include transparency, compatibility, and clarification of a decision situation. In conservation management it can be used to discover if additional conservation spending will bring greater benefits to society (Hughey et al., 2003). Cost Benefit Analysis also has well-known limitations. Its primary limitation is that all costs and benefits are usually expressed in monetary terms. Economic techniques for the valuation of non-market goods have been developed, but these have inherent weaknesses. Non-market valuation techniques usually involve surveys to determine people's willingness to pay for benefits, or their willingness to accept compensation for foregone benefits.

Non-market valuation studies have a number of limitations. They are time-consuming and expensive to undertake, and easily biased. To minimise survey bias, respondents must have a reasonable understanding of the item being valued, otherwise, results may be imprecise (Cullen, Moran, & Hughey, 2005b). In attempting to quantify qualitative goods, economic methods are not as value-neutral as they may seem because non-market valuation tends to distort decisions by treating people's beliefs as wants, which are purely personal and subjective preferences that are neither true nor false. Economic valuation measures the intensity of a person's wants. However, beliefs are objective in the sense that they are justified through reasoning and can therefore be true or false; in effect, judging the validity of a person's belief by her willingness to pay for it is a misunderstanding of the nature of beliefs (Jardins, 1997).

Cost benefit analysis has also been criticised for discounting future benefits. Its anthropocentric nature has been questioned, as has the assumption that the well-being of the individual members of society can be aggregated to represent social welfare (Hughey et al., 2003). Furthermore, economic methods of evaluating ecological effects are misleading because ecological stability can only be determined by studying physical environmental factors (Muller, 1974).

4.3.2 COST EFFECTIVENESS ANALYSIS

Cost Effectiveness Analysis (CEA) finds the least-cost means of meeting an objective by comparing the costs of different options that achieve the same objective. Estimates of the costs and outputs for each course of action are required, with costs being expressed in monetary terms, but outputs are usually measured in non-monetary terms, like pest kill or species survival (Broersma, 2003; Hughey et al., 2003). Cost Effectiveness Analysis can be useful for evaluating conservation management, particularly because it can include ecological measures of effectiveness (Hughey et al., 2003). Like CBAs, CEAs often use discounting and present values (Fairburn, Hughey, & Cullen, 2004).

When only the direct costs of management are considered, cost effectiveness analysis is not useful for informing decision-makers about the impacts on society from conservation management. For a more comprehensive output, opportunity costs must also be considered, but if more comprehensive analyses, such as those involving multiple species, are desired, they may be better approached with other tools such as Cost Utility Analysis or a Multiple Criteria Decision Making framework (Fairburn et al., 2004).

Cost Effectiveness Analysis has been used to evaluate the performance of endangered species programs, which are characterised by demands for resources that exceed supply. For example, Fairburn et al. (2004) attempted to evaluate the performance of the kōkako (*Callaeas cinerea*) recovery program in New Zealand. This endangered bird species is being managed at several sites, with consequent variation in costs and conservation success. Kōkako management at different sites was analysed using standardised data on abundance and costs, but the analysis was restricted by a lack of reliable cost data and by ongoing policy problems. A Cost Effectiveness index was used by Moran et al. (1996) to determine the probability of conservation investment success by country for the Asia-Pacific region. The analysis considered species richness versus investment cost to determine a priority-investment index. This study was limited because no 'real' outcomes were specified and conservation investment costs were averaged across a whole country.

4.3.3 COST UTILITY ANALYSIS

Cost Utility Analysis (CUA) was first developed to evaluate health-care programs, and can be used to compare many competing alternatives. The outputs of a CUA are expressed as utility (Hughey et al., 2003). Like CEA, CUA requires a unit of measurement for calculating cost per unit of output ratios. These output units can be measured in biological or physical terms and do not require an individual's willingness to pay to be calculated (Cullen, Hughey, Fairburn, & Moran, 2005a).

Cost Utility Analysis provides both retrospective and predictive information. If managers want to know the relative cost-effectiveness of expenditures on projects already undertaken, CUA is useful. Its main strength is that it can provide an explicit means for evaluating projects having different objectives. For example, it can evaluate projects that seek to increase the population size of an animal along with projects that seek to protect plant species (Hughey et al., 2003). It was employed by Cullen, Fairburn, and Hughey (1999) to evaluate the output gained from various species conservation management projects. The approach they used, termed conservation-output protection-years (COPY), allowed the effectiveness of unlike activities to be compared. Similarly, Cullen, Fairburn and Hughey (2001) applied CUA to conservation management, where utility refers to the change that occurs in a species. This provides a useful framework for inter-species comparisons that incorporates an ecological measure of effectiveness and the true costs of management. However, this process could be biased according to the response strategy of species' managers (Hughey et al., 2003). In a study by Cullen *et al.* (2005a), CUA was used to determine the most cost-effective multiple species conservation projects in New Zealand. Conservation success was measured in conservation output protection years at each site and this was compared with the present-value cost of implementing the projects.

4.3.4 OPPORTUNITY COST ANALYSIS

Opportunity Cost Analysis (OCA) determines the size of trade-offs in terms of the foregone goods and services for the next best alternative use. For example, in an analysis of the ecologically and socially optimal number of reserves (taking into account ecological indicators and opportunity costs), Groenveld (2004) assessed losses of agricultural profit, diminishing returns to farm area, land trade, and transaction costs. Similar analyses were undertaken by Montgomery *et al.* (1994) to select conservation projects for conservation of the northern spotted owl (*Strix occidentalis* caurina) and Main *et al.* (1999) for the Florida panther (*Felis concolor coryi*). OCA is technical, data intensive, and of limited help in inter-programme comparisons (Hughey et al., 2003). This research is concerned with existing national parks, rather than the establishment of new parks, so OCA is not suitable.

4.4 MULTIPLE CRITERIA DECISION-MAKING FRAMEWORKS

Multiple Criteria Decision Making (MCDM) is the umbrella term for "the study of methods and procedures by which concerns about multiple conflicting criteria can be formally incorporated into the management planning process" (International MCDM Society, 2006). These are formal computer-based methods for considering a wide range of potentially conflicting criteria relevant to a decision situation.

Modern MCDM theory can be traced back to the Dutch-born mathematician Daniel Bernoulli, who in 1738 introduced the concept of utility to explain people's non-linear value for money (Bernoulli, 1954). The MCDM discipline is strongly rooted in the Operations Research literature, a field of study initially focused on making better logistical and industrial decisions during World War II. Operations Research has subsequently expanded into other fields, where it is concerned with developing processes for optimal allocation of resources (Yakowitz & Hipel, 1997). Normative decision theory was formalised by Savage (1954) and has remained largely unchanged. Many MCDM methods were pioneered in the 1970s following the development of single-objective mathematical programming techniques (Edwards-Jones, Davies, & Hussain, 2000). Since the 1980s MCDM methods have developed rapidly, as have real-world applications of MCDM methods, for example Banville *et al.* (1998), Hämäläinen *et al.* (2001), Insua *et al.* (1995), Janssen (2001), Joubert *et al.* (1997), Lamy *et al.* (2002), Maguire (1986), Marshal *et al.* (2004), and Wenstop *et al.* (1988).

The MCDM literature is extensive, involving the development of a diverse suite of frameworks for application to decision problems in different fields of study (Proctor & Qureshi, 2005). The primary distinction among MCDM frameworks is based on the nature of the decision alternatives being evaluated (Figure 4.2). Problems involving a discrete set of alternatives are synonymously termed Multiple Criteria Evaluation, Multiple Criteria Analysis, or Multiple Attribute Decision Making problems, involving the ranking of a pre-determined set of alternatives.

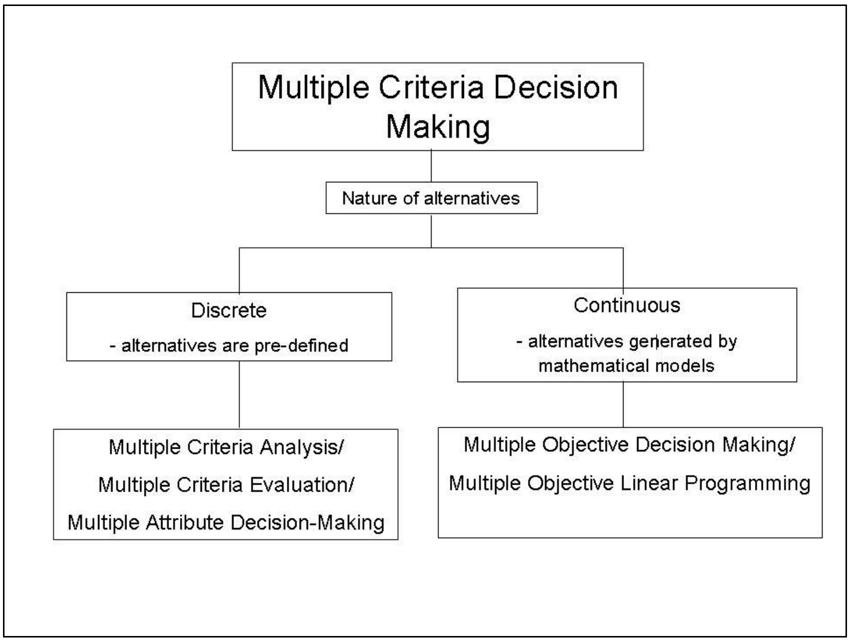
Decisions involving a continuous set of alternatives generated by mathematical models are known as either Multiple Objective Decision Making or Multiple Objective Linear Programming problems (Malczewski, 1999; Pomerol & Barba-Romero, 2000; Proctor & Qureshi, 2005). These models involve design processes that consider the best choice for attaining an objective like the highest profit or the least waste (Malczewski, 1999). Continuous alternatives are generated for problems in planning, routing, scheduling, and design where the models identify an 'optimal' strategy from a set of essentially infinite options (French & Geldermann, 2005). For example, Prato (2001) used mathematical programming to model carrying capacities for national parks, determine which ecosystems are not in compliance with established standards for carrying capacities, and identify appropriate management actions; a problem not characterised by a discrete set of alternatives.

To simplify the classification of MCDM frameworks, the term Multiple Criteria Analysis (MCA) will be used to refer to MCDM problems involving a discrete set of alternatives, and the term Multiple Objective Decision Making (MODM) to refer to problems specifically involving a continuous set of alternatives.

Multiple Criteria Analysis frameworks include methods known as outranking methods, and value or utility functions. Outranking methods are based on pairwise comparisons; thus, rather than giving a value for each alternative, the alternatives are described in relation to other alternatives (Belton & Stewart, 2002). In comparison, value functions and utility functions, like the analytic hierarchy process (AHP) and multi-attribute utility theory or multi-attribute value theory (MAUT/MAVT), evaluate each alternative by assessing the performance of alternatives against individual criteria, and the relative importance of the different criteria (Belton & Stewart, 2002; Kiker, Bridges, Varghese, Seager, & Linkov, 2005).

Figure 4.2

Simple Classification of Multiple Criteria Decision Making Techniques



Source: Adapted from Proctor and Qureshi (2005)

Multiple Objective Decision Making frameworks include goal programming and reference point methods. These emphasise satisfactory levels of achievement for each criterion and are well-suited to problems with a mathematical programming structure that have many or infinite alternatives. The decision-maker's value judgements are expressed as desirable levels of performance for each criterion (Belton & Stewart, 2002).

All MCDM frameworks have been developed to accommodate the decision-maker's preferences for certain criteria. This means that criteria can be allocated a level of importance so some criteria are more heavily weighted than others in the analysis. Holz *et al.* (2006) divided approaches to articulating preferences into three groups: criteria weighting and holistic evaluation methods for MCA frameworks, and aspiration methods for MODM frameworks. Criteria weighting determines the relative importance of each criterion. Specific methods for criteria weighting include the Analytic Hierarchy Process (AHP), where statements of preference are made about pairs of criteria; swing weighting, based on the attractiveness of the swing from worst to best on each criterion; fixed point scoring, involving the distribution of a set number of points amongst the criteria; and, rating, where each criterion is assigned an importance rating, usually between zero and one. Holistic evaluation requires users to weigh the costs and benefits of potential strategies. Specific methods include judgement analysis, where statements of preferences are used to derive weights for the decision criteria; and graphical holistic evaluation tools (Holz et al., 2006). Aspiration methods are based on how close an alternative comes to a pre-determined desired outcome (Choo, Schoner, & Wedley, 1999; Holz et al., 2006). Specific methods include goal programming and target ordering (Holz et al., 2006).

Environmental management problems are typically complex and interdisciplinary and have been one of the most fruitful areas of MCDM applications since the mid 1990s (Broersma, 2003; Hämäläinen & Mäntysaari, 2001; Yakowitz & Hipel, 1997). Both MCA and MODM frameworks have been applied to environmental problems, as shown in Table 4.9. Kiker et al. (2005) reviewed over 40 further environmental applications of different MCA methods. The value and utility functions methods receive dominance in the environmental literature.

Moffett and Sarkar (2006) reviewed 26 MCDM methods for potential use in designing conservation area networks based on systematic conservation planning principles. They found goal programming (MODM), and multi-attribute utility theory and modified analytic hierarchy process methods (MCA) were best, depending on the nature of the alternatives and criteria. As the problem addressed in this thesis involves a set of discrete alternatives – a country's set of national parks – MODM frameworks are unsuitable.

Environmental problems that have been approached using MCA frameworks for decision-making include:

- Water resource regulation (Agrell, Lence, & Stam, 1998; Ballestero, 2000; de Marchi, Funtowicz, Lo Cascio, & Munda, 2000; Joubert et al., 1997; Messner, Zwirner, & Karkuschke, 2006; Mustajoki, Hämäläinen, & Marttunen, 2004; Prato & Hajkowica, 1999; Raju & Pillai, 1999; Ridgley, Penn, & Tran, 1997);
- Energy management (Dunning, Lockfort, Ross, Beccue, & Stonebraker, 2001; Goletsis, Psarras, & Samouilidis, 2003);
- Transportation network planning (Bana E Costa, 2001);
- Land allocation (Marshal & Homans, 2004; Zografos & Oglethorpe, 2004);
- Environmental policies (Bell, Hobbs, Elliott, Ellis, & Robinson, 2001; Wenstop & Seip, 2001);
- Industrial green engineering (Chiou & Tzeng, 2002);
- Forest management (Hjortso & Straede, 2001; Kangas, Store, Leskinen, & Mehtatalo, 2000; Mendoza & Prabhu, 2000,2003; Proctor, 2000; Sheppard & Meitner, 2005; Varma, Ferguson, & Wild, 2000);
- City management for sustainability (Munda, 2005); and,
- Environmental Impact Assessment (Janssen, 2001).

Multiple Criteria Analysis frameworks are increasingly being employed in conservation decision-making. In particular, MCA applications that relate more specifically to protected area management include:

- Metapopulation management (Drechsler, Frank, Hanski, O'Hara, & Wissel, 2003);
- Endangered species management (Drechsler, 2000; Maguire, 1986);
- Conflict management between conservationists and farmers bordering a national park (Kachele & Dabbert, 2002);

Table 4.9

Selected Examples of MCDM Applications to Environmental Problems

MCDM framework	Area of application	Alternatives considered	Criteria	Specific MCDM methods	Preference expression procedure
MCA: value or utility function methods	Green engineering (reclaiming waste) investment strategies for aquatic products processors in Taiwan (Chiou & Tzeng, 2002)	Eight post use process strategies including source reduction, life cycle product design, emission reduction, consumer education, energy recycling	12 criteria, in three categories: business activities, government roles, socioeconomic effects.	Non-additive fuzzy integral technique used to evaluate performance of green engineering strategies.	Fuzzy hierarchical analytic approach used to determine weights of criteria from subjective judgements.
	Research funding priorities, New Zealand Ministry of Agriculture (Mabin, Menzies, King, & Joyce, 2001)	Six categories of research to be funded.	Eight criteria, in two categories: need (information gap, alternative provision, regret, impact) and strategic fit (domestic business, perception, market access, sustainability)	Multi-attribute value functions using Visual Interactive Sensitivity Analysis (VISA) software	Derived using Group Systems software using swing weights.
	Zoning the planned Asinara Island National Marine Reserve in Italy (Villa, Tunesi, & Agardy, 2002)	Four protection levels: integral reserve (no-entry no-take), integral reserve (entry no-take), general reserve, and partial reserve.	27 criteria, in five categories: marine natural value, coastal natural value, recreational value, commercial exploitation value, and ease of access.	Evaluated concordance between the reserve area and four planned protection levels using Spatial MCA (involving GIS). Concordance calculated with GRASS geographical information system software.	Pairwise comparison matrices prepared from stakeholder interviews and inconsistency indexes calculated. For each set of priority weights, concordance and discordance scores were calculated.

MCDM framework	Area of application	Alternatives considered	Criteria	Specific MCDM methods	Preference expression procedure
MCA: outranking Methods	Project proposal ranking in the Armenian Energy Sector (Goletsis et al., 2003)	142 project proposals from organisations: Ministry of Energy, energy experts, humanitarian aid, financing international organisations.	13 criteria in four categories: socio-political, economic, technical, environmental.	MURNAME, pairwise comparison, veto, pseudocriteria, uses applied weight definition technique	Weights modelled using veto and pseudocriteria, modelling hesitations between preference and indifference in a fuzzy way.
	Ranking butterfly population management scenarios in Finland (Drechsler, 2004)	Four landscape scenarios	1000 parameter combinations produced from a Bayesian model fitting.	PROMETHEE used to calculate metapopulation survival probability for each landscape scenario via pairwise comparisons.	DMs had no reason to prefer any parameter combinations over any others.
MODM: goal programming and reference point methods	Choosing sites for land retirement (Marshal & Homans, 2004)	30 landscapes differing in habitat	Three categories of objectives: hydrological improvement, habitat enhancement, expenditure minimisation	Compromise Programming	Weights and distance functions applied. Equal weights also applied.
	Land allocation options in Alto Napo, Amazonian Ecuador. (Zografos & Oglethorpe, 2004)	Four potential activities: pastures, commercial farming, subsistence agriculture, ecotourism	Five categories: financial, economic, social, cultural, environmental	Weighted Goal Programming	Pre-emptive weights determined from four groups on basis of informal interviews.

- Zoning in marine protected areas (Villa et al., 2002);
- The integration of stakeholder preferences in conservation-related decisions (Banville et al., 1998; Messner et al., 2006; Munda, 2003; Pavlikakis & Tsihrintzis, 2003a,2003b; Sheppard & Meitner, 2005); and
- Determining appropriate visitor carrying capacities in national parks (Prato, 2001).

In addition, the public sector has employed MCA to determine funding priorities for land management in New Zealand and Australia. The New Zealand Ministry of Agriculture and Forestry used MCA to determine funding priorities among six research funds using eight criteria (Mabin et al., 2001). The Queensland Department of Natural Resources and Mines in Australia used MCA to assess regional funding priorities across 13 regions within Queensland. The performance criteria related to agricultural profits, geographic extent, degradation costs, landscape value, salinity area, threatened species, historical tree clearance, water quality, and water use (Hajkowicz, 2002).

Many authors outline the strengths of MCA. Its key strength is the ability to provide clarity in complex data sets (Messner et al., 2006). It offers a framework for identifying, organising, storing, and explicitly considering relevant quantitative and qualitative data (Lahdelma, Salminen, & Hokkanen, 2000). Rather than a check-list approach to decision-making, MCA is a tool to improve the transparency, robustness, and understanding of decisions through a systematic, objective, and structured approach (Beinat, 2001; Belton & Stewart, 2002; Edwards-Jones et al., 2000; Janssen, 2001; Lahdelma et al., 2000). The MCA process can help to identify data gaps and, through sensitivity analysis, data that have little impact on the decision under consideration (Edwards-Jones et al., 2000).

Unlike many decision frameworks, MCA facilitates the consideration of subjective, intuitive information and complements and challenges intuitive judgement without replacing it (Belton & Stewart, 2002; Maguire, 1986). It also provides for different points of view, and can accommodate conflict and complex relationships between objectives (Edwards-Jones et al., 2000; Mustajoki et al., 2004; Zografos & Oglethorpe, 2004). Furthermore, MCA approaches can identify otherwise implicit trade-offs and the results are reproducible (Edwards-Jones et al., 2000; Guikema & Milke, 1999; Janssen, 2001).

There are four primary criticisms of MCDM methods. First, apprehension has been expressed over the tendency of ‘conventional’ techniques to assume an unrealistic spatial homogeneity in decisions involving biophysical resources (Malczewski, 1999). However, this may be overcome by using additional techniques such as GIS in partnership with the MCA. Second, the MCDM field has been criticised for offering many analysis methods without a clearly superior one (Edwards-Jones et al., 2000). The field also tends to continually produce new methods to overcome the limitations of existing methodologies, rather than focusing on problem definition and design (Janssen, 2001; Triantaphyllou, 2000). Third, the ‘black box’ nature of some methods can lead to mistrust or excessive faith in the results (Edwards-Jones et al., 2000; Janssen, 2001). Finally, the subjectivity of preference expression in MCA has been criticised. Subjective judgment plays a key role in MCA technique and it is thus considered more arbitrary than a CBA (Broersma, 2003). The accuracy of preference expression can be limited by the effort needed to derive weights, and the poor definition of criteria and/or use of inappropriate weighting processes by some software packages (Choo et al., 1999; Edwards-Jones et al., 2000). However, methods belonging to the MCDM family are the only methods that facilitate the incorporation of preferences into decision making and the sensitivity analysis stage should uncover problems with criteria or weights.

4.5 FRAMEWORK SELECTION

The purpose of this section is to select the most appropriate decision-making framework on which to build a model to help decision-makers allocate funds among national parks. From the first two groups of frameworks reviewed in this chapter, the Conservation Priority Scoring System (Cumming & Jackson, 1984) and the Rapid Assessment and Prioritisation of Protected Area Management (RAPPAM) methodology (Ervin, 2003c) were identified as those with the most potential. Several cost-based frameworks were also discussed along with Multiple Criteria Decision Making, focusing on Multiple Criteria Analysis in particular.

In Chapter Two, the parameters needed for a suitable decision-making framework were outlined. A diverse range of incommensurate information that reflects the complexity of national park benefits and values should be integrated into the model, including social, historical, cultural, ecological, and economic data. The framework must accommodate a potentially large quantity of data, including surrogate data where real data are not available. In addition, the framework must incorporate the weighting of preferences and reliable processes for robustness analysis. In other words, the decision-making framework selected must deal with both the magnitude and importance of decision attributes. The ability of each decision-making framework to accommodate these parameters is shown in Table 4.10.

The Conservation Priority Scoring System and RAPPAM approaches do not meet all the required parameters. Both methods can accommodate incommensurate data, but have limited capacity to use surrogate or large quantities of data. The Conservation Priority Scoring System has a simple system for weighting preferences and neither framework has a facility for robustness analysis. Furthermore, both methods are based on the subjective appraisal of parks by park managers, rather than on more objective, quantitative data.

None of the cost-based assessment methods meet all of the parameter requirements. Cost Benefit Analysis requires all data to be expressed in monetary terms and does not allow preferences to be articulated. If conservation decision makers are required to focus on the economic implications of conservation decisions they need to know which conservation investments have been best. Cost effectiveness analysis and cost utility analysis are the most appropriate tools to answer these questions; however, accurate cost data are essential for both of these techniques (Hughey et al., 2003).

Cost Effectiveness Analysis requires costs to be expressed in monetary terms and so has a limited ability to accommodate incommensurate data. This method is typically applied to project-level decisions and the quantity of information that can be incorporated may be limited. Cost Utility Analysis can incorporate incommensurate data but does not accommodate the other decision-making parameters. Opportunity Cost Analysis addresses the forgone benefits from different types of land use and is therefore not relevant to the problem posed in this thesis.

Table 4.10

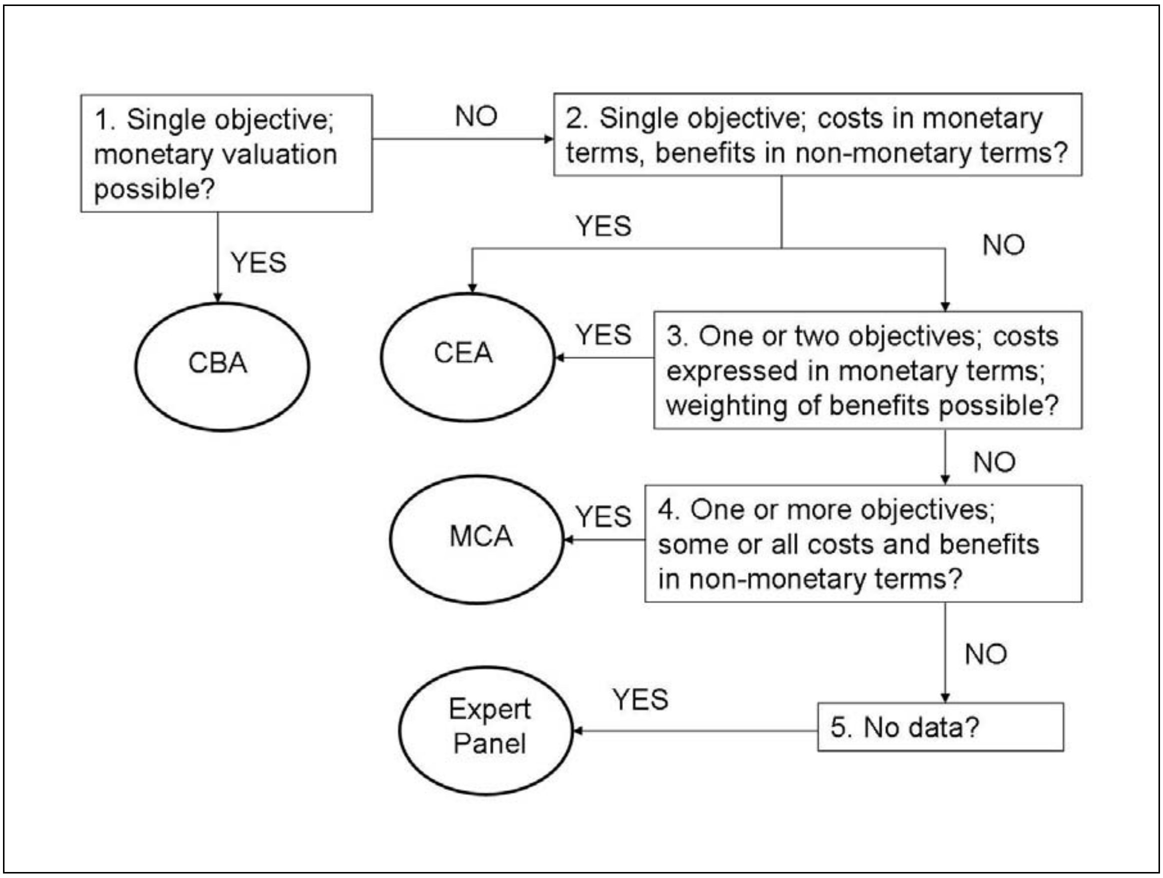
Characteristics of Decision-Making Frameworks

Framework	Description	Can the framework accommodate:				
		A large quantity of information?	Incommensurate data?	Surrogate data?	Weighted preferences?	Robustness analysis?
The Conservation Priority Scoring System (Broersma, 2003)	Prioritises parks based on a combination of biological, socio-economic, landscape/amenity, and conservation status criteria using qualitative assessment.	Limited	Yes	Limited	Limited	No
RAPPAM (Rapid Assessment and Prioritisation of Protected Area Management) (2003)	Assesses the significance of parks based on pressures and threats, biological importance, socio-economic importance and vulnerability using qualitative assessment.	Limited	Yes	Limited	No	No
Cost Benefit Analysis (CBA)	Measures the gains to society from a policy/project against the sacrifices required of society to implement the policy/project, in present dollar terms.	Limited	No	Yes	No	Yes
Cost Effectiveness Analysis (CEA)	Finds the least-cost way to meet an objective or standard based on a single measure of effect. Outputs are usually measured in non-monetary terms.	Limited	Limited	Yes	Yes	Yes
Cost Utility Analysis (CUA)	Developed to evaluate healthcare programmes by measuring the output in terms of utility.	Limited	Yes	No	No	No
Opportunity-Cost Analysis (OCA)	Measures the forgone income from an alternative, rather than the benefits of a project.	Limited	Yes	Limited	No	Yes
Multiple Criteria Analysis (MCA)	Evaluates a range of alternatives in terms of a set of criteria.	Yes	Yes	Yes	Yes	Yes

MCA frameworks fulfil all of decision-making parameters identified in Chapter Two. Multiple Criteria Analysis frameworks allow alternative options to be ranked against criteria that are unable to be quantified in monetary terms (Broersma, 2003). These frameworks can incorporate a large quantity of information because they are software-based. Data can be expressed in incommensurate units and surrogate data can be employed where real data are not available. All MCA frameworks involve the explicit and transparent weighting of preferences and sensitivity analysis. The choice of MCA as the most appropriate decision-making framework is defended in Broersma (2003), as shown in Figure 4.3.

Figure 4.3

Choosing an Appropriate Framework for a Decision Problem



Source: Adapted from Broersma (2000)

In Figure 4.3, the major determinants of the choice of decision-making framework are the units in which costs and benefits are expressed, and the number of decision objectives. Where criteria can be neither quantified nor valued, informed judgement techniques like the Delphi Technique (expert panel) are the only methods available (Broersma, 2003). For the problem this thesis addresses, MCA is the best choice because many of the costs and benefits associated with national parks cannot be expressed in monetary terms.

4.6 MULTIPLE CRITERIA ANALYSIS

Multiple Criteria Analysis (MCA) has been identified as the most appropriate framework with which to develop a tool to assist decision-makers with the allocation of resources amongst national parks. This section provides an overview of how to proceed with an MCA. First, the primary components of an MCA are briefly described. This is followed by an outline of how to implement a MCA, which forms the foundation of the research methodology in this thesis. Finally, the strengths and limitations of MCA frameworks are discussed.

4.6.1 COMPONENTS OF A MULTIPLE CRITERIA ANALYSIS DECISION

The generic MCA approach involves establishing a set of criteria against which alternative courses of action are evaluated. The key components of a decision using MCA include:

1. Decision-makers – those people responsible for making the decision;
2. Stakeholders – the individuals, groups, and organisations who will be affected by the outcomes of the decision. Laws or relevant policies may require some stakeholders to be involved in the decision-making process. Other stakeholders may be able to assist the decision-making process by supplying supporting information or data (either qualitative or quantitative);
3. Analysts – people who develop and conduct the analyses. The results of the analysis are used to inform the decision-makers and guide them towards a balanced decision;
4. Decision objective/s – the goals of the decision-makers in undertaking the decision process;
5. Alternatives (or actions, options, policies, or strategies) – the courses of action under consideration; for example, the national parks competing for limited funds;

6. Criteria (or attributes) – describe the alternatives with reference to the objectives. Edward-Jones et al*.* (2000) state that the most critical aspect of a MCA is the choice of appropriate criteria and suitable measures for those criteria. Ideally, these criteria will draw on scientific data rather than subjective judgements and should be chosen carefully to eliminate redundancy (Hajkowicz, 2002).

7. Data – measures of the criteria. Data may be quantitative or qualitative, real or surrogate. Ranks or semi-quantitative appraisal scores must refer to a monotonic scale that need not be linear, for example rankings like "bad", "good", and "very good" are acceptable (Villa et al., 2002); and,

8. Preferences – the decision-maker's subjective preferences are expressed through the weighting or ordering of criteria, where a number is assigned to each criterion describing its importance (Edwards-Jones et al., 2000; Lahdelma et al., 2000).

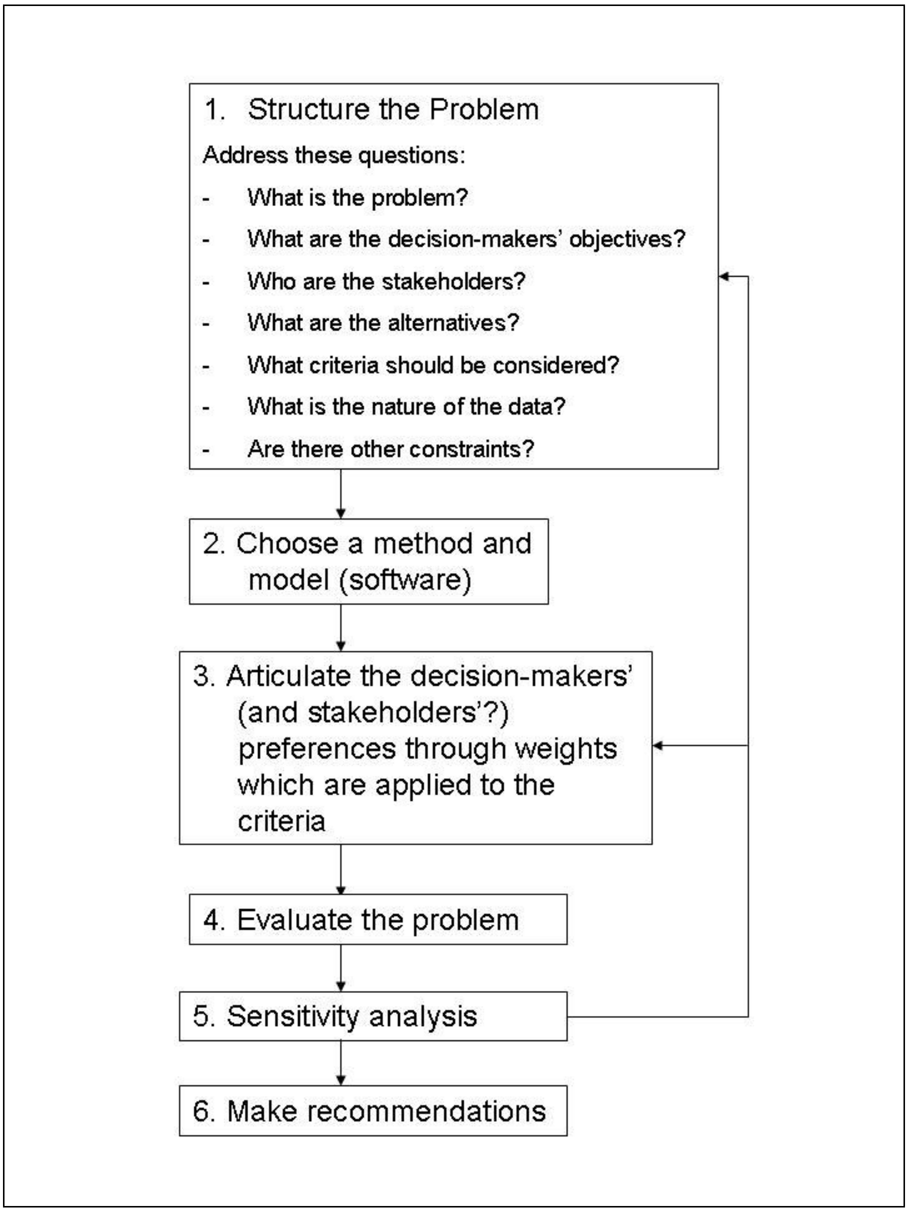
4.6.2 THE MULTIPLE CRITERIA ANALYSIS PROCEDURE

According to Wenstop et al*.* (2001) the MCA process has two distinct input phases. The first involves factual identification of alternatives, criteria, and measures based on scientific credibility and documentation. The second is concerned with the subjective expression of preferences. Information used in the MCA process will include both 'soft' (subjective) and 'hard' (objective) data. Subjective data include qualitative data, preferences, priorities, and judgements, and objective data are quantitative. While many differing MCA methodologies exist, all follow the approach outlined in Figure 4.4.

First, the decision problem is explored and structured, then a suitable analysis method and MCA software are selected. Next, the preferences of the decision-makers for some criteria over others are considered; these are then incorporated into the evaluation of the problem. A sensitivity analysis is performed to ensure that the results of the analysis are robust, then recommendations can be made. These six generic steps of an MCA evaluation are each discussed below.

Figure 4.4

Overview of the Multiple Criteria Analysis Process



Source: Adapted from Clemen (1996)

.(1) Problem Structuring

An oft quoted statement is: "a problem well structured is a problem half solved" (Belton & Stewart, 2002). A decision problem can be broadly defined as the perceived difference between the existing and desired states of a system (Malczewski, 1999). Structuring the problem facilitates better understanding by determining and assessing the decision-makers' objectives, and by identifying the stakeholders, the alternative courses of action, the criteria against which to compare the alternatives, and the nature of the data required to compare them (Belton & Stewart, 2002; Clemen, 1996; Guitouni & Martel, 1998; Malczewski, 1999). This stage of free-thinking about the decision problem explores values, beliefs, priorities, facts, points of view, constraints, consequences, and causes related to the issue (Belton & Stewart, 2002).

(2) Choice of Method and Model

Several MCA methods have been developed, each involving different mathematical processes to compare alternatives against different criteria. In comparison, a MCA model is a software package in which alternatives and criteria are specified, data is entered, and a MCA method is undertaken to process the decision.

Types of MCA methods applied to environmental problems since 1995 include: PROMETHEE (Preference Ranking Organisation METHod for Enrichment Evaluations); ELECTRE (ELimination Et Choix Traduisant la REalite); AHP (Analytical Hierarchy Process); GIS (Geographic Information Systems); MAUT (Multi-Attribute Utility Theory); outranking; and SMART (Simple Multi-Attribute Rating Technique) (Kiker et al., 2005). A selection of MCA methods has been discussed and compared by Belton and Stewart (2002) and Triantaphyllou (2000), and a conceptual framework of guidelines for choosing an appropriate MCA method is presented by Guitouni and Martell (1998). A survey of MCA models is publicly available on the World Wide Web (Maxwell, 2002) to help users choose an appropriate model for their decision situation.

(3) Preference Articulation

The decision-maker's preferences for certain criteria are incorporated into the evaluation method. As mentioned previously, in MCA decisions preferences are expressed through either criteria weighting or holistic evaluation methods (Holz et al., 2006). Assigning weights to criteria is the most common approach to expressing preferences. In doing so, the importance of each criterion relative to other criteria is expressed (Malczewski, 1999). It is vital that the weights and any resulting tradeoffs are a true reflection of the participant's preferences (Belton & Stewart, 2002; Choo et al., 1999; Holz et al., 2006).

(4) Problem Evaluation

Algorithms are used to rank the options against the criteria, using the data and criteria weights to determine an overall performance score for each alternative. These processes differ between MCA methods. The primary output from the evaluation is a ranking of alternatives, and each model can display results in different forms.

(5) Sensitivity Analysis

Uncertainty is inherent in the MCA process because the decision-maker's preferences, expressed as weights, are subjective values. Consequently, MCA has been criticised for being an 'inexact' procedure. Sensitivity analysis explores the robustness of the result(s) and how sensitive they are to changes in aspects of the model (Belton & Stewart, 2002). It also allows greater exploration and understanding of the nature of the decision problem, the weightings, and the data (Proctor & Qureshi, 2005). Sensitivity analysis can be undertaken from a technical, individual, or group perspective (Belton & Stewart, 2002; Edwards-Jones et al., 2000). It systematically varies the weights and/or data to see how they affect the results. If a minor variation in one criterion significantly influences the result, that parameter should be subject to further scrutiny. Sensitivity analysis can act as an exploratory process that facilitates a deeper understanding of the structure of the problem (Malczewski, 1999).

(6) Making a Recommendation

If the sensitivity analysis shows the results to be robust they can be accepted. Recommendations typically take at least one of three forms: a single optimal alternative, a feasible set of options, or specific trade-off relationships between options and objectives (Edwards-Jones et al., 2000). The best decision is the 'one that gives the best outcome' (Clemen, 1996). However, there is no single 'correct answer' resulting from an MCA; rather, MCA is an aid for decision making and its principal benefit is to facilitate better understanding of the problem (Belton & Stewart, 2002). Thus, MCA will not relieve the decision-maker from the responsibility of making a decision.

4.7 CONCLUSION

The review presented here set out to identify a suitable rational decision-making framework in which to build a model to assist decision-makers with the annual allocation of funds amongst national parks. Four sets of decision-making framework were reviewed: frameworks developed to identify areas for protected area designation, frameworks for evaluating the effectiveness of protected area management, cost-based assessment frameworks, and multiple criteria analysis methods.

Making decisions about the allocation of public funds among national parks is complex. Governments need a pragmatic, robust, and transparent process for assisting decision-making. Good decisions depend on a large range of stakeholder preferences and ecological and economic data. Some methodologies have been developed to assist with setting conservation priorities, but all have limitations and many are biologically biased. Multiple Criteria Analysis (MCA) provides an integrated framework for developing a suitable methodology because it can handle a large range of incommensurate data and the expression of preferences in a robust manner. MCA is not a panacea, but goes some way to providing public policy makers with a tool to assist in the decision making process.

5 MODEL DEVELOPMENT AND RESULTS

In this chapter, the methods used to conduct the study are explained and the results are presented. A model is developed and tailored to two pilot studies. In the first section, the development of the model is described and the resulting model is presented. In the second and third sections, two pilot studies are presented where the development and calibration of the model to these real-world park networks is described. The pilot studies were for the national parks managed by the Parks and Wildlife Commission of the Northern Territory (Australia) and the Department of Conservation of New Zealand.

The research embodies both a quantitative and a qualitative approach. Whilst national park attributes are quantified using criteria that are standardised and relatively objective, the relative importance of each attribute is inherently subjective. The MCA process makes preference articulation transparent and separate from the objective parts of the analysis (Logical Decisions, 2002).

5.1 DEVELOPING THE MCA MODEL

The model is intended to act as a benchmark model to which most PAMAs will have access to the required data. Where required, specific criteria can be tailored to a country's databases. For example, there is no standard global classification for cultural landscape features and many PAMAs have adopted unique descriptive categories that could easily be exchanged for the U.S. National Parks Service classification that features in the model.

As outlined in the previous chapter, the key phases of the MCA approach are structuring the problem, choosing the method and model (software), articulating preferences, evaluating the problem, undertaking sensitivity analysis, and making recommendations (Clemen, 1996). The structure of this section covers all of these phases, but deviates slightly from this approach. First, the formal objectives of the model are re-stated. Second, ways to elicit preferences are discussed. Third, the evaluation method and MCA software used in this research are chosen. Fourth, the structure of the model is outlined, including justification for excluding some criteria from the model. Fifth, the process of entering data for each alternative is explained. Sixth, a selection of weight assessment methods are trialled in order to choose the most appropriate. Seventh, a sensitivity analysis is undertaken to determine whether the model results are consistent with the attribute scores of each alternative. Finally, the rationale for the pilot study design is provided.

5.1.1 FORMAL OBJECTIVES

As stated in Chapter 2, the model's overall objective is *to determine national park significance in terms of conservation importance*, where conservation importance is a combination of the natural heritage, economic, and social net benefits associated with each national park. More specifically, these benefits include:

1. Benefits from the protection of a representative sample of the nation's indigenous biodiversity, including viable wildlife populations;
2. Benefits from the ecosystem services provided by national parks;
3. Benefits from tourism income;
4. Benefits from the protection of the cultural and historical heritage found within national parks;
5. Benefits from providing spiritual, scientific, educational, and recreational opportunities; and,
6. Benefits from meeting national obligations under relevant national legislation, and multilateral and bilateral agreements.

5.1.2 PREFERENCE ELICITATION

Deriving preferences or weights for criteria from either an individual or a group is time-consuming (Bana E Costa, 2001; Keeney, von Winterfeldt, & Eppel, 1990). In order for the park ranking process to be practical, the number of people involved should be minimised to reduce time and cost pressures. However, the model must also be robust so those involved should represent relevant fields of expertise. In this research, the key people include the manager responsible for funding decisions, other experienced and knowledgeable PAMA staff, as well as government staff members.

The proposed MCA approach has an expert-driven emphasis and in-house preference elicitation will add to this. A commonly stated advantage of MCA is that it is 'democratic' in the sense that a variety of interested and affected parties can be involved (Belton & Stewart, 2002). Narrowing the spread of involved individuals makes the MCA process is more practical, but may diminish its robustness. A PAMA could consult with a wide range of stakeholders to determine appropriate weightings for the model. However, with practicality in mind, the preference elicitation stage was developed with in-house experts in mind.

Methods for eliciting preferences from groups include surveys, direct value elicitation, indirect value elicitation, focus groups, and public involvement (Table 5.1) (Keeney et al., 1990). Of these methods, a focus group technique called the Delphi technique is the most appropriate for this research because it is robust, quick, and inexpensive (MacMillan & Marshall, 2006).

Focus group research techniques started in the late 1940s and have been used in diverse social-science disciplines since (Bedford & Burgess, 2001). The Delphi technique is an approach to systematically elicit human judgements when experimental or observational data are not available. The method aims to reach consensus between experts through several rounds of deliberation on the assumption that multiple experts will provide more reliable results than one or two individuals (MacMillan & Marshall, 2006). It involves structured group interaction to extract the knowledge, insights, and experience of the participants through communication focussed on a set of predetermined tasks. The technique involves feedback to the group after each iteration on both individual and collective preferences. This gives participants opportunities to reconsider and modify earlier judgements and opinions based on what they learn about others. The flow of conversation ensures that there is dialogue between people and individuals are free to challenge the interpretations and assumptions of other group members (Bedford & Burgess, 2001). The contributions of each participant are evaluated in terms of their intrinsic worth rather than who made the contribution. This removes barriers to communication and the influence of individual personalities (Corporate Partnering Institute, n.d.).

The Delphi approach has many strengths, not least that it is intended to operate in data poor environments where empirical models are not possible. The Delphi technique acts as a more formal, transparent, and consensual alternative to

Table 5.1

Characteristics of Methods for Eliciting Preferences from Groups

Elicitation method	**Explanation**	**Strengths**	**Weaknesses**
Surveys	Preferences are derived from individuals via postal survey.	Inexpensive, can reach people that are geographically distributed and can not easily be brought together in one place.	The hypothetical nature of many questions; intentional or accidental influence of author; possible survey design and administration problems; no immediate feedback from facilitator to participant leading to misunderstandings and misrepresentative weights.
Direct value elicitation	Facilitators and/or decision-analysts work with groups of stakeholders to derive preferences.	Objective and subjective information are clearly separate; can provide important information for policy-makers.	Difficult and expensive to gather people to one place; lay people may have difficulty understanding questions regarding trade-offs.
Indirect value elicitation	Preferences are derived from behaviour in marketplaces, publications, anecdotal social opinion, or contingent valuation techniques.	Contingent valuation can be applied to non-market items and provides a clear set of trade-offs.	Accuracy problems; many preferences do not have a simple economic equivalent; problems combining hypothetical and factual scenarios/information.
Focus groups	Consensus on preferences is sought amongst a group of stakeholders.	Cheap, fast, involving open dialogue to reach consensus.	Small and sometimes unrepresentative groups.
Public involvement	Preferences are derived from contact with the section/group of the community directly affected by/concerned with the problem, including experts, policy-makers and administrators, community members and interest groups.	All stakeholder groups can be involved. Preferences are solicited directly rather than implied as in focus groups.	The problem must be clear and understood by all people present; time-consuming and expensive.

Source: Adapted from Keeney (1990)

informal knowledge-based processes colloquially known as 'rules of thumb'. Expert subjectivity is accounted for by the nature of the Delphi process which involves feedback loops built in as safeguards. If the process allows sufficient debate and consensus building, the chances of an unreliable and biased model being developed are minimised (MacMillan & Marshall, 2006). In doing so, it can accomplish in hours what would otherwise take weeks (Corporate Partnering Institute, n.d.).

One of the Delphi technique's main strengths is the opportunity it provides for open dialogue between researchers and practitioners meaning that weights are derived in a shared intellectual space, breaking down barriers of perspective, prejudice, or language. Furthermore, intuitive reasoning by experts is suited to complex questions where confounding factors and uncertainty in the estimates can obscure empirical modelling (MacMillan & Marshall, 2006). Limitations include the danger that experts may be biased or speculating where they lack adequate knowledge of a subject. The outcome can be affected by the selection of and number of experts, the information provided to the experts, the scoring system employed, and the choice of issues discussed (MacMillan & Marshall, 2006). The technique cannot guarantee consensus and it is important that the facilitator does not let one person dominate discussion (Bedford & Burgess, 2001; Kneale, 2001).

5.1.3 CHOICE OF SOFTWARE (METHOD AND MODEL)

A number of MCA software packages are available and in order to choose a software package, the method of analysis and ideal user parameters were identified.

Evaluation Method

The choice of evaluation method was based on the way preferences are articulated. The most common tool for formalising preferences in MCA is assigning a numerical weight to each criterion (Holz, Kuczera, & Kalma, 2006). Weighting techniques include:

- Pairwise comparison – decision-makers make statements of preference between pairs of criteria. This requires the decision-maker to consider all elements of the decision problem by communicating the importance of each pair on a numeric scale (Hajkowicz, 2002; Holz et al., 2006);

- Swing weighting – decision-makers think about the attractiveness of the swing from worst to best on each criterion (Holz et al., 2006);

- Ordinal ranking – decision-makers rank criteria in order of importance. This is the simplest method, but limits the type of ranking algorithms that can be used (Hajkowicz, 2002);

- Fixed point scoring – decision-makers distribute a set number of points amongst the criteria, where a higher score indicates greater importance. This forces decision-makers to make trade-offs. Percentages are often used (Hajkowicz, 2002; Holz et al., 2006); and,

- Rating – decision-makers assign a score of importance to each criterion in a similar way to a Likert scale questionnaire (Hajkowicz, 2002; Holz et al., 2006).

The analytic hierarchy process (AHP) and multi-attribute utility theory or multi-attribute value theory (MAUT/MAVT) methods are the most theoretically robust evaluation methods (Strager & Rosenberger, 2006). The AHP and MAUT evaluate each alternative by assessing the performance of alternatives against individual criteria, and the relative importance of the different criteria. The AHP enables decision-makers to structure a problem into a hierarchy consisting of goals and subordinate features. Decision elements are then ordered preferentially through pairwise comparisons at each level (Saaty, 2001). However, pairwise comparisons may become onerous if a large number of criteria are involved (Moffett & Sarkar, 2006). The MAUT constructs a unique value function for each criterion. It assigns weights to the criteria on the basis of comparison between alternatives through swing weighting or ordinal ranking (Moffett & Sarkar, 2006). Murray (2005) reported that the AHP and MAUT methods were the most frequently used evaluation methods in published MCA studies and this finding is supported by Moffett and Sarkar (2006).

Due to the strong theoretical foundation and wide application of the AHP and MAUT/MAVT methods within diverse disciplines, a key requisite in choosing MCA software was that either the AHP or MAUT must be used in the model. Further, software packages using both methods were given preference.

Software Package

The problem addressed in the research is a discrete-choice problem where alternatives need to be ranked. Murray (2005) identified five computer-based MCA techniques capable of handling discrete choice problems: Criterium DecisionPlus 3.0, EQUITY, HIVIEW, Hi Priority, and Logical Decisions® for Windows™.

With future use of the model in mind, the software package chosen must be easy for PAMA staff to use. Other necessary parameters identified include: the ability to incorporate multiple stakeholder preferences, the ability to import data and export graphics, the ability to view and print the model structure, graphical representation of results, and the ability to make notes within the structure of the model. These needs were compared against the five software packages, based on the results of an MCA software survey undertaken by Maxwell (2002) (Table 5.2).

Table 5.2

Characteristics of MCA Software Packages Designed for Discrete Choice Problems

Characteristics	**Criterion DecisionPlus 3.0**	**EQUITY**	**HIVIEW**	**Hi Priority**	**Logical Decisions® for Windows™**
Ease of use	✓	✓	*X*	✓	✓
Uncertainty representation/analysis	✓	✓	✓	*X*	✓
Multiple stakeholder capability	✓	✓	✓	✓	✓
Import (database, spreadsheet)	✓	✓	✓	✓	✓
Export (presentation, graphics)	✓	*X*	*X*	✓	✓
Structure display on screen	✓	✓	✓	✓	✓
Structure can be printed	✓	✓	✓	✓	✓
Graphical sensitivity analysis on weights	✓	*X*	✓	✓	✓
Analytical results portrayed graphically	✓	✓	✓	✓	✓
Capable of both AHP and MAUT	✓	*X*	*X*	*X*	✓
User can make notes with text	✓	✓	✓	✓	✓
Total score	13	9	9	10	13

Source: Adapted from Maxwell (2002) and Murray (2005)

The two options that best meet the parameters are Criterium DecisionPlus 3.0 and Logical Decisions® for Windows™.

A thorough assessment of the 'ease of use' of these two packages was undertaken by Murray (2005), and Logical Decisions® for Windows™ (LDW) was found to be the most user-friendly. Thus, LDW is the software package selected.

Some of the characteristics of LDW from the ease of use perspective are presented in Table 5.3. The software offers simple problem structuring, good preference and analysis settings, and high quality figure generation. The key disadvantages of LDW are help files that are hard to use and jargon that differs for that from that used in the majority of the MCA literature. For example, criteria are described as 'measures', and measures of the criteria are described as 'levels'.

Table 5.3

Selected Characteristics of Logical Decisions® for Windows™ Software

Characteristics	**Logical Decisions® for Windows™ Software**
Sensitivity analyses and results analysis	Dynamic weight sensitivity, individual criteria spider graph; others
Scenario analysis	Thorough preference settings
Uncertainty plotting	Monte Carlo simulations capability with six distribution types available
Number of alternatives possible	Unlimited, based on computer memory
Weight assessment methodology	Both AHP and MAUT (SMART and SMARTER)
Problem structuring	Matrix and simple hierarchy
Help files	Difficult to understand initially but accompanying text book is helpful
Graph and figure quality	High quality, clear to read and understand
Cut-off sorting (where limits are placed on criteria levels)	Yes
Cost	US$310 academic price (distributed by Decision Lab, Auckland)
Jargon	Criteria = 'measures' Data = 'levels'

Source: Adapted from Murray (2005)

The decision process in LDW involves the following steps:

1. Structure the problem by:
   a. defining the set of alternatives to be ranked,
   b. defining measures to describe the alternatives,
   c. organising the measures and goals into a goals hierarchy;
2. Enter a level on each measure for each alternative;
3. Review preferences (the relative desirability of different sets of characteristics) so the measure levels can be combined; and,
4. Rank the alternatives (Logical Decisions, 2002).

The first step, problem structuring, is described in section 5.1.4. The remaining steps are covered in section 5.1.5.

5.1.4 BUILDING THE MODEL

The first step in developing the model's structure is to define the alternatives, in this case, a set of national parks to be ranked. The names of specific parks can be added later, but two or more alternatives must be named. The structure of the model is then built from goals and measures. These are organised into a goals hierarchy, with the most general goals at the top and more specific sub-goals below these. The process of dividing general goals into more specific goals continues until the goals are specific enough to measure. Measures are numerical or descriptive variables that capture some quality of the alternatives. Each measure consists of units in a range from least preferred to most preferred (Logical Decisions, 2002). The jargon used in LDW has been adopted for the remainder of this chapter.

LDW conforms to the conventions of the Microsoft Windows™ environment. The decision problem is structured and analysed through three views:

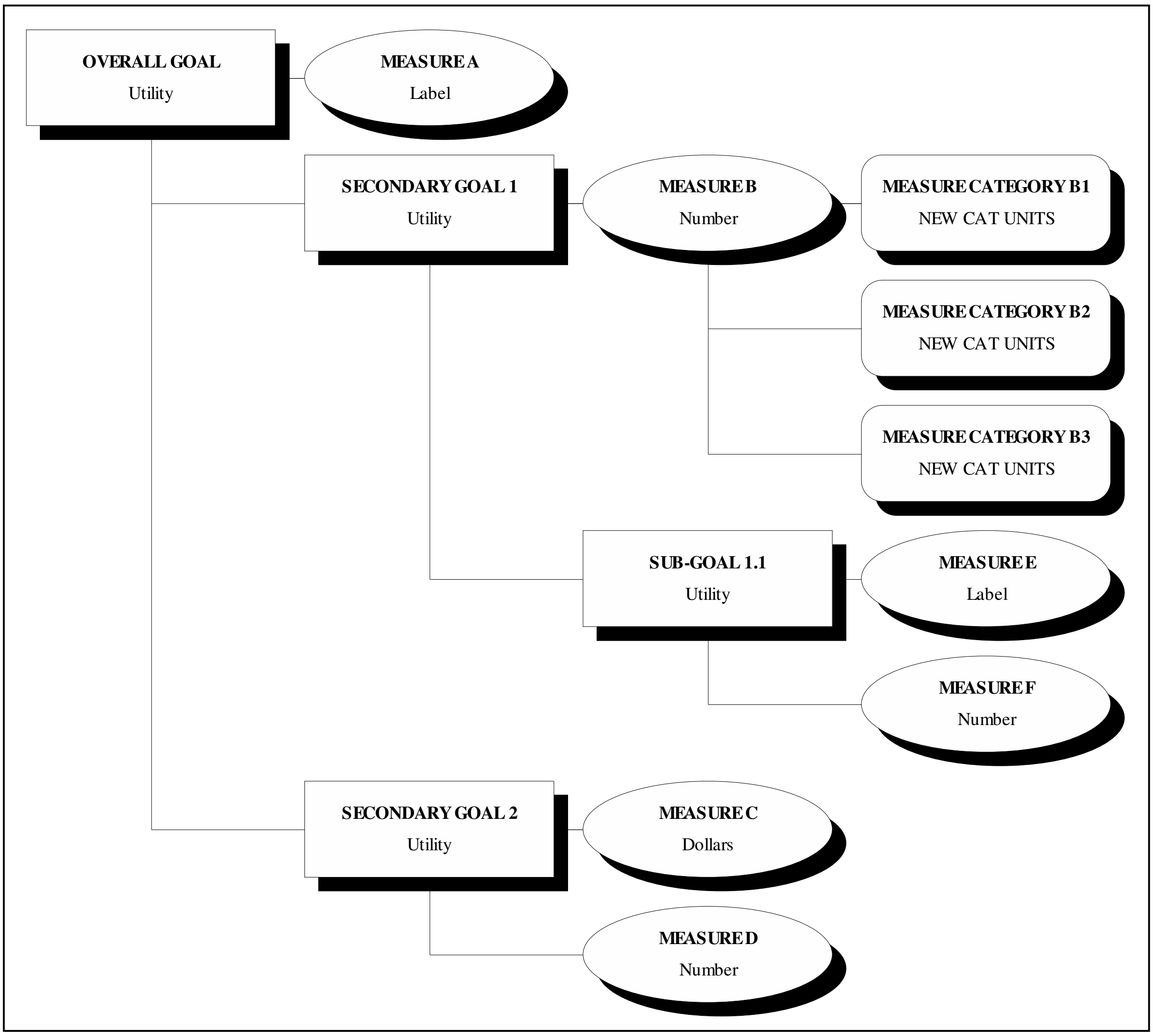
- Goals Hierarchy view – this shows the goals and measures in a hierarchy similar to an organisation chart. This view was used to construct the model (refer to Figure 5.1 for the elements of construction);

- Matrix view – this view shows the alternatives and measures in a matrix similar to a Microsoft Excel spreadsheet. The numbers or labels in each cell show the level of an alternative for a measure; and,

- Summary view – this is a dialog box showing the major objects in the analysis.

Figure 5.1

Simple Goal Hierarchy in Logical Decisions® for Windows™ showing Goals, Measures, and Measure Categories



Each alternative has a raw score called a level for each measure. The levels for each measure can be one of the following:

- Numerical;
- Defined by descriptive labels;
- Probabilistic; or,

- Defined by measure categories where the measure level is the weighted sum or average of several sub-measures. For example, the 'threatened fauna species' measure could be calculated using measure categories where threat status is weighted more strongly for 'critically endangered' species than 'vulnerable' species.

The potential criteria suggested in Chapter 3 were analysed for inclusion in the model using three key conditions:

- The criterion is relevant and meaningful for decision-making;
- The criterion is measurable; and,
- There is a high likelihood that a PAMA could gain access to data regarding each park's performance on the criterion.

Criteria that failed to meet one or more of these conditions were not included in the model, and these are shown in Table 5.4. Park shape and opportunity cost criteria are not relevant to the study, and it is not clear how the spiritual significance of different parks can be compared. Richness and diversity measures are not available on the national park scale because they are dependant on high sampling frequency. These criteria may be relevant in the future if monitoring efforts are significantly increased. It is hard for PAMAs to gain access to information about the economic costs and benefits of parks, including the balance of payments, employment, inflation, risk/dependency, and leakage. It is possible to derive these values, but it is time-consuming and expensive to undertake for all of a country's national parks. Genetic significance and the contribution of ecosystem functions and services are important criteria, but it is currently not clear how to measure them. Qualitative scales for the importance of ecosystem functions were considered, where each function is rated on a Low – Moderate – High – Very High scale for local, regional and national importance. However, it was not clear how to fairly derive these ratings for each national park as it is unlikely that PAMA staff have a good understanding of the magnitude of ecosystem service contributions by each park.

Table 5.4

Criteria that did not meet the Conditions for Inclusion in the Model

Criterion	Reason for exclusion from the model			
	Relevant	**Measurable**	**Data available**	**Comments**
Park shape	*X*	✓	✓	Only relevant for areas less than 1,000 ha in size. The IUCN definition of a national park stipulates the minimum size of a national park as 1,000 ha, rendering this criterion irrelevant.
Richness	✓	✓	*X*	Data are not available at the national park scale. As monitoring efforts improve, this criterion may be included in the model in the future.
Diversity	✓	✓	*X*	Data are not available at the national park scale. As monitoring efforts improve, this criterion may be included in the model in the future.
Genetic	✓	✓	*X*	Data are not available at the national park scale. As understanding about how to measure genetic significance improves and monitoring efforts improve, this criterion may be included in the model in the future.
Balance of payments	✓	✓	*X*	Data are not readily available for all of a country’s national parks. It is time-consuming and difficult to derive these values. This criterion could be included in the model in the future.
Income and GDP	✓	✓	*X*	Data are not readily available for all of a country’s national parks. It is time-consuming and difficult to derive these values. This criterion could be included in the model in the future.
Employment	✓	✓	*X*	Data are not readily available for all of a country’s national parks. It is time-consuming and difficult to derive these values. This criterion could be included in the model in the future.

Criterion	Reason for exclusion from the model			
	Relevant	Measurable	Data available	Comments
Ecosystem functions and services	✓	*X*	*X*	It is currently not clear how to measure the suite of ecosystem functions and services that national parks provide to society. These are of great importance to the model because they represent economic justification for the existence and continued funding of national parks. As research improves and provides standardised measures or rules for measuring the different ecosystem services at the national park scale, these should be included in the model.
Inflation	✓	✓	*X*	Data are not readily available for all of a country's national parks. It is time-consuming and difficult to derive these values. This criterion could be included in the model in the future.
Risk/dependency	✓	✓	*X*	Data are not readily available for all of a country's national parks. It is time-consuming and difficult to derive these values. This criterion could be included in the model in the future.
Leakage	✓	✓	*X*	Data are not readily available for all of a country's national parks. It is time-consuming and difficult to derive these values. This criterion could be included in the model in the future.
Opportunity costs	*X*	✓	✓	This research is concerned with existing protected areas, not converting these to another land use. Thus, opportunity costs are not relevant.
Spiritual significance	✓	*X*	*X*	It is hard to determine expressions of the spiritual significance of national parks – even on a descriptive scale – because spiritual worth differs between individuals and cultures.

As research improves and guidelines and standards are developed that are applicable at the national park scale, measurements of genetic diversity and ecosystem functions/services should be included in the significance assessment.

The criteria that met the three conditions were included in the model and these are briefly described below. Choices were made about the best way to express measures of the criteria, where preference was given to scientific measurements, minimising the need for subjective scales. The redundancy of measurements – where two criteria provide similar measures – was taken into account. Redundancy should be avoided unless measures complement one another to give a fuller picture (Hajkowicz, 2002).

Model structuring is an iterative process and the most efficient structure was developed over time. An overview of the model's structure is shown in Figure 5.2. Each component in the model was numbered manually for ease of analysis because LDW lists goals and measures alphabetically at each stage of the analysis. Each of the four secondary goals was given a majuscule letter as follows:

A. Maximise natural heritage (includes positive measures);

B. Maximise financial net benefits (includes positive and negative measures);

C. Maximise social net benefits (includes positive measures); and,

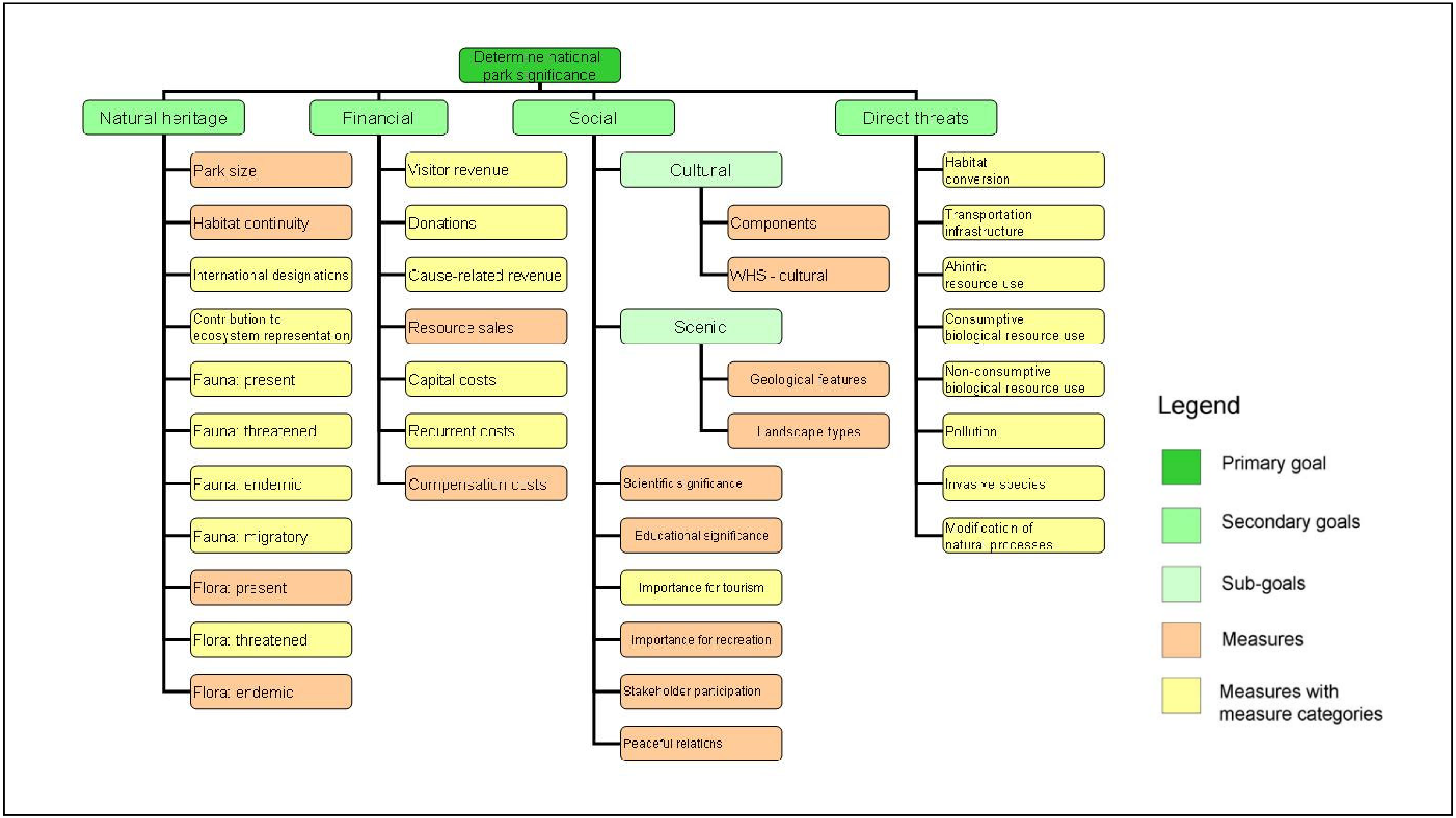
D. Minimise direct threats to natural heritage (includes negative measures).

Further sub-goals and measures were numbered, retaining the majuscule letter, e.g. C1: Cultural heritage (goal) and C1.1 Cultural landscape components (measure).

Where measures were defined by descriptive labels, the number of categories and their labels were defined. Where possible, a four-point 'forced choice' scale was adopted (e.g. Low – Moderate – High – Very High). However, some of the descriptive scales adopted from other research use a five-point scale, and these were defined in the model as five-point scales accordingly.

Figure 5.2

The Decision Hierarchy of the Model Showing Measures with Measure Categories



For example, the special geological features scale from Bell and Martin (1987) (Table 5.10) uses a five-point scale to describe scenic importance.

Measures of Natural Heritage

The measures of natural heritage are predominantly numerical. Only the habitat continuity measure involves descriptive levels. This measure was hard to quantify because it is complicated to assess the quality of individual habitat mosaic elements (corridors or stepping stones) and hard to combine scores if multiple elements are present. A more practical descriptive scale was adopted where land use type in the surrounding landscape is rated with regard to habitat connectivity.

The types of distinctive species used as criteria in the model are threatened, endemic, and migratory species. These species characteristics have influence in the conservation planning literature, are a focus for PAMAs, and can be readily recognised by PAMA staff (meaning that information is readily accessible).The other distinctive species characteristics outlined in Chapter 3 are inappropriate at the national park scale and more suited to specific habitat management and species recovery plans. Furthermore, some of the characteristics will apply to threatened and/or endemic species, leading to double counting. Thus, the following types of species were not specified in the model: area-limited, dispersal-limited, dominant, flagship, high-habitat specificity, high natural mortality, high utility, K-selected, keystone, living fossils, process limited, sensitive, slow maturation, social, top carnivore, and umbrella species.

To avoid double-counting, transboundary protected area agreements do not feature under 'international designations' because these are specifically counted in the 'peaceful relations' measure under the social benefits goal. To some extent, the natural heritage benefits of a transboundary protected area arrangement are also represented in the 'habitat continuity' measure. Threatened species are included in the model at the international IUCN Red List scale. PAMAs may have a preference for a national threat classification system over the international system, or for both to be included. In the model, only one system is specified to avoid double counting.

The measures of the secondary goal 'maximise natural heritage' are defined below.

A01: Park size

The area of the park where a larger size is better because ecosystem processes can occur unhindered, there is habitat available for more species and species with large habitat ranges, and a larger area is more resilient to outside forces. Park size is measured in hectares.

A02: Habitat continuity

The habitat continuity measure is an indication of the quality of habitats within the landscape surrounding the park where natural habitat types are best because they can facilitate the movement of individual species through the landscape. The descriptive labels for this measure are defined in Table 5.5.

Table 5.5

Descriptive Levels for the Habitat Continuity Measure

Habitat continuity	Definition
Poor	The surrounding landscape is dominated by urban areas or agriculture without a habitat mosaic linking the park to other areas.
Moderate	The surrounding landscape is dominated by intensive agriculture and horticulture and/or extensive agriculture with a habitat mosaic of low quality.
Good	The surrounding landscape is dominated by forestry or extensive agriculture with a habitat mosaic of good quality.
Very Good	The surrounding landscape is dominated by natural environments, e.g. large tracts of natural vegetation, ocean, wetland, lake and/or river, with a habitat mosaic of excellent quality.

A03: International designations

If an area has been designated under an international environmental agreement due to its natural heritage importance, it has greater worth than areas that do not have international designations. A designation is relevant if all or part of the national park has been designated as one or more of the following:

- A UNESCO World Heritage Site (natural);
- A Wetland of international importance under the RAMSAR Convention;

- A BirdLife International Important Bird Area;
- A BirdLife International Endemic Bird Area;
- A WWF Global 200 Eco-region; and/or,
- Other relevant regional agreements (PAMAs can add additional agreements as desired).

'International designations' is a measure, and the relevant designations have been included as measure categories. This allows decision-makers to weight the agreements differently if they wish (as a default, each will have the same weight). Further, this allows decision-makers to see the specific agreements, rather than a simple sum with calculations elsewhere.

A04: Contribution to ecosystem representation

This measure is based on the notion that the national park system should contain the full range of natural ecosystem variation within the country. In practice, some ecosystems – usually those with low productivity (e.g. high altitude) – are better represented than others. National parks with high representativeness values are those containing ecosystems that are poorly represented within the national park network (Ervin, 2003).

This measure is calculated for each national park as the weighted summation of the percentage of each ecosystem occurring within the national park. This involves the measure category feature in LDW, where the percentage of each ecosystem represented within the national park is weighted by an importance score for the particular ecosystem. For each country, a suitable ecosystem classification must be identified. The total area of each ecosystem within the country, the total area of each ecosystem within the national park network, and the total area of each ecosystem within each national park must be determined.

First, the importance score is derived for each ecosystem, by calculating the percentage of each ecosystem type represented within the national park network. The ecosystems are given an importance score from 1-8 based on the information presented in Table 5.6, where poorly represented ecosystems have a higher importance score. A measure category is created in LDW for each ecosystem type that occurs within the national park network and the importance score is entered as the weighting on that measure category.

Second, the percentage of each ecosystem occurring within each national park is calculated, based on the total area of the ecosystem occurring within the national park network. This score is entered into the measure category and LDW calculates the measure of 'contribution to ecosystem representation' for each park according to Equation 5.1.

Table 5.6

Importance Scores for Ecosystems based on Representation within the National Park Network

Importance Score	**Percentage of each ecosystem represented within the country's national park network**
1	81-100%
2	61-80%
3	41-60%
4	21-40%
5	11-20%
6	6-10%
7	1-5%
8	<1%

Equation 5.1

Calculation of a National Park's Contribution to Ecosystem Representation using Measure Categories in Logical Decisions® for Windows™

$$R = X_1 Y_1 + X_2 Y_2 \ldots$$

Where:

R = contribution of the national park to ecosystem representation within the national park network
X = percentage of ecosystem type occurring within the national park
Y = ecosystem importance weight score

A05: Fauna species present

The number of fauna species with viable populations occurring within the national park. The ‘fauna species present’ measure has six measure categories: amphibians, birds, fish, invertebrates, mammals, and reptiles. Each measure category has the same default weighting of one. However, decision-makers may wish to give greater weight to a sub-category of fauna species. Separating the species may give decision-makers a better insight into the make-up of the information.

A06: Threatened fauna present

The number of fauna species present that are ‘critically endangered’, ‘endangered’, or ‘vulnerable’ according to the IUCN RedList. These are included as measure categories, where critically endangered species have a weighting of 2, endangered species a weighting of 1.5, and vulnerable species a weighting of 1. Decision-makers may chose to modify these weightings.

A07: Endemic fauna present

The number of fauna species present in the national park that are endemic to the area/country, with the same measure categories as the ‘fauna species present’ measure.

A08: Migratory fauna present

The number of migratory fauna that occur in the national park according to the species listed in the appendices of the Convention on Migratory Species of Wild Animals (CMS or Bonn Convention). The number of Appendix I (migratory species threatened with extinction) and Appendix II (migratory species that need or would significantly benefit from international co-operation) species are entered into measure categories. The Appendix I category has a weighting of 1.5 and the Appendix II category a weighting of 1. Additional categories can be added for migratory species at the national level.

A09: Flora species present

The number of viable flora species occurring within the national park.

A10: Threatened flora present

The number of threatened flora species present that are 'critically endangered', 'endangered', or 'vulnerable' according to the IUCN RedList, using measure categories as for the fauna equivalent.

A11: Endemic flora present

The number of plants occurring in the national park that are endemic to the area/country.

Measures of Financial Factors

This is the most straight forward sub-goal because all measures are in units of currency. The model was developed keeping language positive for benefits and negative for costs, for example revenue from user fees is called 'visitor revenue'. Most measures involve measure categories, e.g. visitor revenue is the sum of revenue from activities tourists engage in, contracting out, facility use, entry revenue, and the sales of goods. These categories are given equal weighting, but are included this way to give decision-makers a better insight into the make-up of the information. It is unlikely that decision-makers will want to give the measure categories different weights, but it is possible for them to do so.

Unlike the other secondary goals, the measures in the 'maximise financial benefits' goal include positive and negative measures. It is important that cost figures are entered with a negative sign. The measure names are clearly stated as benefits or costs to avoid any possible confusion. The data used in the model is that from the last financial year/annual report.

The measures of the sub-goal *maximise net financial benefits* are defined below.

B01: Benefits: Visitor revenue

Visitor revenue is the sum of five equally weighted measure categories: revenue from activities tourists engage in, contracting out, facility use, entry revenue, and the sales of goods.

B02: Benefits: Donations

Donations to the national park are divided into two equally weighted measure categories: recurring payments, where the donation is regular and can be relied upon; and, one-off payments. Decision-makers may be interested in the distinction.

B03: Benefits: Cause-related revenue

Income earned from ‘causes’ is divided into three equally weighted measure categories: ‘friends of the park’ schemes, adoption programmes, and special events. Decision-makers may be interested in the distinction.

B04: Benefits: Resource sales

This is a measure of income to the national park from resource sales, such as selling wildlife to zoos or other protected areas.

B05: Costs: Capital

Capital costs are outlays for new infrastructure or facilities.

B06: Costs: Recurrent

The recurrent costs measure is divided into four equally weighted measure categories: enforcement costs (e.g. anti-poaching patrols), the costs of maintaining facilities, research and monitoring costs, and staff salary and support costs. Decision-makers may be interested in the distinction.

B07: Costs: Compensation

The compensation costs measure is divided into two equally weighted measure categories: the costs of compensating local communities for damage to property by wildlife, and the costs of compensating local communities for foregone rights to harvest resources from the national park. Decision-makers may be interested in the distinction.

Measures of Social Benefits

Some of the social criteria are expressed directly as measures, and others have multiple measures that need to be combined, so are expressed as sub-goals. The sub-goals are ‘cultural heritage’ (C03) and ‘scenic significance’ (C06).

In the discussion of potential criteria outlined in Chapter 3, multiple measures were suggested for many of the social criteria. It is important to avoid double-counting, so for most criteria only one measure was selected. For example, the number of refereed publications relating to the park was selected as the measure for 'scientific significance'. The other potential measures for this criterion, including the number of visiting scientists to the park, research agreements with universities, and professional comparative assessment by a team of scientists, were not included in the model. Similarly, the measure of educational importance in the model is based on an established methodology relating to the frequency of educational fieldtrips to the national park, and measures of the number of participants in educational/ interpretative programmes and the presence of a visitor centre directly associated with the park were not included in the model. In addition to redundancy concerns (double-counting), these criteria are more a measure of management actions in place than the inherent educational significance of the park and pose problems where these educational initiatives target multiple parks/areas.

The significance of the park for visitors is divided into two measures and one sub-goal following the typology used by Parks Victoria (c.2000) where visitor numbers, recreational, and scenic importance are combined. In the model presented in this thesis, annual visit-days and (descriptive) importance for recreation are separate measures. The descriptive categories for scenic importance used by Parks Victoria (c.2000) are less specific than the descriptive categories outlined by Bell and Martin (1987). Thus, measures of the (descriptive) uniqueness of geological features and number of landscape types present were adopted in the model as indicators of scenic importance.

The measure of potential stakeholder participation (descriptive) reflects the likeliness of the PAMA working with traditional owners to form management arrangements. This may be a function of personalities, assertiveness, and attitudes towards past grievances. Potential stakeholder participation is more meaningful than current stakeholder participation and the latter is more a reflection of current management practices than national park significance per se.

The measures of the secondary goal 'maximise social benefits' are defined below.

C01: Number of refereed publications

The number of refereed publications in the past financial year/annual reporting period that involve the study of the national park. Most PAMAs will have a record of this because researchers usually gain permission from PAMAs or work with the PAMA to publish research.

C02.1: Significance for education

The importance of the park for education is based on the scores used by Parks Victoria in its Visitor Service Levels Framework (Parks Victoria, c.2000). These are shown in Table 5.7 below.

Table 5.7

Descriptive Levels for the Education Significance Measure

Level of importance	Definition
Very Low	Little or no use for education.
Low	Occasional but infrequent use by schools/colleges.
Moderate	Regular use by a moderate number of schools/colleges.
High	An important regional destination for schools/colleges from across the State.
Very High	Major destination for schools/colleges from across the nation.

Source: Adapted from Parks Victoria (c.2000)

C03.1: Cultural landscape components

The cultural landscape components measure belongs to the ‘cultural heritage’ sub-goal and is divided into nine equally weighted measure categories. The measure categories are the nine cultural landscape components defined by the US National Parks Service (National Parks Service, 1990,1994) (Table 5.8). Each of these components will be counted consistently across a country’s national park network, though many PAMAs will use a different classification system. Decision-makers may wish to weight landscape components differently, but the default is equal weights. By distinguishing between types of cultural landscape component, decision-makers will be more informed.

Table 5.8

Definitions for the Cultural Landscape Components Measure Categories

Landscape component	Definition
Structures	The physical remains of a deliberately constructed feature associated with human activity, such as a house, garden or water race.
Complexes	A number of features that are related to each other in some way – for example, through use or function, such as structures associated with a farm or military barracks.
Sites	The location of an event, structure, earthwork or complex where no above-ground evidence remains.
Features	Components or elements of landscapes, including structures, sites or complexes and field boundaries, as well as natural features such as an avenue of exotic trees or alluvial streamside deposits containing minerals.
Linear networks	Long, narrow landscape or landscape components, such as a river, canal/aqueduct, or transport route and its associated elements.
Historic vernacular landscape	A landscape that evolved through use by people whose activities or occupancy shared it. Through social or cultural attitudes of an individual, a family, or a community, the landscape reflects the physical, biosocial, and cultural character of everyday lives. Function plays a significant role in vernacular landscapes. This can be a farm complex or district of historic farmsteads along a river valley – rural historic districts or agricultural landscapes.
Historic site	A landscape significant for its association with a historic event, activity, or person.
Historic designed landscape	A landscape that was consciously designed or laid out by a landscape gardener, architect, engineer, or horticulturalist according to design principles, or an amateur gardener working in a recognized style or tradition. The landscape may be associated with a significant person, trend or even in landscape architecture, or illustrate an important development in the theory and practice of landscape architecture. Aesthetic values play a significant role in designed landscapes.
Ethnographic landscapes	A landscape containing a variety of natural and cultural resources that associated people define as heritage resources – contemporary settlements, sacred religious sites, massive geological structures with small plant communities, animals, and subsistence and ceremonial grounds.

Source: Adapted from the U.S. National Park Service (1990; 1994)

C03.2: Cultural World Heritage status

The status of the national park with regard to UNESCO World Heritage Site status for cultural reasons is a measure belonging to the 'cultural heritage' sub-goal.

Three labels are used to measure this criterion: yes, no, and pending (if an application is before the World Heritage committee).

C04: Importance for tourism

Annual visit-days, divided into two equally weighted measure categories: domestic visitors and foreign visitors. A visit-day is the number of day visitors plus the number of overnight stays. A day visitor is a person entering the park for the first time on any given day and staying in the park for one day or less (Parks Victoria, c.2000). Decision-makers may be interested in the origin of the visitors, whether they are domestic or foreign.

C05: Importance for recreation

The importance for recreation measure is based on the scores used by Parks Victoria in its Visitor Service Levels Framework (Parks Victoria, c.2000). These are shown in Table 5.9. The descriptions for each level below apply to national parks in a country that has states or provinces and will need modification for countries where this does not apply.

Table 5.9

Descriptive Levels for the Importance for Recreation Measure

Level of importance	Importance for recreational activity
Very Low	There are many similar and therefore alternative sites in the region for recreational activities. The site draws all or most of its visitors from the local area.
Low	The national park is of regional importance and people are often prepared to travel for up to 1.5 hours to visit the site.
Moderate	The national park is of regional importance and people are often prepared to travel for up to 3 hours to visit the site.
High	The national park is of importance to the State because of the recreational activities it provides. It is one of only a few sites offering a particular activity and attracts people from throughout the state and nearby interstate areas.
Very High	The national park is of national importance because of the recreational opportunities it provides. There are few or no other substitute sties. It attracts many interstate and international visitors.

Source: Adapted from Parks Victoria (c.2000)

C06.1: Geological features

The geological features measure belongs to the scenic importance sub-goal, based on the premise by Bell and Martin (1987) that a park with more unique geological features has greater scenic value as shown in Table 5.10.

Table 5.10

Descriptive Levels for Geological Features

Level of importance	Definition
Very Low	Nothing of unusual interest
Low	Some exposure of rock/fossil/geomorphological interest
Moderate	Good exposure of rock/fossil/geomorphological interest
High	Sole representative of geological feature in country
Very High	Sole representative of geological feature in world

Source: Adapted from Bell and Martin (1987)

C06.2: Landscape types

The number of scenic landscape types measure belongs to the 'scenic importance' sub-goal. It is the number of landscape types within the national park, based on Bell and Martin (1987). The possible number of landscape types will be calibrated to the country's ecosystem classification.

C07: Potential stakeholder participation

The potential stakeholder participation measure has four descriptive labels for the degree of participation that traditional owners/stakeholder groups have in the management of the national park. Following Uunila (2002), the labels are: awareness raising, education, advisory committee, and co-management.

C08: Peaceful relations

The peaceful relations measure uses descriptive labels for the transboundary relationship/s between the national park and protected areas in adjacent countries. Such arrangements improve political stability. The labels are:

- Peace park with two neighbouring countries;

- Peace park with one neighbouring country;
- Peace park negotiations in progress; and,
- No transboundary relationship.

Measures of Direct Threats to Natural Heritage

Direct threats are to the natural heritage category as financial costs are to the financial factors category of the model. However, the direct threats to the ecological integrity of the parks have been separated from the natural heritage (benefits) goal. As shown by Perlman and Anderson (1997), some conservation experts give greater priority to areas with high natural heritage worth that are most threatened, while others give priority to areas with high natural heritage that face little threat. Thus, by separating the threat and natural heritage goals, these preferences can be more easily expressed.

The direct threat measures are of the impacts of threats that are currently influencing the ecological integrity of the national park and their expected impacts over the next ten years. The nature of the threats facing a national park are context specific. The threat measures in the model are currently listed as threat categories as a guide, but once specific threats are identified for all the parks in the national park network, the measures should be renamed to reflect the specific threat (e.g. plant and animal pests listed separately, rather than an 'invasive species' measure, which is less informative).

The expression of threat magnitude follows the methodology outlined by Salafsky *et al.* (2003). First, the impact of each threat affecting the park is assessed in terms of its scope (either spatial or percentage of targets) and severity, scored on a scale of 0-4 as shown in Table 5.11. Scope is the range across which the impact of the activity occurs. This is assessed in either spatial terms or as the percentage of targets affected. For example, the scope of a poaching threat would be measured relative to the occurrence of the species population (Ervin, 2003). This may require multiple measures of poaching tailored to specific species or populations. Severity is the seriousness of the damage posed by the threat.

Table 5.11

Categorical Measurements for Threat Scope and Severity

Variable	Categorical Measurement	Comment
Scope (spatial) the area of the project site (or target occurrence) affected by a threat within 10 years	4 = Throughout (>50%) 3 = Widespread (16-50%) 2 = Scattered (5-15%) 1 = Localized (<5%)	Calculated as a percentage of possible area (i.e., pollution as percentage of aquatic habitat at a site, not entire site)
Scope (% of targets) the number of target occurrences affected by a threat within 10 years	4 = Most or all (>50%) 3 = Many (26-50%) 2 = Some (5-25%) 1 = Few (<5%)	Is an alternative way of measuring scope
Severity the degree to which a threat has an impact on the viability/integrity of targets within the national park within 10 years	4 = Serious damage or loss 3 = Significant damage 2 = Moderate damage 1 = Little or no damage	Independent of area; different continuous measures needed for each target type

Source: Adapted from Salafsky *et al.* (2003)

Second, the scope and severity measures are combined using The Nature Conservancy's 5-S framework rules (The Nature Conservancy, 2000) as shown in Figure 5.3. The resulting descriptive label gives an indication of threat magnitude. The labels are specified in LDW in reverse order, so that 'Low' is best and 'Very High' is worst. This assumes that parks facing low threat magnitude are more significant than those facing high threat magnitude. This aspect of the model must be discussed during the Delphi focus group and changed as required.

Figure 5.3

Rule-Based Procedure for Calculating Threat Magnitude

		Scope			
		4-Very High	3-High	2-Medium	1-Low
Severity	4-Very High	4-Very High	3-High	2-Medium	1-Low
	3-High	3-High	3-High	2-Medium	1-Low
	2-Medium	2-Medium	2-Medium	2-Medium	1-Low
	1-Low	1-Low	1-Low	1-Low	1-Low

Source: Salafsky *et al.* (2003, p. 20)

Possible measures for the secondary goal ‘minimise direct threats to natural heritage’ are listed in threat categories below. Because threats are context specific, the threat measures will be modified as applicable.

D01: Abiotic resource use

Threats may include: geothermal energy, mining, oil and gas drilling, water withdrawal, wind farms, coral mining, and desalizanation plants (Salafsky et al., 2003).

D02: Consumptive biological use

Threats may include: hunting, non-timber forest product collection, grazing, logging, gathering, fishing, and trawling (Salafsky et al., 2003).

D03: Habitat conversion

Threats may include: housing, industrial development, farms, plantations, ski areas, dam construction, golf courses, docks, channelization, shipyards, aquaculture, and destructive fishing (Salafsky et al., 2003).

D04: Invasive species

Threats may include: invasive animals, diseases, pathogens, and plants (invasive species may be alien or native) (Salafsky et al., 2003).

D05: Modification of natural processes

Threats may include: climate change, loss of key predators, grazing patterns, fire regimes, desertification, sea-level rise, fragmentation, sedimentation, loss of key predators, flow regimes (dams), shoreline stabilisation, and coral bleaching (Salafsky et al., 2003).

D06: Non-consumptive biological resource use

Threats may include: ATVs/snowmobiles, hiking/biking, scientific research, military manoeuvres, jet skis, boating, and scuba/snorkelling (Salafsky et al., 2003).

D07: Pollution

Threats may include: acid rain, solid waste, toxins, radio active fallout, agricultural run-off, salizanation, municipal waste, thermal pollution, and sonic pollution (Salafsky et al., 2003).

D08: Transportation infrastructure

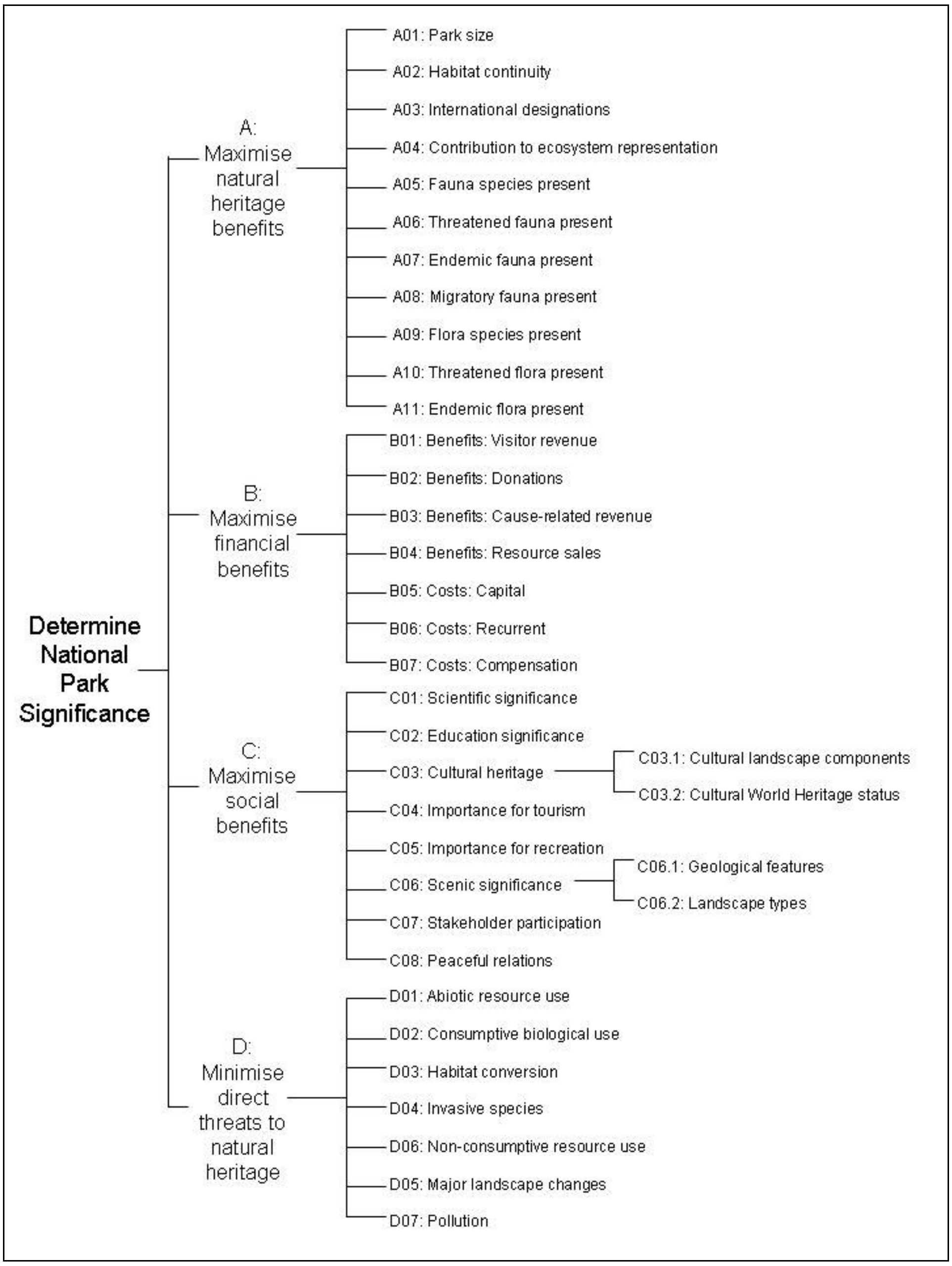
Threats may include: utility lines, roads, railroads, levees and dikes, dredging, and shipping lanes (Salafsky et al., 2003).

The MCA Model

The full structure of the model, excluding measure categories, is shown in Figure 5.4.

Figure 5.4

Goal Hierarchy of the Multiple Criteria Analysis Model



5.1.5 ENTERING LEVELS

The levels for each measure are entered into LDW in the matrix view. The majority of measure levels used in this analysis are point estimates, which are single numbers with no uncertainty. Measure levels with measure categories are defined by a weighted sum, and descriptive levels have textural descriptions (labels).

The best and worst levels for each measure are defined within LDW as the 'most preferred level' and 'least preferred level' (from the goals hierarchy or matrix view). For numerical levels these extremes are a function of the characteristics of the particular national park network being analysed, rather than universal standards. As an example, the calculations for the maximum and minimum levels of the 'contribution to ecosystem representation' measure are given in Table 5.12. Here five ecosystems, labelled A-E, occur within the national park network. The importance scores (weighting) for each ecosystem were randomly chosen and are shown in parenthesis.

Table 5.12

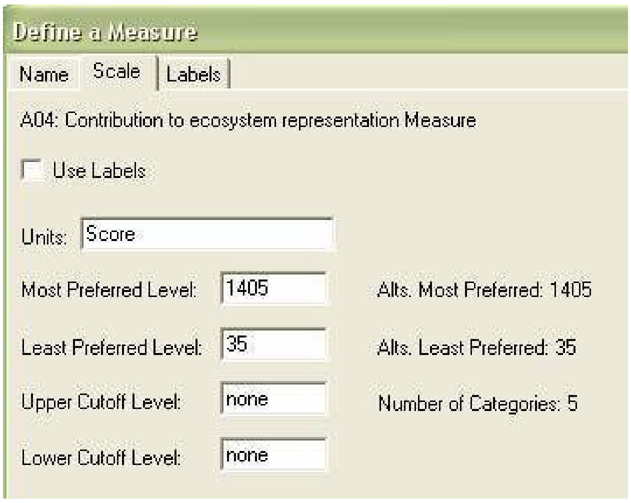
Hypothetical Example showing Levels for the 'Contribution to Ecosystem Representation' Measure

National Park	**Ecosystem (importance score)**					**Weighted sum (level)**
	A (8)	**B (7)**	**C (4)**	**D (2)**	**E (1)**	
Park 1	100	60	0	70	45	1405
Park 2	0	40	100	30	20	760
Park 3	0	0	0	0	35	35
TOTAL	100	100	100	100	100	2200

In this example, the greatest weighted sum (for Park 1) is 1405, representing the 'most preferred level'. In LDW, 1405 is specified as the 'most preferred level'as shown in Figure 5.5. Similarly, the lowest score is 35 (for Park 3), which is specified in LDW as the 'least preferred level' for the measure. The same procedure was followed for the other numerical measures.

Figure 5.5

Specifying the Most and Least Preferred Levels for the 'Contribution to Ecosystem Representation' Measure



5.1.6 CHOOSING WEIGHT ASSESSMENT METHODS

The next step in the analysis is to combine levels to compute each park's overall utility score by describing preferences about the relative importance of measures and goals. This is the subjective part of the analysis, which is divided into three stages. First, measure categories are weighted using category multipliers as described in section 5.1.4. LDW then converts incommensurate levels to common units called 'utility', before combining the measures according to a weight assessment method and ranking the alternatives.

LDW offers six weight assessment methods, including two Multiple Attribute Utility Theory (MAUT) methods and the Analytic Hierarchy Process (AHP) method. The MAUT methods are the 'simple multi-attribute rating technique using swings' (SMART) and the 'simple multi-attribute rating technique exploiting ranks' (SMARTER). The SMART method uses the concept of relative importance to determine weights amongst criteria, while the SMARTER method computes criteria weights from a rank order using a 'centroid' formula (Edwards & Barron, 1994). The AHP method uses pairwise comparisons between sets of criteria to determine criteria weights (Edwards & Barron, 1994). These methods were trialled in order to determine the most appropriate for use by PAMA decision-makers.

Category Multipliers

The preferences for category multipliers were discussed in section 5.1.4. These apply to measures of ‘contribution to ecosystem representation’, ‘threatened fauna present’, ‘migratory fauna present’, and ‘threatened flora present’. The other measures with measure categories have been left with equal weightings.

Common Units Conversions

Measure levels are converted from their original units to standardized units of utility. The most preferable utility for a measure is one, and the least preferable is zero. The intermediate levels can be assigned in LDW using one of five methods: single-measure utility functions (SUFs), the Analytic Hierarchy Process (AHP), AHP SUFs, Adjusted AHP, or direct assessment. All five methods are applicable to point estimate measures, but measures with labels can only be converted to common units through direct assessment, AHP, or adjusted AHP.

For point-estimate measures the simplest conversion method is a graphical SUF. The most common SUF is a straight line SUF, which is the default in LDW. If a straight-line SUF is not suitable for a measure, a negative straight-line SUF, or negative or positive exponential SUF can be specified. This method was used for point estimate measures in the analysis. All but four point estimate measures were converted to utility with the default linear SUF. A positive exponential SUF is more appropriate for the measures of ‘park size’, ‘fauna species present’, ‘flora species present’, and ‘cultural landscape components’ so the SUF was modified. For these measures the SUF curve was modified so that the mid-point had a utility score of 0.75 (Figure 5.6).

The measures with labels were converted to common units using the direct assessment method. For all but the measures for ‘potential stakeholder participation’ and ‘peaceful relations’, the default linear (equally spaced) utilities for labels were adopted (Figure 5.7).

The utilities for ‘potential stakeholder participation’ labels were modified to better reflect the similarity between ‘awareness raising’ and ‘education’, and the difference between ‘education’, ‘advisory committee’, and ‘co-management’ as described by Uunila (2002) (Figure 5.8).

Figure 5.6

Single-measure Utility Function for the 'Fauna Species Present' Measure

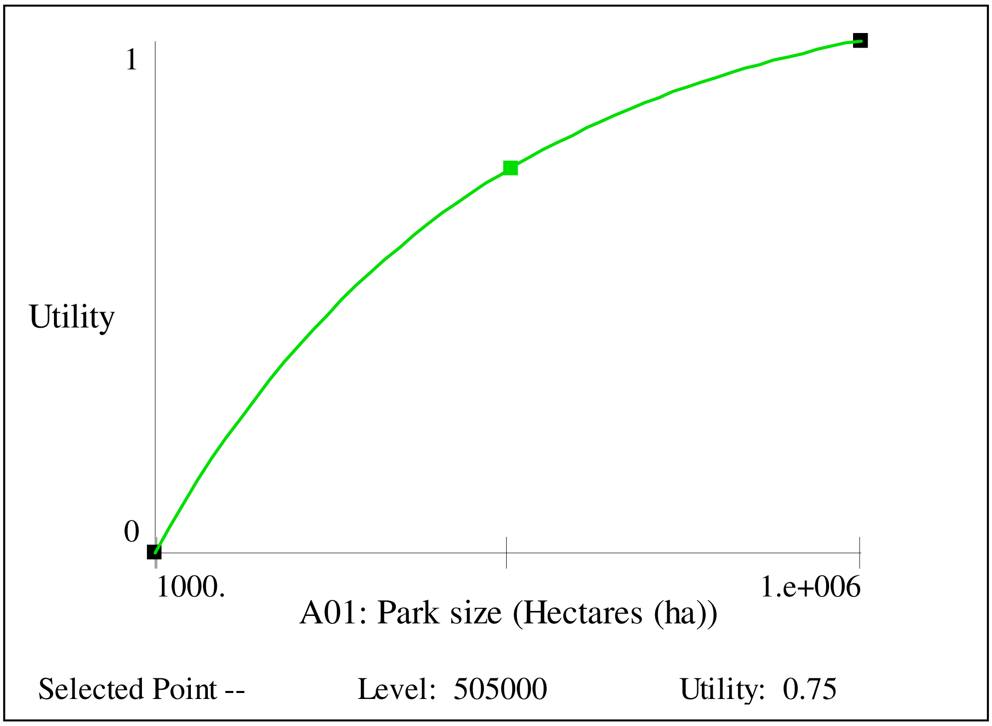


Figure 5.7

Default Linear Utilities for Labels on the 'Importance for Recreation' Measure

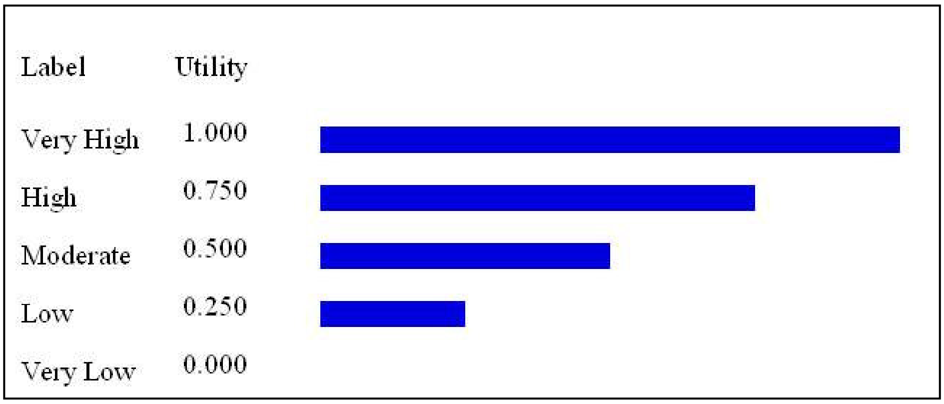
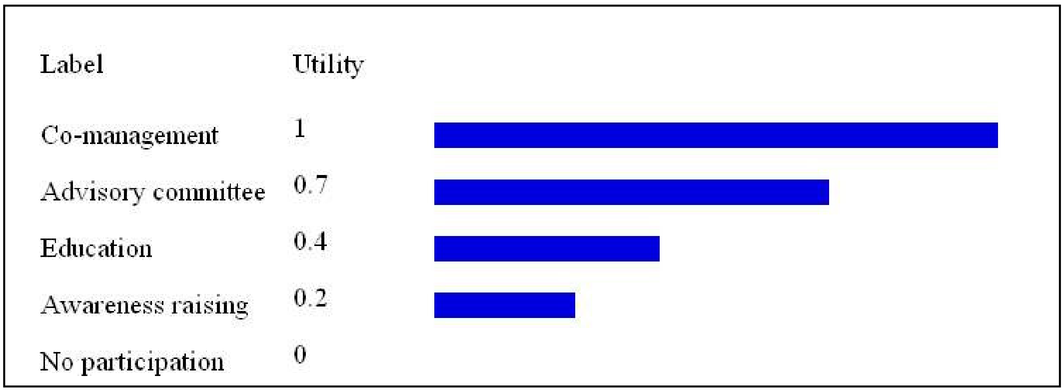


Figure 5.8

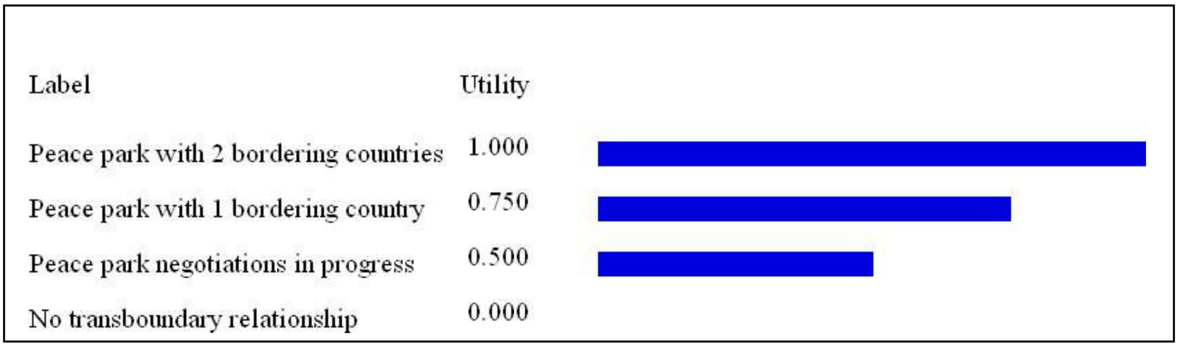
Modified Utilities for Labels on the 'Potential Stakeholder Participation' Measure



Similarly, the utilities for the ‘peaceful relations’ measure were modified to reflect the large jump from no transboundary relationship to one that is in progress, and smaller jumps from negotiations to an agreement with one country, and an agreement with two countries (Figure 5.9).

Figure 5.9

Modified Utilities for Labels on the ‘Peaceful Relations’ Measure



Weight Assessments

The primary goal, secondary goals, and sub-goals are also described by a number called utility. This is computed by combining the utilities for each of a goal’s members (measures or sub-goals) in a weighted average called a MUF (multi-measure utility function). The utilities of the measures and goals under each goal must all sum to one. This is repeated for each goal grouping of the analysis. For example, the utilities of the 11 members of secondary goal ‘maximise natural heritage benefits’ must sum to one, and the utilities of the four sub-goals for the overall goal ‘determine national park significance’ must also sum to one.

Weight assessment methods are used to determine the MUF for each goal. If a MUF is not defined for a sub-goal, its members will be included in the next higher goal’s MUF. Separate MUFs for each goal are beneficial because they simplify the assessment by requiring fewer members to be considered at once (Logical Decisions, 2002).

Preference information is stored in LDW as a preference set. The information in each preference set includes category multipliers, SUFs, and the weight assessment information LDW uses to compute the MUFs for goals. The three weight assessment methods (SMARTER, SMART, and AHP) were applied to the model in separate preference sets. For each assessment, the category multipliers discussed in section 5.1.4 and common units conversions discussed above were used. Furthermore, the measures belonging to the secondary goals ‘maximise financial benefits’ and ‘minimise direct threats to natural heritage’ were given equal weightings for this exercise. The weightings used reflect interpretations of anecdotal and implied preferences from the literature. These are hypothetical weights, used to demonstrate the usefulness of the model. The preferences for the secondary goals in descending order of importance are: ‘A: Maximise natural heritage benefits’, ‘C: Maximise social benefits’, ‘D: Minimise direct threats to natural heritage’, and ‘B: Maximise financial benefits’.

The two MAUT methods, SMARTER and SMART, and the AHP method were trialled. Conceivably, all three of the methods could be used in an analysis, but all were trialled to determine if they are easy to use and understand.

The SMARTER Method

The SMARTER (simple multi-attribute rating technique exploiting ranks) method requires the user to identify the order of importance for a goal’s measures. The most important option is ranked ‘1’, the second-most important, ‘2’ and so forth (Figure 5.10).

The LDW text book suggests that:

> One way to assess the ordering is to think of an alternative with all the active members at their least preferred level. Then decide which member you would like to improve to its most preferred level. Assign this member an order of one. Then decide which member you would next most like to improve, assign it an order of two, and so on. (Logical Decisions, 2002, p. 7/36)

Multiple measures may also have the same number, indicating equal importance. Based on this order, a set of weights is computed using a ‘centroid’ approach. The assessments with the SMART and AHP methods were based on this order.

The SMARTER method was easy to use and understand. The users are required to reach consensus on a simple rank order for a goal’s members and this would be simple to undertake in a Delphi focus group situation.

Figure 5.10

The SMARTER Method for Weight Assessment

Please enter the importance ordering for A: Maximise natural heritage benefits

Importances must be between 0 and 11. Ties are allowed.

Lower numbers indicate more importance. 0 = no importance.

	Importance Order (1 = most)
A02: Habitat continuity Measure	11
A11: Endemic flora present Measure	10
A07: Endemic fauna present Measure	9
A08: Migratory fauna present Measure	8
A04: Contribution to ecosystem representation Measure	7
A09: Flora species present Measure	6
A10: Threatened flora present Measure	5
A03: International designations Measure	4
A05: Fauna species present Measure	3
A06: Threatened fauna present Measure	2
A01: Park size Measure	1

The SMART Method

The SMART (simple multi-attribute rating technique using swings) method is based on the principle of 'relative importance'. The user is asked to define the relative importance of measures using 'swing weights', where the relative importance of changing a measure from its least preferred level to most preferred level is considered (Figure 5.11). The most important swing is given a weight of 100.

The LDW text book suggests that:

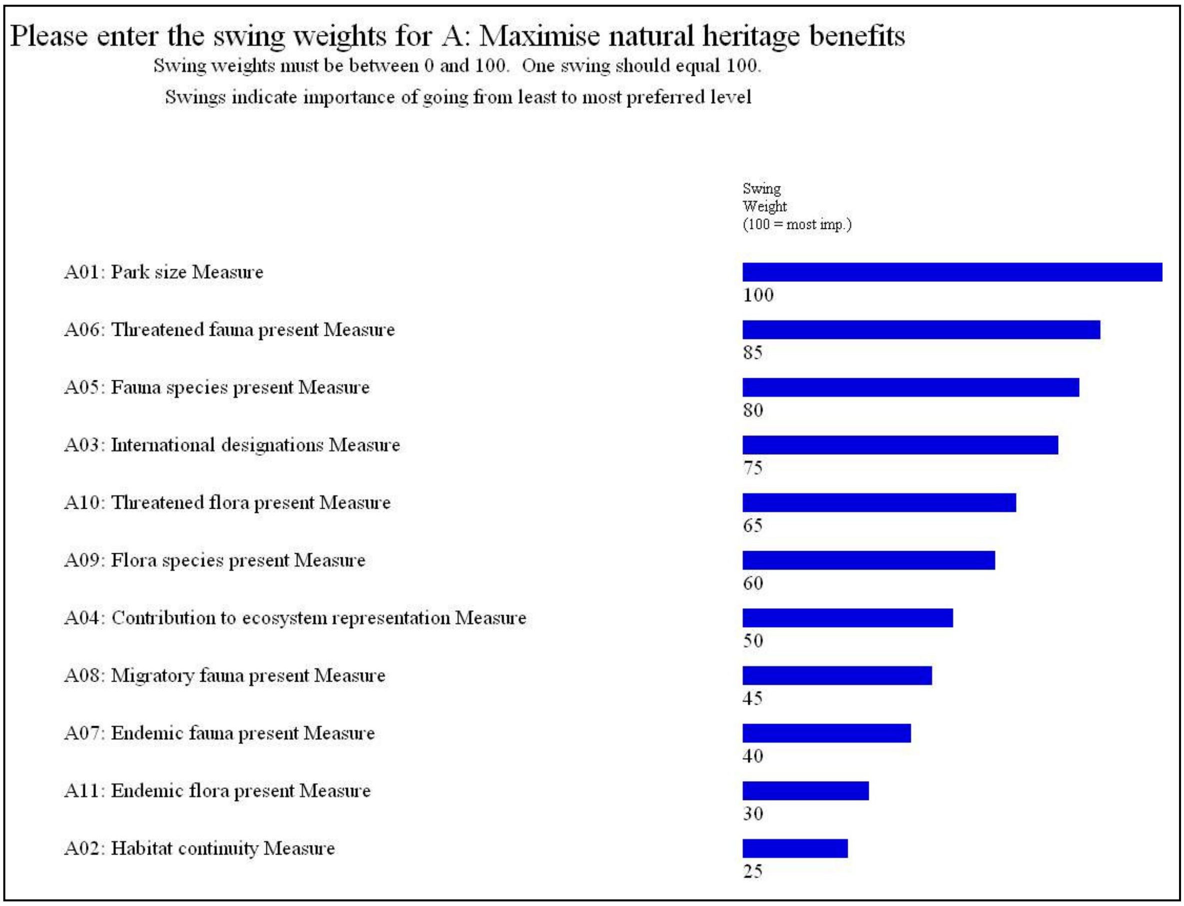
> One way to assess the swing weights is to first think of an alternative with all active members at their least preferred level. Then think of being allowed to improve just one member from its least preferred to its most preferred level. When you have decided which member you would most like to improve, assign it a swing weight of 100. then identify the member you would next most like to improve, and assign it a swing weight that reflects your estimate of the relative importance of improving this member

compared with improving the first member … You can continue to assign swing weights by comparing the importance of improving each of the remaining members to the first member's importance. (Logical Decisions, 2002, p. 7/37)

LDW computes the weights for each measure by adjusting the swing weights to sum to one.

Figure 5.11

The SMART Method for Assessing Measure Weights

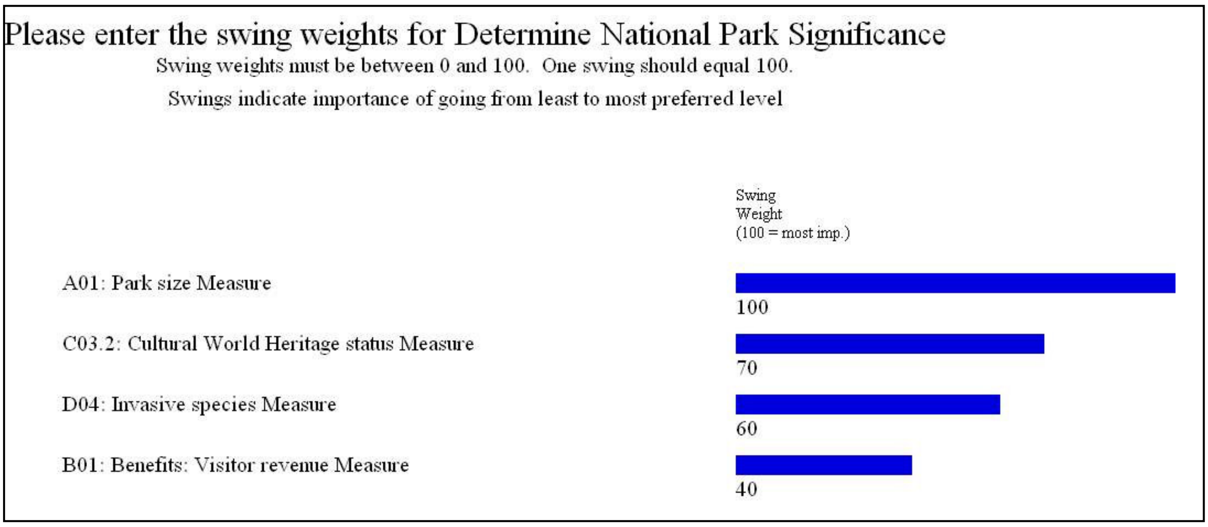


For the secondary goal, 'maximise natural heritage benefits', a representative was chosen from each of the sub-goals. The four representatives were then ranked using the same procedure (Figure 5.12).

The SMART method was applied using the measure order determined using the SMARTER method. It was hard to decide on the relative importance of improving a measure in comparison to the measure ranked above it. This weight assessment method was easy to use, but conceptually hard to understand; even after multiple iterations.

Figure 5.12

The SMART Method for Assessing Overall Goal Weights using Representative Measures



The AHP Method

The AHP (Analytic Hierarchy Process) method requires the user to assess weight ratios for all possible pairs of measures for each goal. This process involves entering more ratios than are strictly needed. An approach based on linear algebra is used to compute a best fit set of weights based on the ratios entered (Logical Decisions, 2002).

For each pair, LDW prompts the user to identify which measure is more important. Then the user must select an 'importance strength' rating, indicating the ratio of importance of the better performing measure to the other measure. The importance strength is selected from a scale of one (equal) to nine (extreme), as shown in Figure 5.13. Explanations for the nine levels are given in Table 5.13.

This ratio is then automatically added to the assessment matrix, as shown in Figure 5.14 where the blue cells have been assessed and the white cells have not. The ratio of a member to itself must be one, so ratios are not shown on the diagonal of the matrix (the grey cells). Instead, these cells show the current weight for each measure. The default is for all measures to have equal importance, with ratios of one. Every pair combination appears twice in the matrix, so ratios are only entered in the cells above the diagonal. Once a weight ratio has been entered, LDW uses the AHP computation process to compute a new set of weights for the members (Logical Decisions, 2002).

Figure 5.13

Pairwise Comparison using the Analytic Hierarchy Process for Weight Assessment

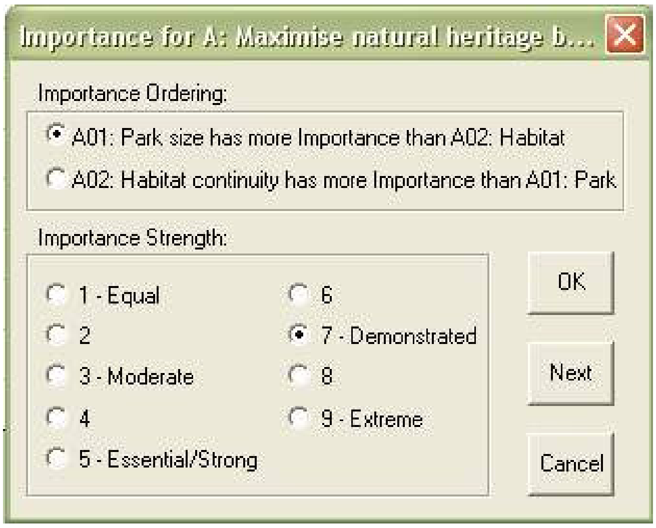


Table 5.13

The Scale of Relative Importance

Intensity of Importance	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Weak importance of one over another	Experience and judgment slightly favour one activity over another
5	Essential or strong importance	Experience and judgement strongly favour one activity over another
7	Demonstrated importance	An activity is strongly favoured and its dominance demonstrated in practice
9	Extreme importance	The evidence of favouring one activity over another is of the highest possible order of affirmation
2,4,6,8	Intermediate values between the two adjacent judgements	When compromise is needed

Source: Adapted from Logical Decisions (2002)

In the upper left cell of the assessment matrix, LDW provides information about the consistency of the ratios in the matrix. The 'consistency index' (C.I.) is an absolute measure of the consistency of the ratios. The 'consistency ratio' (C.R.) is a relative measure of consistency, and if this is above 0.10 the ratios should be adjusted to make them more consistent (Logical Decisions, 2002).

Figure 5.14

Assessment Matrix for Weight Assessment using the Analytic Hierarchy Process

l-max = 11.359 C.I. = 0.036 C.R. = 0.024	A01: Park size	A02: Habitat continuity	A03: International designations	A04: Contribution to ecosystem representation	A05: Fauna species present	A06: Threatened fauna present
A01: Park size	0.129	7.000	1.000	1.000	1.000	1.000
A02: Habitat continuity	0.143	0.078	1.000	1.000	1.000	1.000
A03: International designations	1.000	1.000	0.088	1.000	1.000	1.000
A04: Contribution to ecosystem representation	1.000	1.000	1.000	0.088	1.000	1.000
A05: Fauna species present	1.000	1.000	1.000	1.000	0.088	1.000
A06: Threatened fauna present	1.000	1.000	1.000	1.000	1.000	0.088

The AHP method was applied based on the original measure order used in the SMARTER assessment. It was simple to decide which measure is more important (or if the measures are of equal importance) for each pair. However, it was initially challenging to decide upon the strength of the importance of one measure over another. This became easier through the familiarity gained over multiple iterations. The AHP method seems the most robust because it requires the decision-maker to make explicit trade-offs between pairs of measures. To elicit pairwise comparisons from a Delphi group of more than 3 people, another version of LDW, Logical Decisions® for Groups, will need to be used. This is an enhanced version of LDW that captures and saves the judgments of an entire group. Results can then be computed and displayed for either the group consensus or for any individual.

The SMART method generated significantly different absolute weights than the SMARTER and AHP methods, even though all three assessments were based on the same basic rankings (Table 5.14). For the SMART method, the variation in utility of the four sub-goals was less than the SMARTER and AHP methods, where the utility of sub-goal ‘A: Maximise natural heritage benefits’ was greater than 0.5.

Table 5.14

The Absolute Weights Calculated for Each Preference Set

Weighted element	SMARTER	SMART	AHP
Overall goal: Determine National Park Significance			
A: Maximise natural heritage benefits	0.5208	0.3513	0.5974
B: Maximise financial benefits (goal)	0.0625	0.1502	0.0474
C: Maximise social benefits (goal)	0.2708	0.2733	0.2272
D: Minimise direct threats to natural heritage (goal)	0.1458	0.2252	0.1280
Secondary goal A: Maximise natural heritage benefits			
A01: Park size	0.2745	0.1527	0.2537
A02: Habitat continuity	0.0083	0.0382	0.0151
A03: International designations	0.1079	0.1145	0.1123
A04: Contribution to ecosystem representation	0.0518	0.0763	0.0466
A05: Fauna species present	0.1382	0.1221	0.1632
A06: Threatened fauna present	0.1836	0.1298	0.1999
A07: Endemic fauna present	0.0275	0.0611	0.0249
A08: Migratory fauna present	0.0388	0.0687	0.0306
A09: Flora species present	0.0670	0.0916	0.0566
A10: Threatened flora present	0.0851	0.0992	0.0798
A11: Endemic flora present	0.0174	0.0458	0.0173
Secondary goal B: Maximise financial benefits			
B01: Benefits: Visitor revenue	0.1429	0.1429	0.1429
B02: Benefits: Donations	0.1429	0.1429	0.1429
B03: Benefits: Cause-related revenue	0.1429	0.1429	0.1429
B04: Benefits: Resource sales	0.1429	0.1429	0.1429
B05: Costs: Capital	0.1429	0.1429	0.1429
B06: Costs: Recurrent	0.1429	0.1429	0.1429
B07: Costs: Compensation	0.1429	0.1429	0.1429
C01: Scientific significance	0.0335	0.0962	0.0328
C02: Education significance	0.0543	0.0962	0.0479
C03: Cultural heritage (goal)	0.3397	0.1923	0.3287
C04: Importance for tourism	0.2147	0.1538	0.2311
C05: Importance for recreation	0.1522	0.1442	0.1577
C06: Scenic significance (goal)	0.1106	0.1346	0.1063
C07: Potential stakeholder participation	0.0793	0.0577	0.0712
C08: Peaceful relations	0.0156	0.1250	0.0243
Sub-goal CO3: Cultural heritage			
C03.1: Cultural landscape components	0.2500	0.2857	0.1667
C03.2: Cultural World Heritage status	0.7500	0.7143	0.8333

Weighted element	SMARTER	SMART	AHP
Sub-goal C06: Scenic significance			
C06.1: Geological features	0.7500	0.8333	0.8750
C06.2: Landscape types	0.2500	0.1667	0.1250
Secondary goal D: Minimise direct threats to natural heritage			
D01: Abiotic resource use	0.1429	0.1429	0.1429
D02: Consumptive biological use	0.1429	0.1429	0.1429
D03: Habitat conversion	0.1429	0.1429	0.1429
D04: Invasive species	0.1429	0.1429	0.1429
D05: Major landscape changes	0.1429	0.1429	0.1429
D06: Non-consumptive resource use	0.1429	0.1429	0.1429
D07: Pollution	0.1429	0.1429	0.1429

Conclusion

The model was evaluated using three weight assessment methods, SMART and SMARTER (Multiple Attribute Utility Theory methods), and the AHP (Analytic Hierarchy Process). These methods convert ordinal and cardinal alternative levels into a common ‘utility’ unit. The decision alternatives are then ranked from greatest to least utility. A multi-method approach to preference assessment contributes to the robustness of results and all three methods could be applied to a decision problem. However, the SMART method was hard to understand and produced results that varied markedly from the SMARTER and AHP methods. These methods were easier to understand and should be used in future applications of the model.

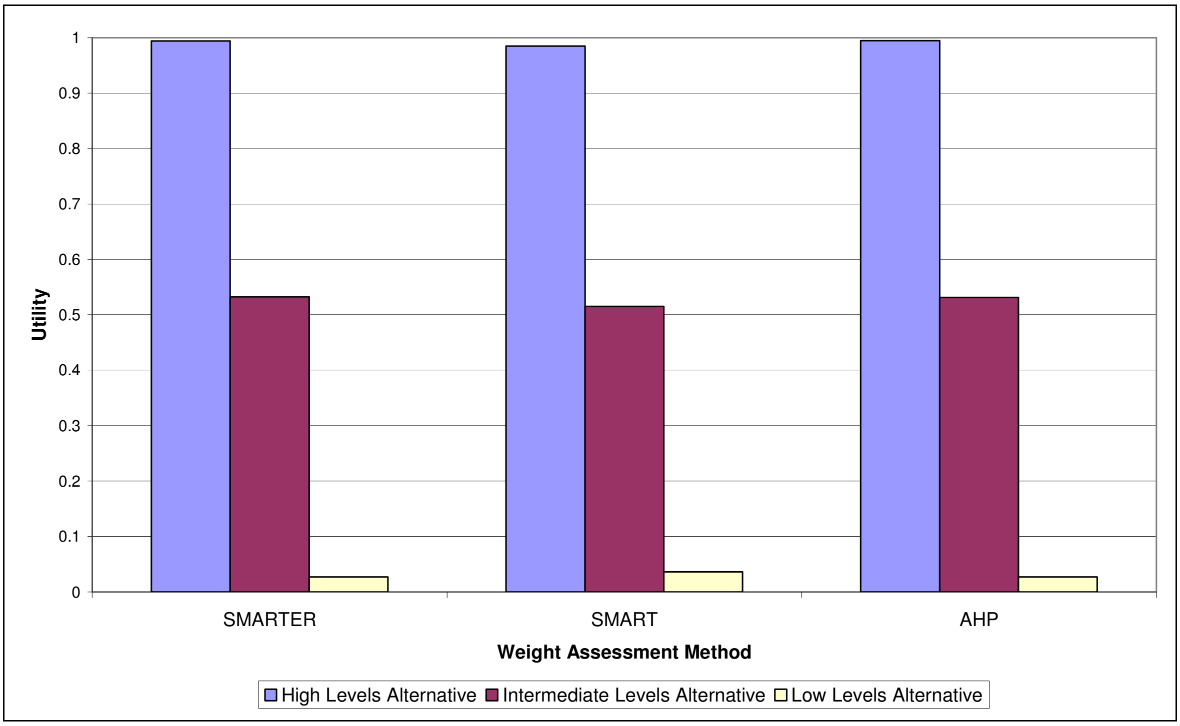
A copy of Logical Decisions® for Groups should be used for Delphi group situations of four or more experts. It would be wise to employ the SMARTER method first and use the measure order decided upon by the experts as a guide for the pairwise comparisons in the AHP weight assessment.

5.1.7 SENSITIVITY ANALYSIS

The weight assessment method trials were undertaken in conjunction with a sensitivity analysis to determine whether the model results are consistent with the measure levels of each alternative. The model was tested with three hypothetical alternatives (national parks) representing the highest, lowest, and intermediate levels for each measure. Assumptions were made about the nature of these alternatives, because a well-managed large park with many rare species and a large number of visitors is likely to have more staff members and more monitoring programmes in place than a 'poor' park that is small, has low ecological importance, and fewer visitors. This means that the 'High Levels' alternative has the most preferred levels for all measures except for the recurrent costs for staff, and research and monitoring.

The utility scores for the hypothetical alternatives with each preference assessment method are shown in Figure 5.15. The utility scores are consistent for each weight assessment method. The model was also tested using the same alternatives with different weight preferences, resulting in the same consistent utility scores. This indicates that the model is robust because the utility scores reflect the measure levels for each alternative.

Figure 5.15
Sensitivity Assessment showing the Utility Score for each Alternative resulting from the Different Weight Assessment Methods



5.1.8 PILOT STUDY DESIGN

Ideally, the model would be tested in a diverse set of national park management contexts, including:

- Different market economies (developed market economies, economies in transition, and developing market economies);
- Different biomes (e.g. tropical, temperate); and,
- Island and continental nations.

The PAMAs detailed in Appendix B (Australia, New Zealand, the Czech Republic, Nepal, and South Africa) cover this diversity of national park management contexts. Unfortunately, it was not possible to pilot the model across such a diverse range of market economies due to the time, language, and financial constraints of this research. The pilot studies selected are the national parks managed by the Department of Conservation in New Zealand, and the Parks and Wildlife Commission of the Northern Territory in Australia. These represent English-speaking developed market economies. A benefit of piloting the model in developed market economies is that the PAMAs should be better resourced than transitional and developing economies, and therefore have better access to appropriate data. New Zealand is a temperate island nation. In comparison, the Northern Territory of Australia has tropical, subtropical and semi-arid environs and exists on the continent of Australia (with neighbouring provinces as opposed to countries).

5.2 PILOT STUDY A: THE NATIONAL PARKS OF THE NORTHERN TERRITORY, AUSTRALIA

The model was adapted and applied to the 16 national parks managed by the Parks and Wildlife Commission of the Northern Territory (PWCNT) in Australia. Information was accessed in June and July 2005 at the PWCNT office in Alice Springs, complemented by interviews with relevant staff at the Palmerston office near Darwin. Other data, such as the number of refereed publications was accessed at a later date.

The PWCNT is responsible for educational wildlife and botanic parks in the urban centres Darwin and Alice Springs, the management of the NT's 90+ protected areas, and for documenting the flora and fauna of the Northern Territory, both within and outside designated protected areas (Northern Territory Department of

Natural Resources Environment and the Arts, 2006). In Australia, protected areas are managed by the provincial governments. However, the country's UNESCO World Heritage Sites are managed by the Federal Government agency, Parks Australia. This means that the flagship national parks in the Northern Territory, Kakadu and Uluru Kata-Tjuta National Parks, are not managed by PWCNT and were not included in the analysis. The context of national park management in the Northern Territory (NT) is detailed in Appendix B, including a brief description of the environmental variation across the NT.

5.2.1 DEVELOPING THE NORTHERN TERRITORY MODEL

In this section, the procedure followed in applying the model to the national parks managed by the PWCNT is described. The availability and form of data determined whether measures were retained, modified, or removed from the model. The data sources used in the analysis included spatial Geographic Information System (GIS) databases, national park 'plans of management' (POMs), the 'Northern Territory Parks and Conservation Masterplan' (the Masterplan) (Northern Territory Department of Natural Resources Environment and the Arts, 2005), relevant websites, and PWCNT staff.

Measures of Natural Heritage

Natural heritage data for the NT is stored by PWCNT in spatial databases that are queried in the GIS software ESRI® ArcMap™ 9.2 (Environmental Systems Research Institute, Redlands, California, USA). These spatial data layers were merged and queried in ESRI® ArcMap™ as appropriate, and tabled data was manipulated in Microsoft Access 2003 and Microsoft Excel 2003.

The national park polygon layer formed the basis of all data queries. However, the existing national park polygon layer was not appropriate for the analysis because each national park was represented by a number of polygons separated by small features that are not legally part of the national park. These features include clusters of buildings, road easements, and Aboriginal Land Corporation areas less than 2km wide that are essentially managed as part of the national park. For example, it would be inappropriate to discount flora and fauna survey points that occur within 2km of a road because this area is not officially part of the national park.

The national park polygon layer was modified so that one discrete polygon represented each park. New polygons were manually drawn in ESRI® ArcMap™ to cover roads and resorts, and the new layers were merged with the old layer to create the single polygon layer shown in Figure 5.16.

Djukginj National Park, Gregory National Park, and Mary River National Park involve two or more large areas separated by large areas of alternative land use that were not merged. Under the Masterplan, proposed national parks and national park extensions are to be declared as a matter of importance, and these areas were included in the analysis (Northern Territory Department of Natural Resources Environment and the Arts, 2005).

Three natural heritage measures were removed for the NT pilot study, ‘endemic flora present’, ‘endemic fauna present’, and ‘habitat continuity’. Endemism data was not spatially available, nor was there a ‘look-up’ list available to query in Microsoft Access. The ‘habitat continuity’ measure was considered redundant due to the intactness of natural habitat within the NT.

Park size

Park size was determined by querying the national park polygon layer in ESRI® ArcMap™. The area calculations were checked in the relevant POM for each park (where available), and each was within 50ha of the reported size. Some of the POMs are dated or non-existent, so the most consistent and up-to-date way to determine park size was to query the ESRI® ArcMap™ data layer.

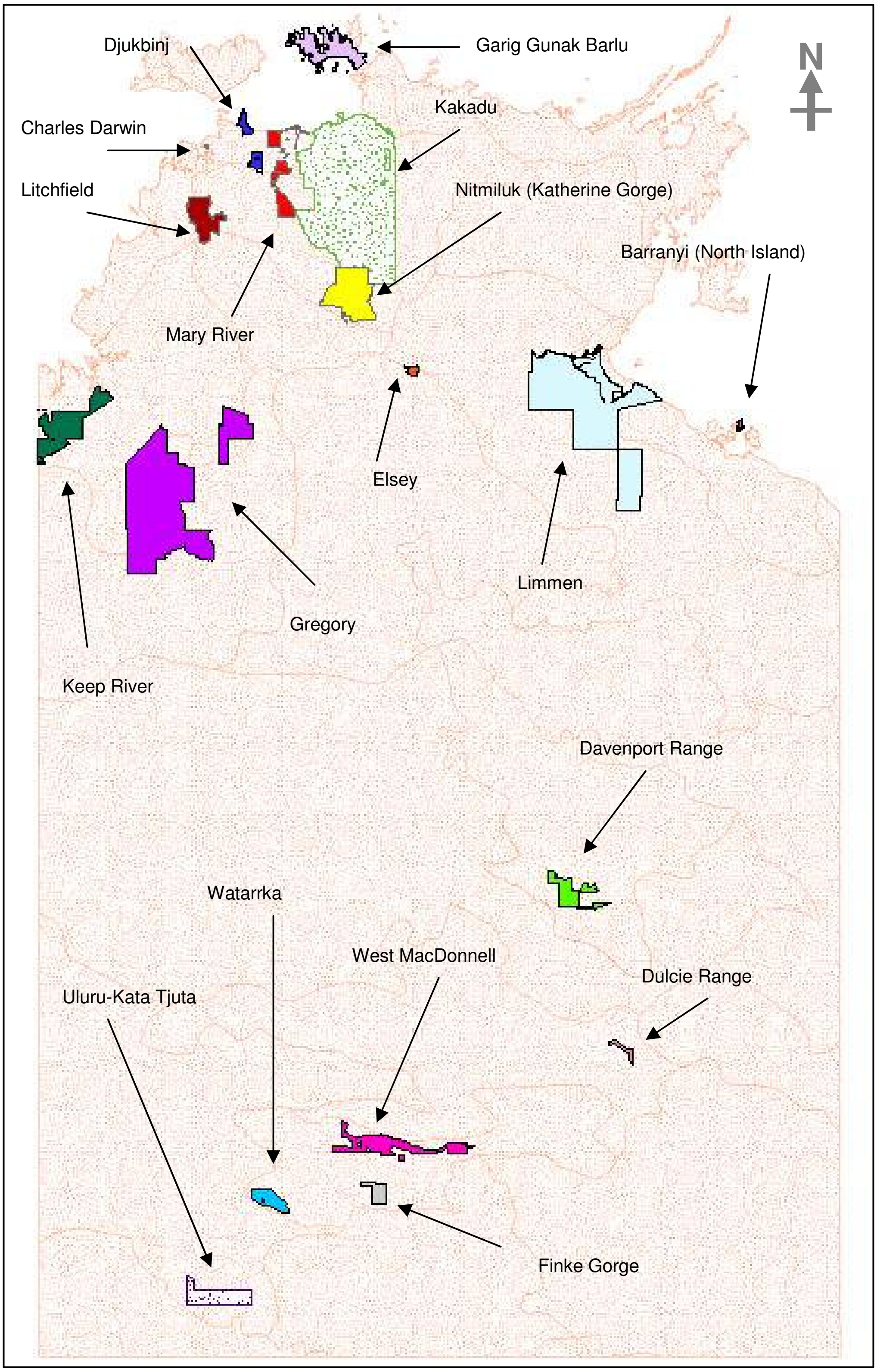
Habitat continuity

The environments of the NT remain in a largely natural state. This can be attributed to a small human population and consequently little habitat conversion. The Aboriginal cultural landscape has survived in the NT for over forty thousand years. Land tenure generally falls into three broad types: pastoral lands (c.45%), Aboriginal lands (c.50%), and conservation lands (c.5%), although some

Aboriginal land is managed as pastoral or conservation land (Northern Territory Department of Natural Resources Environment and the Arts, 2006).

Figure 5.16

Map showing the National Parks of the Northern Territory



Pastoral practices in the NT are not intensive. Cattle range is dependant on proximity to waterholes, which are usually artificial bores. Most bores are located an adequate distance from park boundaries, ensuring that stock do not graze on park land. Similarly, many pastoral weed species rely on the proximity of bore water and have not encroached on national parks. This means that habitat within the NT is largely continuous. Thus, the 'habitat continuity' measure is redundant and was not included in the NT model.

International designations

None of the parks managed by the PWNCNT have UNESCO World Heritage Site status. According to the Masterplan, Garig Gunak Barlu National Park is the only RAMSAR wetland in the NT. The Masterplan lists wetlands that meet international importance criteria, and wetlands of national significance. Sites of national conservation significance are also stated in the Masterplan. Sites of botanical significance have been determined for the southern end only and need to be assessed for the parts of the NT above 18 degrees longitude (Northern Territory Department of Natural Resources Environment and the Arts, 2005).

The measure was renamed 'Importance classifications', with four measure categories:

- Sites of national importance (category multiplier = 1);
- Wetlands of national importance (category multiplier = 1);
- Wetlands meeting international importance criteria (category multiplier = 1.5); and,
- RAMSAR wetlands (category multiplier = 2).

When the sites of botanical significance have been determined for all of the NT, this could also be included in the analysis.

Contribution to ecosystem representation

The Interim Biogeographic Regionalisation of Australia (IBRA) divides Australia into eighty regions based on field knowledge, published research and environmental reports about the climate, lithology/geology, landform, vegetation, and fauna of Australia (Thackway & Cresswell, 1995). According to the latest IBRA iteration available as a GIS layer (version 6.1) there are 25 biogeographic regions in the NT, further divided into 63 sub-regions.

The IBRA sub-regions occurring in each national park were analysed according to the methodology described in section 5.1.4. The ecosystems occurring in Kakadu National Park and Uluru Kata-Tjuta Uluru Park were considered in the importance score analysis determination because these areas are strictly protected, even though they are not managed by the PWCNT. In addition, some of the coastal parks include a protected marine element and this was treated as another type of biogeographic region, though marine environments are not included in the IBRA classification. The total marine area within the national park network was treated as the entire area of the marine category.

A measure category was created in LDW for each of the 19 biogeographic regions occurring within the NT's national parks. First, an importance score was determined for each biogeographic region, as shown in Table 5.15, and this was used as the category multiplier for each region.

The percentage of each ecosystem occurring within each national park was then calculated, based on the total area of the ecosystem occurring within the national park network, and these figures were entered into LDW.

Fauna species present

The PWCNT Fauna Atlas was queried to determine which fauna species are present in each national park. In the Fauna Atlas, fauna records (observed and captured fauna) exist as geographic data points. The PWCNT does not maintain fish or invertebrate species data layers, so the fauna species measure was reduced to four measure categories: amphibians, birds, mammals, and reptiles. The measure categories had equally weighted category multipliers of one.

The data points located within a national park polygon were analysed to infer the presence of that species within the park. Each species was only counted once for each park and feral animal species were removed from the count. The data may include species that do not have viable populations within each park.

Table 5.15

Determining Category Multipliers for Ecosystems Represented with the National Parks of the Northern Territory

Biogeographic Region	Area within the Northern Territory (ha)	Area within the national park network (ha)	Percentage within national park network	Importance score (category multiplier)
Arnhem Plateau P1	1038929	421938	40.6	3
Arnhem Plateau P2	1267187	64997	5.1	7
Burt Plain P4	526195	19099	3.6	7
Daly Basin	2097507	28524	1.4	7
Darwin Coastal	2852958	795827	27.9	4
Davenport Murchison Range P2	1588396	113941	7.2	6
Gulf Coastal P1	2642097	291946	11.0	5
Gulf Coastal P2 Pellews	68659	5377	7.8	6
MacDonnell Ranges P1	1485225	206548	13.9	5
MacDonnell Ranges P2	1094019	118018	10.8	5
Mackay	8555212	134324	1.6	7
Marine	36369	36369	100.0	1
McArthur-South Nicholson Basins	8739019	948112	10.8	5
Ord-Victoria Plains P3	753194	360901	47.9	3
Pine Creek	2855880	1204095	42.2	3
South Kimberley Interzone	4416262	205781	4.7	7
Sturt Plateau P3	3587528	8733	0.2	8
Tiwi-Cobourg P2	262624	206119	78.5	2
Victoria Bonaparte P1	4576992	988196	21.6	4

Threatened fauna present

The PWCNT classifies the conservation status of flora and fauna species according to the IUCN Red List criteria (version 3.1), as stipulated by the Northern Territory of Australia Territory Parks and Wildlife Conservation Act 2003. The status of a species in the NT may differ from its status in another State or at the national level. A species with a restricted distribution in the NT classified as threatened, might be common elsewhere in Australia and, consequently, have a national classification of unthreatened (Parks and Wildlife Commission of the Northern Territory, 2005). The NT threat status database is most accurate and accessible for the NT species and, consequently, the model only incorporates threat at the Territory level.

Where species in the database had not been rated due to recent taxonomic (name) changes or inadequate surveying, resident scientists were consulted for a rating. If it was not possible to determine an appropriate rating this way, the species was labelled ‘not evaluated’. The threat database was then combined with the ‘fauna species present’ data determined for the previous measure category. There are no ‘critically endangered’ NT species occurring within national parks, so the measure categories were modified in LDW to ‘endangered’ with a category multiplier of 1.5, and ‘vulnerable’ with a category multiplier of one.

Migratory fauna present

Information regarding migratory fauna was not spatially available. However, in accordance with section 209 of the Environment Protection and Biodiversity Conservation Act 1999, the Minister for the Environment is required to maintain an official List of Migratory Species for Australia, based on species listed under the following International Conventions:

- The Japan-Australia Migratory Bird Agreement (in force from 6 February 1974, and amended from time to time);
- The China-Australia Migratory Bird Agreement (in force from 20 October 1986 and amended from time to time); and,

- The Convention on the Conservation of Migratory Species of Wild Animals - (Bonn Convention).

The List of Migratory Species for Australia makes no differentiation between the species listed in each convention, nor the Appendix I and II fauna specified in the Bonn Convention. The list is available online and was treated as a 'look-up' list, so each species on the list was queried in Microsoft Excel against the birds, mammals, and reptiles occurring within each national park. In LDW, the measure categories were modified to separate birds, mammals, and reptile species, each with a category multiplier of one.

Flora species present

Point data for flora species was updated with recent survey information and queried following the same process used for fauna.

Threatened flora present

The number of threatened plants in each national park was determined following the same process used for threatened fauna. Similarly, there were no 'critically endangered' species occurring within the national parks, so measure categories for 'endangered' and 'vulnerable' species were used, with the same category multipliers of 1.5 and 1 respectively.

Measures of Financial Factors

Tourism is the greatest source of GDP in the NT. Access to PWCNT national parks is free, and the only income generated by parks is through fees for campground use. This small income stream is usually absorbed by the NT Government Treasury, but in some cases, fees are set aside for campground cleaners.

The national park estate is the foundation of nature-based tourism in the NT and spending is focussed on infrastructure to support high visitor numbers. Once staffing costs (based on historical need), operations, and maintenance costs have been met, there is little discretionary funding available (W. Binns, personal communication, 11 July 2005). This means management activities (like the control of feral animals, fire, and weeds) always come second to visitor needs (G. Leach, personal communication, 12 July 2005).

Access to financial data at the park level was not granted. However, regional spending on staff and operations within all NT parks (not national parks specifically) was given for the 2004-2005 financial year as shown in Table 5.16. Further, AU$3.02 million was spent throughout the NT on maintenance.

Table 5.16

Regional spending on Personnel and Operations in the 2004-2005 Financial Year

Administration Region	Spending (AU$)	National Parks
Palmerston	6.224 million	Charles Darwin, Garig Gunak Barlu, Mary River, Litchfield, Djukbinj
Katherine	10.551 million	Barranyi (North Island), Elsey, Gregory, Keep River, Limmen, Nitmiluk
Alice Springs	6.222 million	Davenport Range, Finke Gorge, Watarrka, West MacDonnell, Dulcie Range

Source: W. Binns (personal communication, 11 July 2005)

In order to include cost information in the model, these values were assumed to be evenly spread across the relevant region's national parks on a per hectare basis.

Measures of Social Benefits

Data for social measures was hardest to access and the structure of this section was significantly modified for the NT model. The measures of education significance, importance for recreation, and scenic significance were removed due to data unavailability. The potential stakeholder participation and peaceful relations measures are redundant in the NT and, consequently, do not feature in the NT model.

It was not possible to fairly determine the level of importance for education or of geological features in each park, nor the number of scenic landscape types experienced by visitors. However, visitor numbers were available for all but one of the national parks, and this measure was taken to represent the full importance of parks to visitors.

All of the national parks managed by the PWCNT are currently undergoing a process of joint management, rendering the 'potential stakeholder participation' measure redundant. The process involves each park's traditional owners regaining ownership of the land and leasing it back to the PWCNT for a 99 year term. The parks will then be managed by the PWCNT with full input from the traditional owners. The 'peaceful relations' measure is also redundant because the NT is bordered by States that are members of the same country. Incidentally, none of the national parks in the NT are located on its border.

Scientific importance

A thorough database search of referred journals was undertaken using the Web of Science (version 4.2). The current name of each park (and previous and/or English name where applicable) was used in a keyword search. Citations and abstracts were checked for relevance to the natural and/or cultural environs of the current national park. Only 32 articles were found, spanning the time frame 1985-2005. With so few publications per year, the time-span for this measure had to incorporate multiple years to allow meaningful comparison. The number of refereed publications for the previous five years (published 2000-2005) was entered as a numerical level for the scientific measure. Technically, the analysis should not include publications from 2005 because the other data used, such as visitor numbers, is from 2004. However, five of the 21 articles published over the 2000-2005 period were published in 2005, in comparison to one article published in 1999. The 2000-2005 period was used because it makes the measure more meaningful by providing greater differentiation amongst the parks.

Cultural Heritage

Cultural heritage information was available in the POMs, Masterplan, and as a GIS layer of sacred sites. The structure of the cultural heritage goal was modified in accordance with the available data and dived into three measures:

- Historical worth (descriptive);
- Cultural UNESCO World Heritage status (descriptive); and,
- Aboriginal sacred sites (number).

The historical worth of each park was determined from descriptive information provided in each POM, and the Masterplan. Where a POM was not available for a park, online visitor information and fact sheets provided by PWCNT were used. From the information presented in these documents it was not possible to accurately classify landscape components as defined by the U.S. National Park Service (1990; 1994). Instead, labels were used to describe the historical worth of each park on a scale of Low – Moderate – High – Very High (Table 5.17).

The Masterplan makes special mention of only three national parks with notable 'historic locations' and these automatically received a 'High' rating. One of these parks was promoted to 'Very High' due to the detailed description of historical components from multiple cultures described in the POM. Parks with a historical element listed on the Register of the National Estate were also rated 'High'. The online Register of the National Estate was of no use because the database does not specify the location of registered items, making it impossible to know if one is located within a national park without prior knowledge. The only items known to be listed on the Register of the National Estate were stated as such in the POMs. If there was no mention of historical worth for a park in the POM it was rated 'Low'. All other parks with some historical features, or features stated as locally or regionally important, were given a 'Moderate' rating.

The only exception to these rules is Charles Darwin National Park, which was given a 'High' rather than 'Moderate' ranking due to the proximity of the national park to the city of Darwin and the greater awareness of historical worth that this generates. The resulting rankings are subjective, but the exercise was undertaken in a consistent manner.

According to the Masterplan, the West MacDonnell National Park will be nominated for UNESCO World Heritage Site status for natural and cultural reasons (Northern Territory Department of Natural Resources Environment and the Arts, 2005). The Cultural World Heritage status measure was retained, and the West MacDonnell National Park was given 'pending' status.

Table 5.17

Historical Worth Ratings for the Northern Territory National Parks

National Park	Historical components	Reference	Historical Worth
Barranyi	None mentioned	Plan of Management	Low
Charles Darwin	Military: ordinance facility established during World War II	Plan of Management	High
Davenport Range	Pastoralism: buildings European occupation: Police Station	Plan of Management	Moderate
Djukbinj	Notable historic location: early settlement	Masterplan	High
Dulcie Range	Pastoralism: homestead, wagon shed, blacksmith's shop, horse yard, and stockyard	Plan of Management	Moderate
Elsey	None mentioned	Plan of Management	Low
Finke Gorge	None mentioned	Plan of Management	Low
Garig Gunak Barlu	Notable historic location: fort ruins	Masterplan	Very high
	Macassan occupation: 18 sites, including the remains of stone fireplaces, wells and artefacts like pottery fragments. Also remnants to many trepang curing sites and the customs house. European occupation: British Military settlements Fort Wellington (1827-29) and Victoria Settlement (1838-49). Extensive evidence, over 60 structures or sites. Cape Don Lighthouse (1916)	Plan of Management	
Gregory	European exploration: Gregory's Tree (reserved under the Heritage Conservation Act and on the Register of the National Estate) Pastoralism: homesteads, stockyards, precinct and depot	Plan of Management	High
Keep River	None mentioned	Fact sheet	Low
Limmen	Pastoralism: the Gulf Track stock route and pastoral sites	Fact sheet	Moderate
Litchfield	Notable historic location: homestead and tin mine	Masterplan	High
Mary River	European exploration: the Stuarts Tree site (on the Register of the National Estate) Pastoralism: old campsites in three areas, but little evidence remains	Plan of Management	High
Nitmiluk	European exploration: some sites Pastoralism: yards, sawmill remnants Military: remains of a World War II alien (Italian) internment camp (considered to be of "local historic interest")	Plan of Management	Moderate
Watarrka	European exploration: some sites (considered "regionally significant")	Plan of Management	Moderate

National Park	Historical components	Reference	Historical Worth
West MacDonnell	European exploration: the original route of the Overland Telegraph Line crosses the park Pastoralism: wooden stock yard remains, sheep yards and stone hut ruins, timber remains of a well. Also more recent bores, fences and yards occur in the recently acquired extension. Early tourism: chalet ruins and dam	Plan of Management	Moderate

The final measure of cultural heritage involves the number of Aboriginal sacred sites within each park, according to a layer of ESRI® ArcMap™ point data. It is assumed that these sites conform to the Northern Territory Aboriginal Sacred Sites Act (2004), which uses the following definition of 'sacred site', as specified in the Northern Territory Land Rights Act (1976):

> … a site that is sacred to Aboriginals or is otherwise of significance according to Aboriginal tradition, and includes any land that, under a law of the Northern Territory, is declared to be sacred to Aboriginals or of significance according to Aboriginal tradition. ("Aboriginal Land Rights (Northern Territory) Act," 1976, p. 19)

Descriptions in the more recently published POMs imply that historical Aboriginal sites, such as middens, are officially recognised as sacred sites. To avoid double counting, the 'historical worth' measure does not include Aboriginal historical components, some of which were mentioned in the POMs.

Importance for tourism

The PWCNT's Visitor Monitoring Strategy is an integrated system of visitor monitoring across the NT with a central information storage and retrieval base. It is based on the best practice guidelines for visitor monitoring developed by the Australian and New Zealand Environment Conservation Council (ANZECC) Working Group on bench marking and best practice for National Parks and protected areas. Visitor information is collected by:

- Measurement of visitor use by counter (traffic and pedestrian);
- Measurement of visitor use and satisfaction by survey (questionnaires);

- Measurement of visitor use by fee collection (concessionaires and camping fees); and,
- Measurement of visitor use by ranger observation (diary/observation sheets and visitor books) (Parks and Wildlife Commission, 1999).

Parks are divided into high use (Type 1) and low use (Type 2) parks, as shown in Table 5.18.

Table 5.18
Classification of Type 1 and Type 2 Northern Territory National Parks for Visitor Monitoring Purposes

Type 1 (high visitation) Parks	**Type 2 (low visitation) Parks**
Charles Darwin National Park	Barranyi (North Island) National Park
Elsey National Park	Davenport Range National Park
Finke Gorge National Park	Djukbinj National Park
Litchfield National Park	Gregory National Park
Nitmiluk National Park	Garig Gunak Barlu National Park
Watarrka National Park	Keep River National Park
West MacDonnell National Park	Limmen National Park
	Mary River National Park

Source: Adapted from Parks and Wildlife Commission (1999)

In Type 1 parks, the minimum requirement for visitor use measurement is by calibrated counter and survey (Parks and Wildlife Commission, 1999). Surveys are undertaken in peak, off-peak, and shoulder periods (J. Weighell, personal communication, 29 June 2005). The minimum requirement for visitor monitoring in staffed Type 2 parks is by calibrated counter. It can be difficult to calibrate counters in unstaffed Type 2 parks and these parks are periodically monitored. Ranger observation is used at times in both Type 1 and Type 2 parks to assess visitor use and/or behaviour with regard to a specific management issue. Information obtained by concessions operatiors and park staff from fee collection or other permit systems are used in both Type 1 and Type 2 parks. Data from different sites in a park are standardised to gain a value for the whole park.

Visitor number data for 2004 was available for all national parks aside from Dulcie Range National Park. The data does not differentiate between overseas and domestic visitors, so measure categories were not employed in LDW. The missing value for Dulcie Range National Park was taken as the average number of visits to Type 2 national parks.

Measures of Direct Threats to Natural Heritage

The Northern Territory is characterised by three major land use types, conservation areas (including national parks), pastoral land, and aboriginal land. This means that natural habitat is largely continuous and the threats to national parks from industry and urban areas are minimal. Erosion is viewed as a threat to the region from a pastoral perspective, but as a natural process in national parks. Mining occurs throughout the Northern Territory, but not within PWCNT national parks. Through discussions with PWCNT staff, three types of direct threat to national parks were identified: feral animal species, invasive weed species, and damage by fire. The environments of the NT are divided by what is colloquially known as the ‘Berrimah line’, which separates the tropical ‘Top End’ from the arid ‘South’. The impact of fire and invasive species on the environments of the NT differs between these two regions.

Invasive (feral) animals

Data on the occurrence of feral animal species in national parks was based on GIS point data from ecological surveys. Thirteen feral animal species have been recorded within the national parks of the Northern Territory (Table 5.19). Wild dogs, cats, and foxes predate on native fauna and the group of native mammals of 500g-5kg are most threatened by these feral carnivores. Rabbits, camels, horses, donkeys, pigs, and goats are herbivores that browse on native flora and compete with native fauna for resources (Northern Territory Department of Natural Resources Environment and the Arts, 2005).

The scope and severity of threat posed by each feral animal species differs with location. For example, horses pose a high threat in Watarrka National Park, but a low threat in Dulcie Range National Park.

Table 5.19

Feral Animals Occurring in Northern Territory National Parks

Feral Animal	Impact Potential	Impacts
Banteng (*Bos javanicus*)	Low	Now one of the most abundant mammals in Garig Gunak Barlu National Park, where populations are maintained as an economic resource for trophy hunting.
Camel (*Camelus dromedaries*)	Moderate	Damage vegetation, foul waterholes and contribute to soil erosion.
Cane Toad (*Bufo marinus*)	High	Many impacts including widespread loss of vertebrate predators (mammals and reptiles), killed by the toad's toxins.
Cat (*Felis catus*)	High	Now occurring across almost all of the Territory, including offshore islands, contributed significantly to the decline and extinction of many mammal species and to the decline of some bird and reptile species.
Dingo (*Canus familiaris* and *Canis lupus*)	Low	Dingoes and feral dogs are widespread across the Territory. Their impacts upon biodiversity are not well established. Dingoes were part of Territory ecosystems before colonisation.
Donkey (*Equus asinus*)	High	High densities may degrade soils, water and vegetation.
Fox (*Vulpes vulpes*)	High	Has contributed very significantly to the decline and extinction of many Territory mammal species, and the decline of at least some birds and reptiles.
Goat (*Capra hircus*)	High	Currently relatively restricted in the Territory, causing considerable detriment to native vegetation.
Horse (*Equus caballus*)	High	Impacts most pronounced to and around water sources in more arid areas.
Pig (*Sus scrofa*)	High	Widespread across the Top End, causing considerable environmental damage, including eating the eggs and young of reptiles and birds, digging up rainforest and wetland herbs, consuming fallen fruit and seed crops, digging up aestivating turtles and frogs, and soil damage.
Rabbit (*Oryctolagus cuniculus*)	Moderate	Became one of the Territory's most abundant animals, causing considerable damage to vegetation, soil erosion, and the build-up of exotic predators. Numbers have been reduced following the spread of rabbit calicivirus disease.
Rock Dove (*Columba livia*)	Low	Populations are intensively controlled due to the human health risk associated with the diseases that the birds carry.
Water Buffalo (*Bubalus bubalis*)	High	Widespread across the Top End, particularly in floodplain areas, some control measures but populations are increasing.

Source: Adapted from Northern Territory Department of Natural Resources Environment and the Arts (2005) and S. Eldridge (personal communication, 29 June 2005)

The PWCNT feral animal staff were consulted to rate the magnitude of threat posed by each feral animal species occurring within each national park. These were rated on a scale of magnitude of None (absent) – Low – Moderate – High. The threat posed by feral animals was included in LDW as a goal with thirteen measure categories, described with labels.

Invasive plants

Data on the occurrence of invasive weed species in national parks was based on spatial point data from ecological surveys. Fourty-three weed species occur within the national parks of the Northern Territory. The magnitude of threat posed by weeds differs between the Top End and South. Botanists on the PWCNT staff in the Top End and South were consulted to rate the weed species as ‘highly competitive’ or ‘less competitive’. Of the 43 weed species occurring within national parks, seven were rated highly competitive.

The threat posed by invasive weeds was Included in LDW as a measure with 44 measure categories. A level of one was entered to indicate the presence of a weed in a park, and highly competitive weeds had a category multiplier of two. One weed, *Cynodon dactylon*, was rated less competitive in the Top End parks, and highly competitive in the South parks, so two measure categories were used for this weed.

Susceptibility to damage by fire

Fire is an integral part of the ecosystems of Australia's rangelands. However, fires that are too frequent can be damaging to ecosystems, particularly to plants that need some years free of fire in order to establish. The magnitude of fires is mitigated to some extent by on-park fire management practices, but there is a correlation between the magnitude of a fire and the species of under storey vegetation. Another way to identify areas prone to damaging fires would be to analyse aerial images for historical events.

A crude estimation of risk from damaging uncontrolled fires was undertaken, based on the premise that the under storey species dictate the susceptibility of an area to significant damage from fire. Using vegetation survey maps of the Northern Territory (Wilson, Brocklehurst, Clark, & Dickinson, 1991a,1991b) that are also spatial GIS layers, PWCNT herbarium and fire management staff from the Top End and Southern office respectively, indicated the vegetation unit with the species most likely to facilitate severe fires. Vegetation units were rated as either high threat or low threat.

Fire threat was expressed in LDW as a measure category. The percentage area of each national park with a high threat was entered as a level. This area was determined by merging the GIS layer for vegetation units with the national park polygons and the area of each vegetation unit occurring with a park was determined. These values were exported into Microsoft Excel to determine the total hectares of high threat vegetation.

The Northern Territory Model

The full structure of the Northern Territory model is given in Appendix C. A representation of the goals and measures is given in Figure 5.17.

5.2.2 ANALYSIS

The NT model was analysed following the procedure undertaken for the theoretical model (section 5.1.4). Once the levels were entered for each alternative on a measure, the most and least preferred levels were indicated. Care was taken to ensure that for the cost, feral animal, invasive plant, and fire risk measures, the most preferred level was specified as zero or none. This means that the parks with the lowest threat are most preferred. Category multipliers were entered for measure categories as described in the previous section. Measure levels were then converted to units of utility.

Common unit conversions were undertaken using single-measure utility functions (SUFs) for point-estimate data, and direct assessment was used for descriptive labels. The measures for park size, fauna present, flora present, and sacred sites were modified from linear SUFs to positive exponential SUFs, with a utility of 0.75 at the mid-point as described in section 5.1.5.

The only descriptive measure modified from the default linear conversion was historical worth, where 'low' worth was changed from a default of zero to 10%, and the other labels were equally spaced between 10% and 100% (Figure 5.18).

Figure 5.17

Goal Hierarchy of the Northern Territory Model

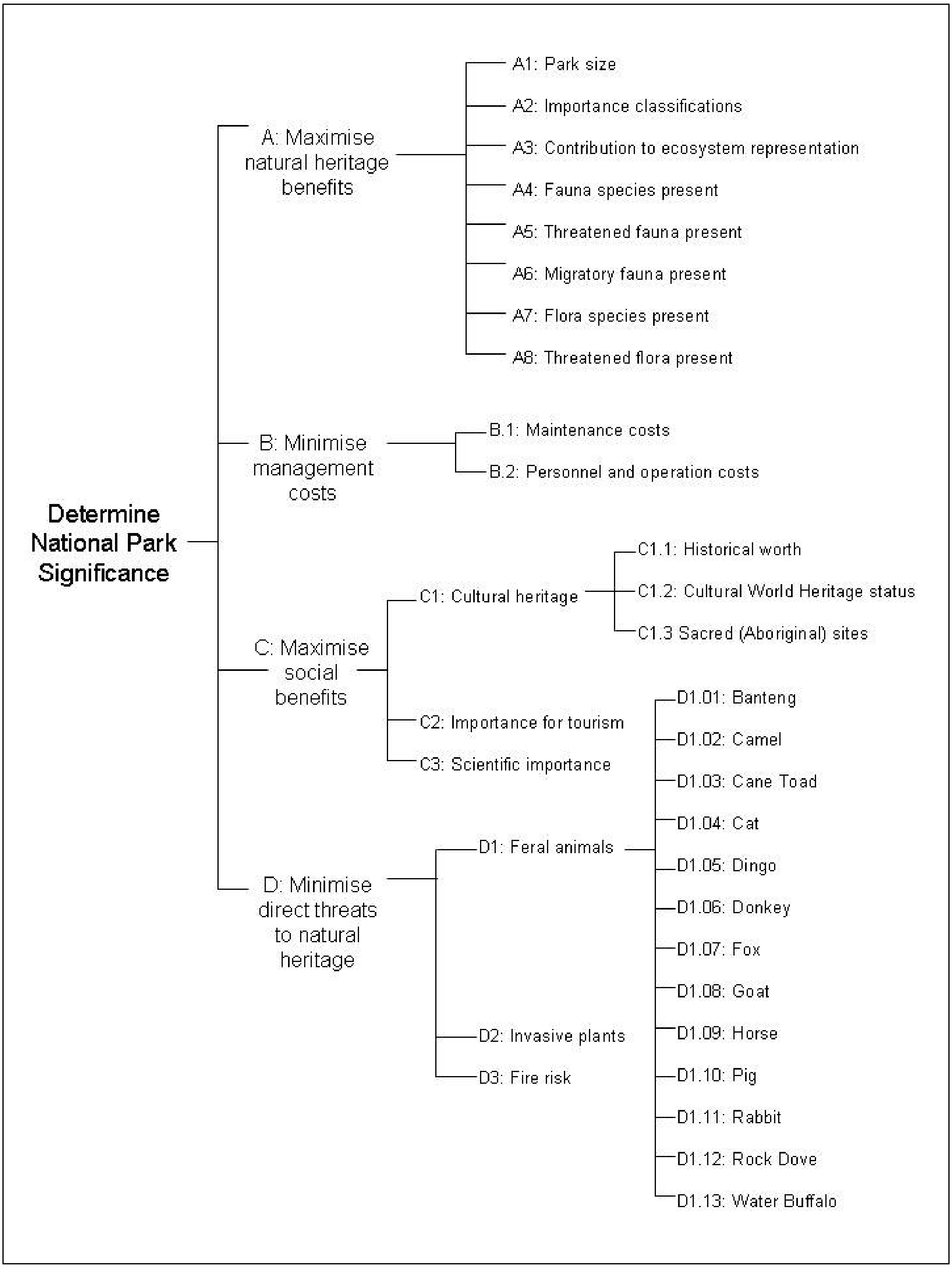
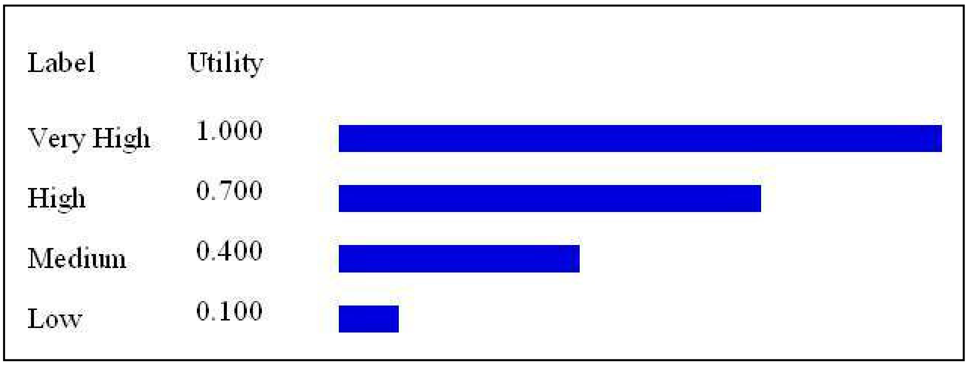


Figure 5.18

Modified Utilities for Labels on the 'Historical Worth' Measure



Weight Assessment

It was not feasible to undertake a Delphi focus group with the relevant PWCNT staff members because of the large geographic distances between offices. Furthermore, the chief district rangers live in or near certain national parks, far from the main urban offices. If adopted by a PAMA, a Delphi focus group exercise will be needed to elicit preferences. However, the significance rankings were already compromised by lack of financial data, so to demonstrate the usefulness of the model two preference set scenarios were applied. Weights were assessed using the SMARTER and AHP methods with a bias for natural heritage benefits, followed by a bias for social benefits.

For the 'Maximise natural heritage benefits' secondary goal, a conjoint analysis exercise was undertaken to gain an indication of the preferences of PWCNT Biodiversity Conservation staff (scientists). Conjoint analysis provides a quantitative measure of the relative importance of different attributes by asking a respondent to make trade-off judgements (Aaker, Kumar, & Day, 2004). Individual PWCNT staff were approached to take part in a ten minute long 'game', in which they were asked to order a set of cards. Staff members were told that they are responsible for allocating funds amongst a set of hypothetical national parks, where each park is described on a card. The variables on the cards were explained and the staff member was asked to order the cards from most important to least important.

The conjoint analysis exercise is not described in depth as it was not a key part of the methodology and is not recommended for future applications of the MCA model. The exercise is not statistically significant for such a small sample size (ten staff members). However, the results indicated that park size is most important, followed by ecosystem representation, threatened species, and the number of species present. The importance classifications measure was least important. These preferences were loosely expressed in the weight assessment exercises.

The final weighting stage for each preference set is defining the weights for the overall goal. For the assessments with the natural heritage bias, preferences for the secondary goals in descending order of importance were: 'A: Maximise natural heritage benefits', 'D: Minimise direct threats to natural heritage', 'B: Minimise management costs', and 'C: Maximise social benefits'. This order was changed for the socially biased assessment, where sub-goals A and C swapped position. The weights generated in each preference set are shown in Table 5.20.

Table 5.20

Measure and Goal Weights with each Preference Set for the Northern Territory Model

Weighted element	**SMARTER (natural heritage bias)**	**SMARTER (social bias)**	**AHP (natural heritage bias)**	**AHP (social bias)**
Overall goal: Determine National Park Significance				
A: Maximise natural heritage benefits	0.5208	0.0625	0.5558	0.0553
B: Minimise management costs	0.1458	0.2708	0.1364	0.2622
C: Maximise social benefits	0.0625	0.5208	0.0489	0.5650
D: Minimise direct threats to natural heritage	0.2708	0.1458	0.2589	0.1175
Secondary goal A: Maximise natural heritage benefits				
A1: Park size	0.3397	0.3397	0.3193	0.3193
A2: Importance classifications	0.0156	0.0156	0.0247	0.0247
A3: Contribution to ecosystem representation	0.2147	0.2147	0.1851	0.1851
A4: Fauna species present	0.0793	0.0793	0.0964	0.0964
A5: Threatened fauna present	0.1522	0.1522	0.1446	0.1446
A6: Migratory fauna present	0.0335	0.0335	0.0402	0.0402
A7: Flora species present	0.0543	0.0543	0.0636	0.0636

Weighted element	SMARTER (natural heritage bias)	SMARTER (social bias)	AHP (natural heritage bias)	AHP (social bias)
A8: Threatened flora present	0.1106	0.1106	0.1260	0.1260
Secondary goal B: Minimise management costs				
B1: Maintenance costs	0.5000	0.5000	0.5000	0.5000
B2: Personnel and operation costs	0.5000	0.5000	0.5000	0.5000
Secondary goal C: Maximise social benefits				
C1: Cultural heritage (goal)	0.6111	0.6111	0.6370	0.6370
C2: Tourism importance (visitor numbers)	0.2778	0.2778	0.2583	0.2583
C3: Scientific importance	0.1111	0.1111	0.1047	0.1047
Sub-goal C1: Cultural heritage				
C1.1: Historical worth	0.3333	0.3333	0.1429	0.1429
C1.2: Cultural World Heritage Site status	0.3333	0.3333	0.5714	0.5714
C1.3: Sacred (Aboriginal) sites	0.3333	0.3333	0.2857	0.2857
D: Minimise direct threats to natural heritage				
D1: Feral animals (goal)	0.6111	0.6111	0.6370	0.6370
D2: Invasive plants	0.1111	0.1111	0.2583	0.2583
D3: Fire risk	0.2778	0.2778	0.1047	0.1047
D1: Feral animals				
All 13 measures equally weighted	0.0769	0.0769	0.0769	0.0769

For all the preference sets, the measures of the secondary goals ‘B: Minimise management costs’ and ‘D1: Feral animals’ were given equal weights. Measures of the sub-goal ‘C1: Cultural heritage’ were given equal weight in the SMARTER assessments. However, these were modified in the AHP assessments. The bias of each preference set is only evident in the weights for the secondary goals. The measure and sub-goal weights are identical for both of the SMARTER assessments and both of the AHP assessments.

In addition to the SMARTER and AHP methods, the weights used by LDW to rank the alternatives after the common units conversion (without a formal weight assessment) are presented in the table. The danger of not undertaking the weight assessment stage in LDW is that weights are equally distributed amongst the measures, giving the greatest weight to the secondary goal with the most measures. For the NT model, the 'minimise direct threats to natural heritage' goal has the greatest number of measures and consequently received a weighting of 0.500.

5.2.3 RESULTS

The national park rankings for each of the five preference sets are shown in Figure 5.19, Figure 5.20, Figure 5.21, and Figure 5.22. In each of the stacked bar graphs, natural heritage benefits are shown in black, management costs are shown in red (where a longer bar represents lower management costs), social benefits are shown in green, and threats are shown in yellow (where a longer bar represents fewer threats). A summary of the change in utility of each park between the AHP preference sets is shown in Figure 5.23.

From Figure 5.23 it can be seen that the overall utility of every park differs with a social or natural heritage bias. The size of this difference is dependant upon the characteristics of each park. Gregory National Park and Limmen National park, for example, have the best utilities with the natural heritage biased preference set. However, with the social bias weight assessment, these parks have some of the lowest utilities. This indicates that these parks have high natural heritage significance, but that they are not areas with high social importance.

The national parks from the NT's southern Alice Springs administration region – Davenport Range, Finke Gorge, Watarrka, and West MacDonnell national parks – feature less prominently than the Top End parks in the ranking with natural heritage bias. These parks are of moderate size and the harsh arid environments support fewer species than the humid tropics.

Figure 5.19

Park Rankings with SMARTER Weight Assessment biased towards Natural Heritage Benefits

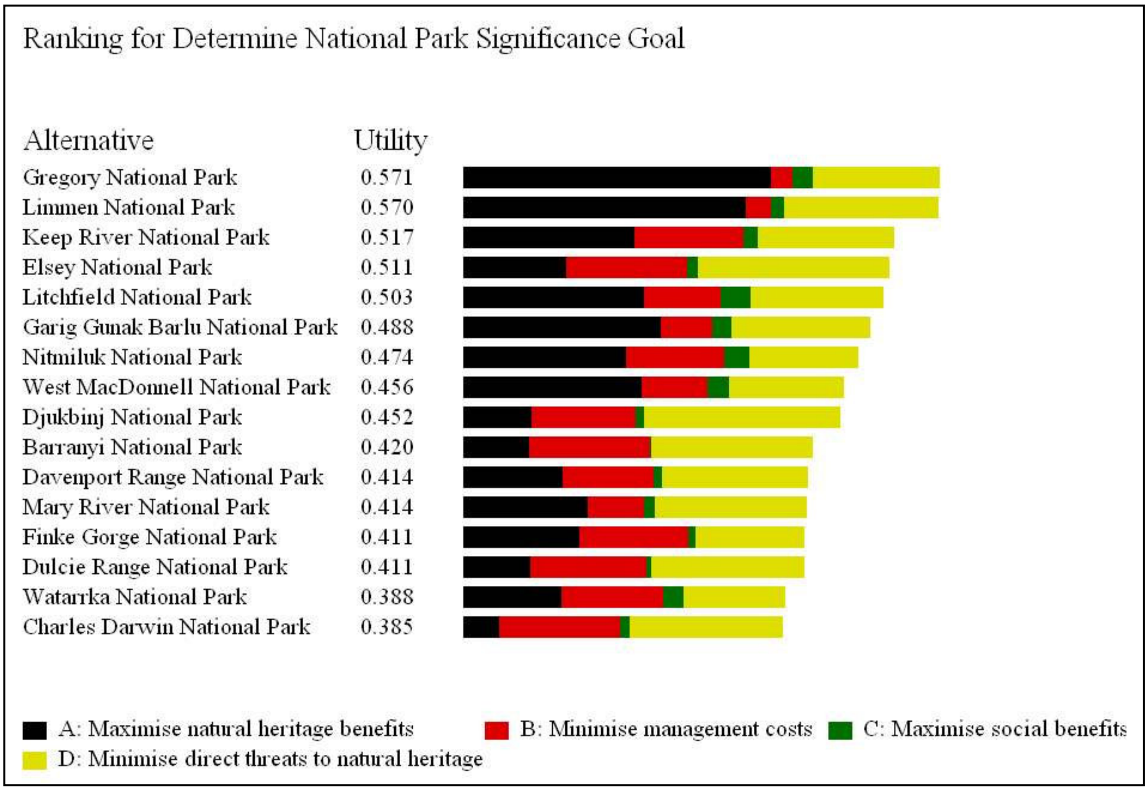


Figure 5.20

Park Rankings with AHP Weight Assessment biased towards Natural Heritage Benefits

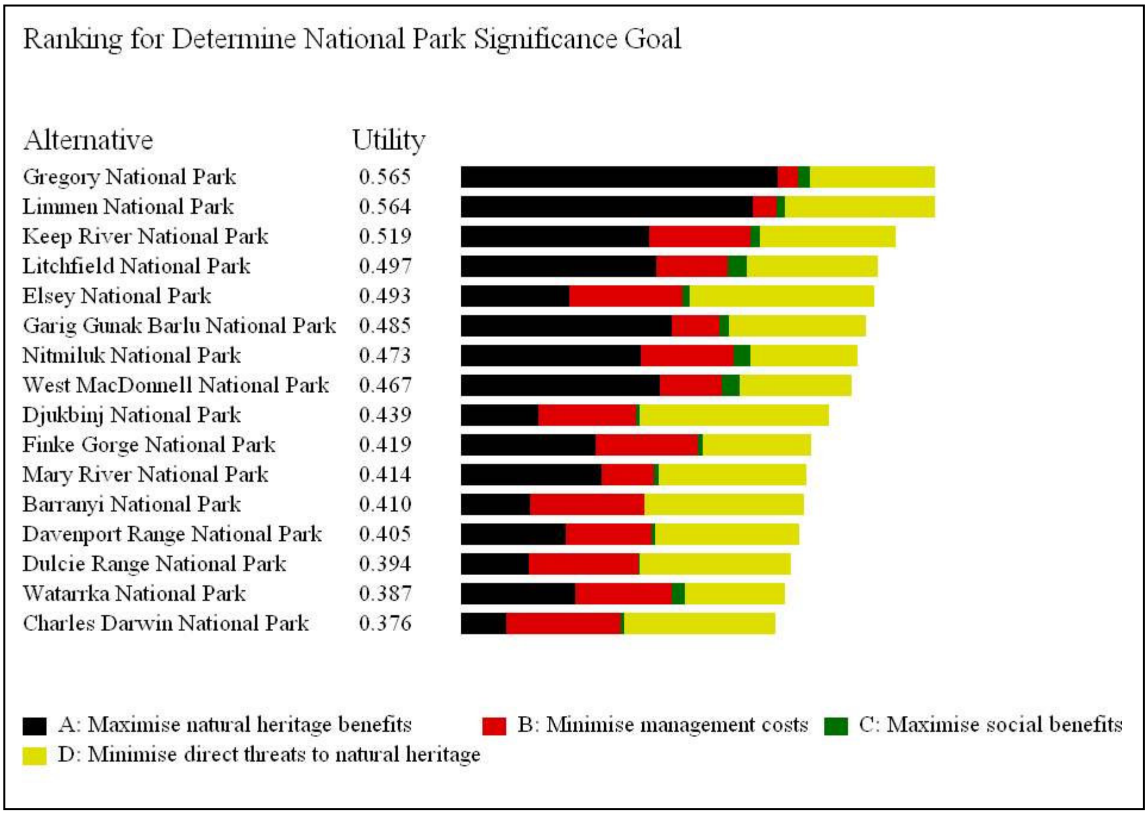


Figure 5.21

Park Rankings with SMARTER Weight Assessment biased towards Social Benefits

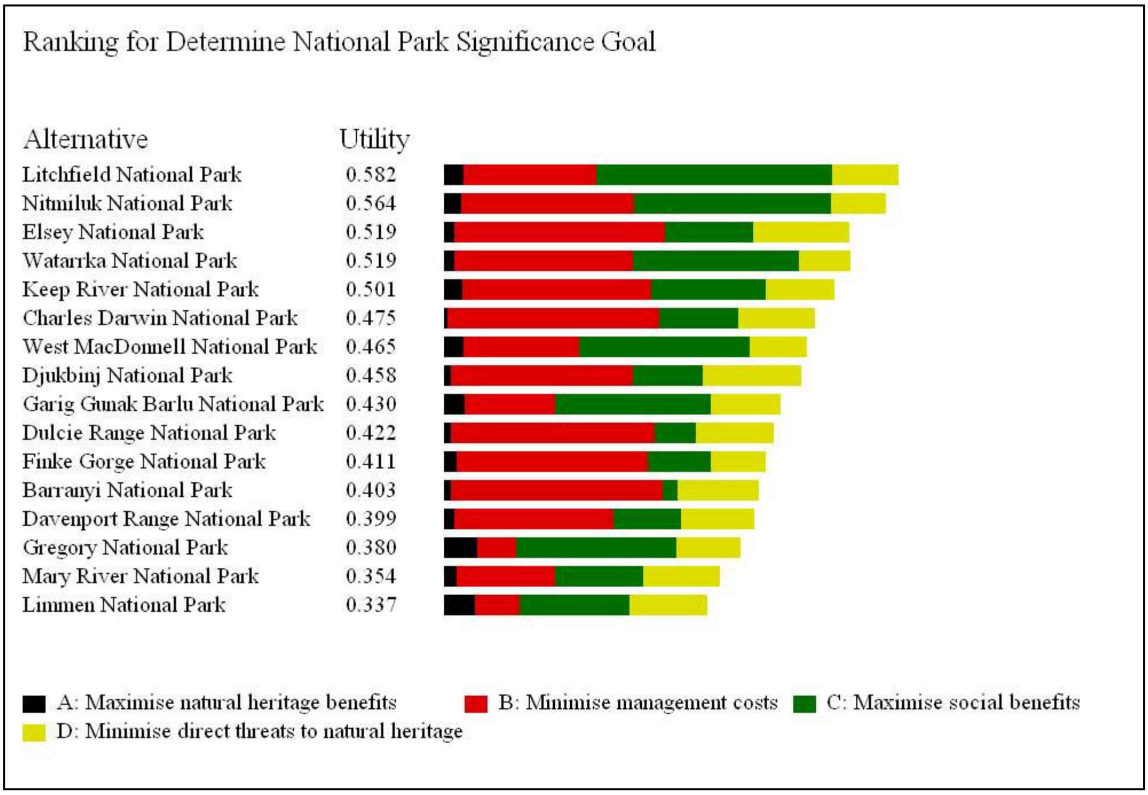


Figure 5.22

Park Rankings with AHP Weight Assessment biased towards Social Benefits

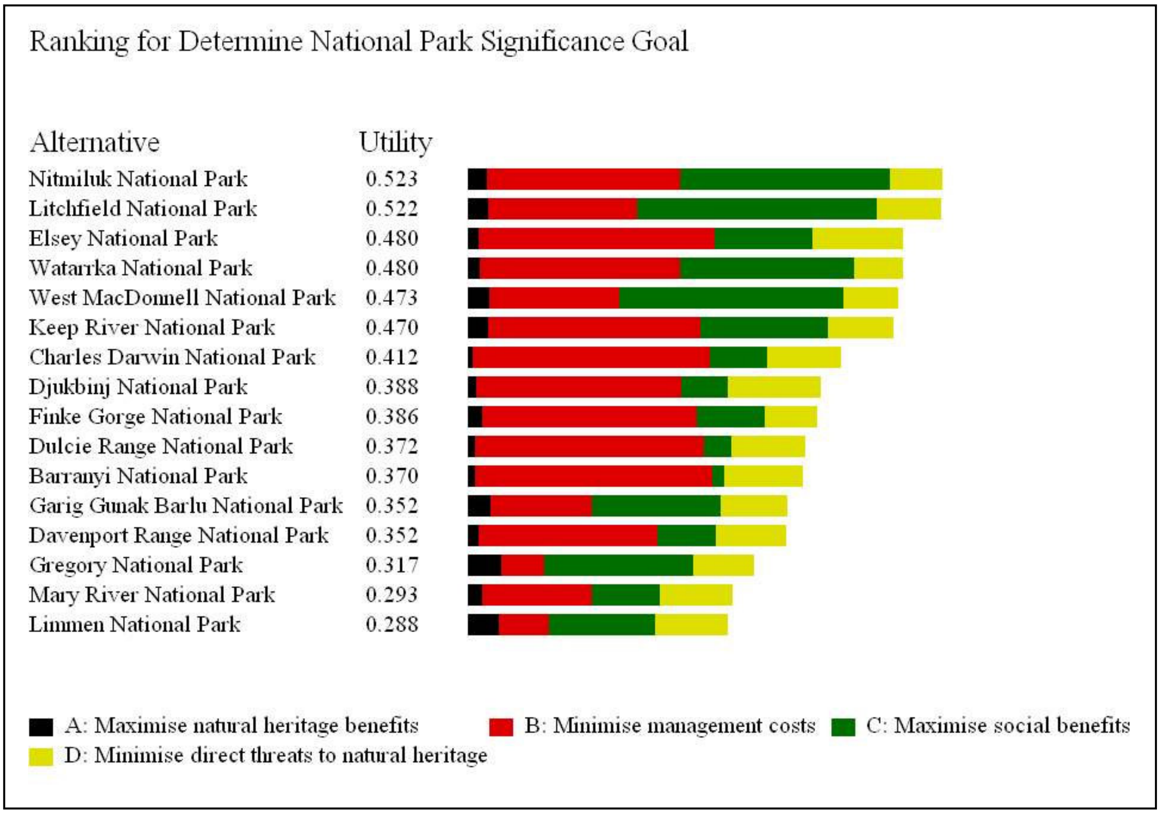
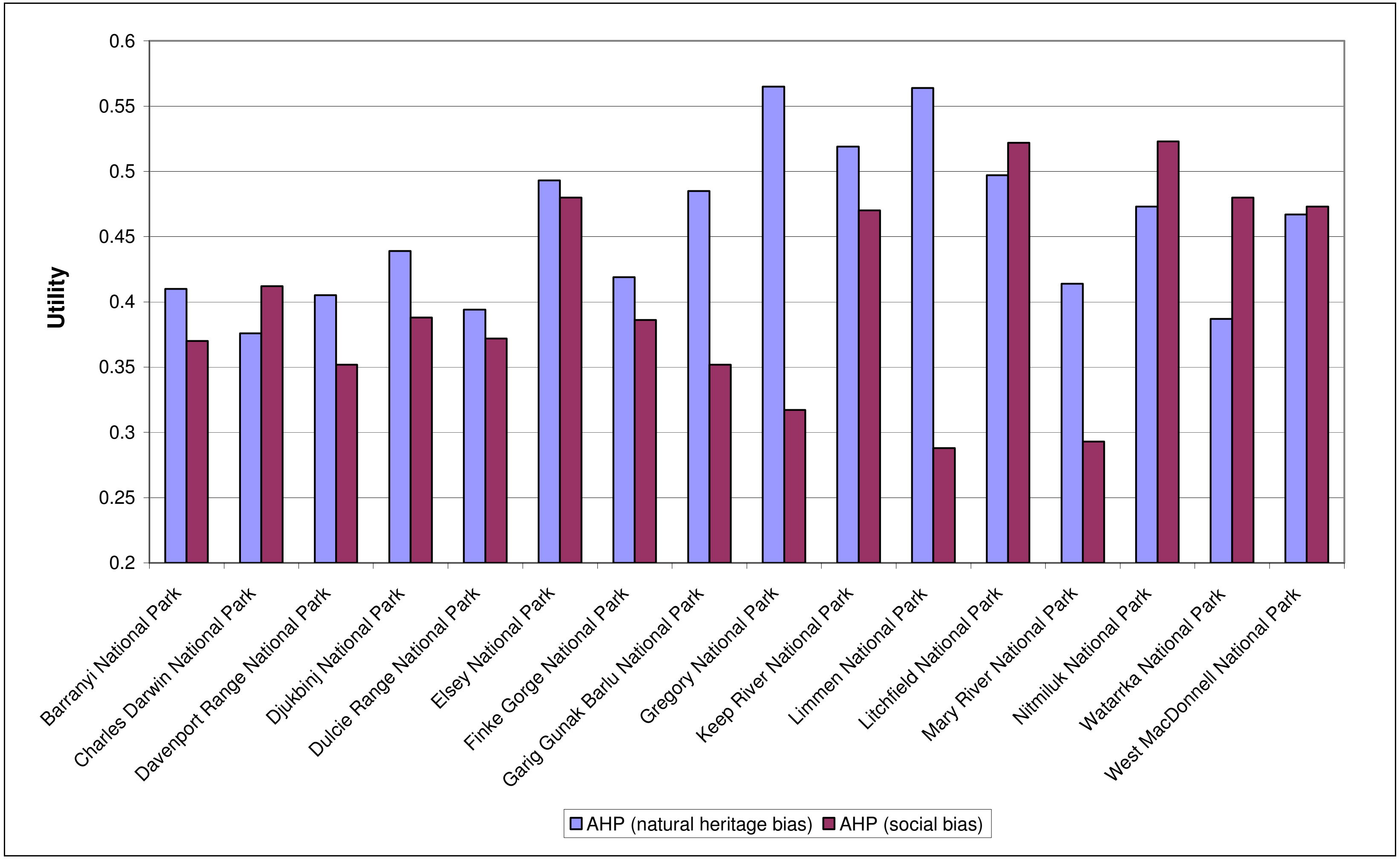


Figure 5.23

Comparison of National Park Utility with Biased AHP Preference Weightings



The radar plots in Figure 5.24 and Figure 5.25 show the four parks with the highest and lowest rankings in each of the AHP weighted analyses. The scale shown is utility, where the 'park significance' axis shows the total utility (ranking) for the parks. Each of the other axes shows the utility of the parks for the secondary goals. In addition to the four national parks, the goal weight is depicted as a dashed polygon. This line always intercepts the 'park significance' axis at one because the combined weight of the secondary goals always sums to one. The shape of the dashed polygon clearly indicates the weight bias for each assessment. The shape of national park polygons, and their interception points on the 'park significance' axis are modified in accordance with the weight bias.

Charles Darwin National Park is one of the NT's smallest national parks, so it has a low utility for the 'natural heritage benefits' secondary goal. However, it has moderate social benefits and this is reflected in the assessment with social bias. The small size of this park improves the park's rank for management costs, because these were allocated on a per hectare basis. With accurate management cost data, the rankings for this park, and other parks, may change significantly.

Figure 5.24

Utilities for Selected Parks with AHP Weight Assessment biased towards Natural Heritage Benefits

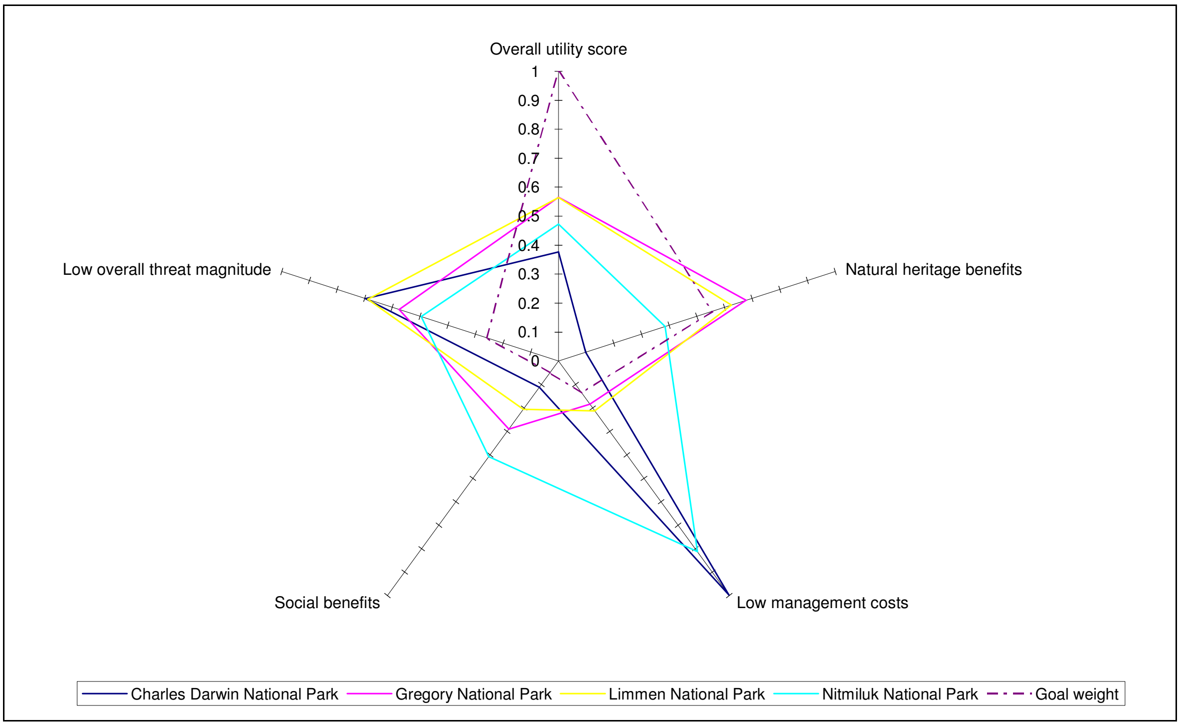
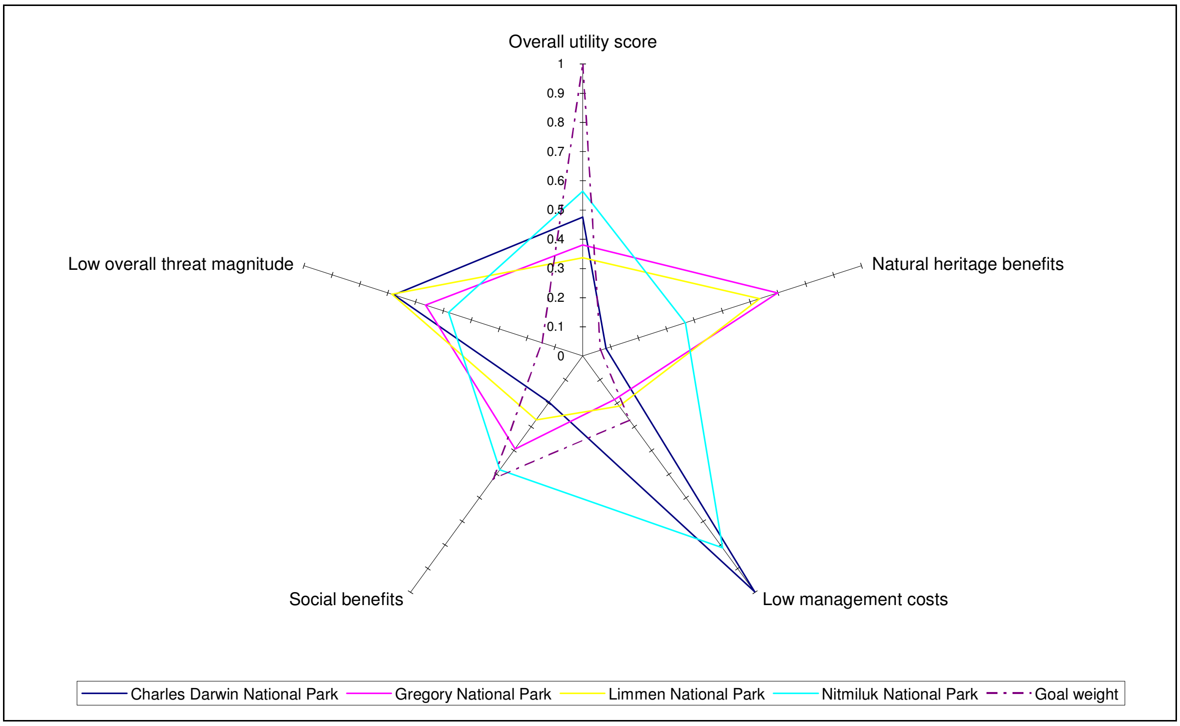


Figure 5.25

Utilities for the Selected Parks with AHP Weight Assessment biased towards Social Benefits



5.2.4 ASSUMPTIONS AND LIMITATIONS

There are assumptions and limitations associated with the development of the NT model structure, the levels entered on each measure for each park, and the assessment of preferences. Many of these assumptions were discussed in section 5.2.1 and are briefly re-stated here. The model is hindered by lack of specific financial data and the poor quality of species presence data.

Model structuring

The model structuring phase involved defining the set of alternatives to be ranked, defining measures to describe the alternatives, and organising the measures and goals into a goals hierarchy. According to the Masterplan (Northern Territory Department of Natural Resources Environment and the Arts, 2005), all proposed national parks and proposed national park extensions are to be declared as a matter of importance. The PWCNT national park data layer includes these proposed areas so these were included as alternatives in the analysis. The NT model only includes measures for which data are available. This means that measures of endemic flora and fauna, importance for recreation, and scenic importance do not feature in the model.

Measure Levels

There are limitations associated with the data used as measure levels in the analysis. The polygon layer for national parks was smoothed in ESRI® ArcMap™ so that each park (aside from the three parks comprised of geographically separate areas) is represented by one polygon that encompasses roads and some other features that are not legally part of the national park. The rationale for this is that species records located within these features should be counted as occurring within the relevant park.

Assumptions were made regarding the natural heritage measures. Three of the parks are comprised of two or more large geographically separate areas. Because each of the areas is greater than 1,000 ha (parks smaller than 1,000 ha are susceptible to negative edge effects), these areas were simply added together to determine each park's size. Because the NT remains in a relatively natural state, it is assumed that the 'habitat continuity' for all parks is excellent and this measure was removed from the model.

For the 'contribution to ecosystem representation' measures, the ecosystems protected in Kakadu and Uluru Kata-Tjuta national parks were incorporated into the ecosystem importance score. These parks are not managed by PWNCNT, but offer the same level of ecosystem protection as the other national parks in the NT so this protection was reflected in the importance scores. Some of the NT parks include a marine element and this was treated as a type of bioregion. Furthermore, the analysis assumes that the biogeographic region data are accurate, but ground-truthing has not been undertaken for the boundaries of all regions and the NT's IBRA assessment is less accurate than the assessments undertaken in other Australian states (B. Sparrow, personal communication, 29 June 2005);

The species presence data forms the basis of the threatened species, migratory species, feral animal species, and invasive plants levels. However, the flora and fauna point data, based on surveys and observational records, is wrongly used to infer the presence and absence of species. The data are opportunistic, as opposed to a systematic inventory of the NT environments (B. Sparrow, personal communication, 29 June 2005). By using this data in the NT model, it is assumed that it accurately reflects the presence and absence of species. It is assumed that the threat status data for all species is up-to-date and accurate.

Access to financial information was denied at the park level. In order to include financial data in the analysis, regional-level cost information was distributed equally amongst applicable parks on a per hectare basis in the analysis. The resulting cost information per park does not reflect the true costs of management and this inaccurate data will modify the ranking results. However, if the PWCNT were to adopt the model, accurate financial data could be used. Without operational budget information for each park, it is not clear how individual parks rank in terms of current resource allocation, and it is not possible to compare these rankings to those generated with the NT model.

Descriptive data derived from the Masterplan and Plans of Management (POMs) for each park was used for some of the social measures. The robustness of information derived from documents is limited because they were not developed to provide inventories for comparative purposes. Further, POMs are not available for all of the national parks managed by PWCNT, and some of the POMs are dated. It is assumed that the process of determining the historical worth of each park, determined from relevant PWCNT publications, is fair and accurate. PWCNT is renewing all POMs in line with the joint management process in place so this situation will improve.

Assumptions were made regarding other social measures. The sacred sites ESRI® ArcMap™ point Data are used with the assumption that all sites have equal importance. Visitor Data are assumed to accurately reflect the popularity of each park with tourists. Data was not available for Djukbinj National Park, so the mean visitor numbers for the Type 2 (low visitation) parks was used in the analysis. Data used in the analysis is derived from different time periods: 2004 visitor data, June 2005 species records, and refereed articles published 2000-2005. Visitor and species data represents the latest available data. However, the additional year was included in the publication data because the large (in relative terms) number of articles published in 2005 markedly increases the size of the dataset, providing more meaningful information.

For the threat analysis, it is assumed that the expert rating is a fair and accurate method of determining the threat magnitude of feral animals and invasive plants in each national park. Similarly, it is assumed that using understorey vegetation species as a surrogate for the susceptibility of an area to fire is fair and consistent.

Preference Assessments

The preference assessment involves entering most and least preferred levels for each measure, defining the weights for measure categories, converting incommensurate levels into common units of utility, and undertaking weight assessment to rank the alternatives. The primary limitation with the preference expression phase of the model is that preference for areas facing low threat over those facing high threat, or *visa versa*, must be specified in the model at the state where the least preferred and most preferred levels are specified for each measure. The model was built assuming that low threat is most preferred. This means that the best ranking results reflect the parks facing the lest threat from feral animals, fire, and weeds. In future applications of the model, the Delphi group must reach consensus on preference for parks facing high or low threat. The analyst must check that the least and most preferred levels specified in LDW reflect this preference before the model is evaluated.

The measure category weights and common unit conversion SUFs for each measure are assumed to be fair and accurate. These conversions should be outlined in the Delphi group so that participants have a good understanding of what the model entails. If concerns are raised, these assumptions could be modified accordingly.

The weight assessment preferences expressed in the analysis presented here are arbitrary. The weights used in these rankings do not reflect the preferences of PWCNT managers or staff. The results simply illustrate how the utility of each park changes with different weights. These results should in no way be used to influence the decision-making at PWCNT without accurate financial data and a weight assessment representative of the PWCNT’s priorities.

5.3 PILOT STUDY B: THE NATIONAL PARKS OF NEW ZEALAND

In New Zealand, the Department of Conservation (DOC) is responsible for the management of 14 national parks, along with other protected areas throughout the country. Further information about national park management in New Zealand (NZ) is detailed in Appendix B.

Strategic mangers at the DOC were anxious to support any research that can potentially improve prioritisation. However, managing around parks is not the basis on which the DOC operates. This lack of park-focus also meant that DOC could not easily provide the required information. The spatial species distribution database ‘BioWeb’ maintained by the DOC is not of good quality and it is hard to extract information of relevance. Because financial costs are coded to regional activities, rather than geographic areas, it is extremely difficult and time-consuming for the DOC to calculate spending on a per-park basis.

At the time DOC was approached, there was a major project underway to collect information about the characteristics of conservation land in NZ for a Natural Heritage Management System (NHMS) to improve conservation management. Concern was expressed that this research on prioritisation within a park-focussed management paradigm might undermine the work being done on the NHMS. In light of these concerns, the New Zeland pilot study was restricted to information available within the public domain through national park management plans and resources on the DOC website (www.doc.govt.nz).

In accordance with the National Parks Act 1980, every national park in NZ must have a national park management plan (NPMP) that provides for the management of the park. NPMPs are reviewed at least every ten years, and are jointly prepared by the relevant Conservancy in consultation with its Conservation Board and representatives from tāngata whenua (the indigenous Māori people) and other interested groups and individuals (Department of Conservation, 2003). The structure of the NPMPs is similar, but the detail of information is inconsistent from one plan to another.

A sample of only four parks was adopted for the analysis for two reasons. First, in analysing a subset of New Zealand’s 14 national parks, the results will do less to undermine the work being undertaken by the DOC. Second, it is imperative that reasonable measure levels are available for each alternative analysed. Visitor statistics are available on the DOC website for six of the national parks. Four of these parks are also UNESCO World Heritage Areas. The application process for World Heritage status involves detailed inventory data and, accordingly, the national park management plans for these are the most informative. Thus, the four national parks analysed are: Aoraki/Mt. Cook National Park (NPMP published 2004 by the Canterbury Conservancy), Fiordland National Park (NPMP published 2007 by the Southland Conservancy), Tongariro National Park (NPMP published 2006 by the Tongariro/Taupo Conservancy), and Westland/Tai Poutini National Park (NPMP published 2001 by the Westland/Tai Poutini Conservancy).

5.3.1 DEVELOPING THE NEW ZEALAND MODEL

The structure of the NZ model was limited by the data available. Using the measures from the original model as categories, relevant information was extracted from the four NPMPs. The levels for visitor numbers, habitat continuity, and scientific importance were not available from the NPMPs and were derived from other publicly available sources. These are shown in Table 5.21. A summary of the information derived from the NPMPs is shown in Table 5.22. A description of the NZ model's structure follows.

Table 5.21

New Zealand National Park Data from other Publicly Available Sources

Measure	Aoraki/Mt. Cook National Park	Fiordland National Park	Tongariro National Park	Westland/Tai Poutini National Park
Habitat continuity	Good	Very good	Moderate	Good
Visitor numbers (2007)	159,000	415,200	100,600	364,000
Refereed articles published (2003-2007)	4	7	3	2

Table 5.22

New Zealand National Park Data from the National Park Management Plans

Measure	**Aoraki/Mt. Cook National Park**	**Fiordland National Park**	**Tongariro National Park**	**Westland/Tai Poutini National Park**
Size (ha)	70,728	1,260,740	79,598	117,608
Special conservation areas	None stated	2 x Specially Protected Area 3 x Wilderness Area	2 x Wilderness Area 2 x Pristine Areas	None stated
Fauna present	Amphibians: - Birds: 30 Fish: - Invertebrates: 700+ Mammals: - Reptiles: -	Amphibians: - Birds: 14 listed Fish: 14 listed Invertebrates: 3000+ Mammals: 4 listed Reptiles: 5	Amphibians: - Birds: 7+ listed Fish: 14 listed Invertebrates: - Mammals: 1 Reptiles: -	Amphibians: - Birds:36 listed Fish: 15 Invertebrates: - Mammals: - Reptiles: -
Threatened fauna	2 x nationally endangered 2 x nationally vulnerable 1 x nationally critical 1 x serious decline	1 x critically endangered 6 x "threatened" birds	Not stated	8 x "rare nationally"
Flora present	Not stated	Not stated	550 + species	600+ species
Threatened flora	1 x serious decline 2 x range restricted 1 x sparse	18 x "rare"	Not stated	Not stated
Scientific importance	"national importance" (p.11)	Not stated	Not stated	"national importance" (p. 13)
Education	Visitor centre	2 visitor centres	Visitor centre	Visitor centre
Cultural WHS	No	No	Yes	No
Historic heritage	"local interest" (p.11) 11 known or potential sites	35 sites actively managed	7 actively managed sites, 21 passively managed sites stated	"local interest" (p. 13) 15 sites actively managed
Māori spiritual significance (High/ Moderate/ Low)	Tōpini in place (High)	Tōpini in place (High)	A spiritual home of the Māori people, Pristine Areas declared in part to protect spiritual values (High)	Important, but less so that parks with Tōpini in place (Moderate)

Measure	Aoraki/Mt. Cook National Park	Fiordland National Park	Tongariro National Park	Westland/Tai Poutini National Park
Recreation importance (Very High/ High/ Moderate/ Low)	International recognition for mountain climbing (Very High)	World renowned tramping, 2 Great Walks, finest alpine rock climbing in NZ (Very high)	Nationally significant for recreation, sites with high international use, ski fields used by North Island residents (High)	Internationally recognised (Very high)
Scenic importance (Very High/ High/ Moderate/ Low/ Very Low)	Icon status with highest mountain (High)	International attraction, fiords (Very high)	Dominates the landscape, significant reason for gazettal (Very high)	Internationally recognised (Very high)
Participation	Legislated consultation	Legislated consultation	Legislated consultation, “co-operative conservation management”, Ngāti Tūwharetoa permanent position on the park board.	Legislated consultation
Threats – weeds	Over 130 introduced plants	12 listed	2 (of many more) listed	Limited to disturbed sites and rarely troublesome
Threats – feral animals	10 species specified, non-indigenous fish and bird (15 species) are “insignificant” (p. 58)	12 listed	8 listed	12 listed
Threats – other	Aircraft noise (impacts on visitors) Climbers on Aoraki summit (spiritually offensive to Ngāi Tahu) Bolting of rock climbing routes Bodily human waste disposal by climbers	Visitor damage – trampling, weed dispersal, inappropriate waste disposal Land use up river – weed infestation, sediment, elevated nutrient loads Hydroelectric power – minimum flows established	Visitor damage (very high numbers) Bolting and vegetation removal by rock climbers	Aircraft noise (impacts on visitors) Bolting of rock climbing routes

Measures of Natural Heritage

The natural heritage section of the NZ model was severely limited by lack of data. The original model has eleven measures of natural heritage and the NT model has eight, but there are only three viable measures for the NZ model.

Park size

Park size information was readily available in the NPMPs.

Habitat continuity

Habitat continuity was determined from observations of New Zealand satellite imagery accessed viewed online through Google Maps (http://maps.google.co.nz). Some of the NPMPs commented on aspects of adjacent land use and this was taken into account where available.

International designations

No international designations were evident from the NPMPs or internet searches, aside from UNESCO World Heritage Site status. Because all of the national parks assessed are natural World Heritage Sites, this measure was removed from the model.

Special Conservation Areas

Some of the national parks have special conservation area zones that are afforded recognition to protect important natural attributes. Wilderness Areas are category Ib protected areas, "managed mainly for wilderness protection" (IUCN-WCMC, 1994, p. 3) and do not have visitor facilities. Under section 12 of the National Parks Act 1980, any part of a national park can be set apart as a 'specially protected area'. Fiordland National Park has two of these areas, which are intensively managed and require restrictions on human access. One has been set aside to manage the sole remaining wild population of the flightless takahē bird (*Porphyrio mantelli*) living in its natural habitat. The other protects a fragile cave and karst system from excessive visitor use (Department of Conservation, 2007). In Tongariro National Park, the alpine zone of Mount Ruapehu and the alpine zone of Mount Tongariro/Mount Ngauruhoe have been set aside as 'pristine areas' in recognition of outstanding cultural heritage and landscape attributes. Infrastructure is forbidden in the pristine areas and management is focussed on preserving landscape characteristics (Department of Conservation, 2006b). A new measure, 'special conservation areas' was added to the model to incorporate these areas into the analysis.

Contribution to ecosystem representation

Information about the contribution of each park to ecosystem representation was not available for this analysis. Levels for this measure could be calculated based on the Land Environments of New Zealand (LENZ) classification, which divides New Zealand into 20 national-scale environments and 500 regional/district-scale environments (Leathwick, Wilson, Rutledge, Wardle, Morgan et al., 2003). The DOC has access to GIS data for LENZ ecosystems and national park polygons, so this measure would be viable if the DOC were to adopt a tool such as the one developed in this research.

Species-level measures

Neither the total number of fauna and flora species, nor the total number of threatened species in each park is evident from the NPMPs. The DOC has developed a national system for classifying species according to threat of extinction. This system is similar to the IUCN Red List, but takes into account the geographic and ecological characteristics of NZ, including the large number of species with naturally restricted ranges and small population sizes (Molloy, Bell, Clout, de Lange, Gibbs et al., 2002).

Without basic species-presence data, it is impossible to determine:

- The number of threatened species present;
- The number of endemic species present (a list of endemic birds is available online at Wikipedia); and,
- The number of migratory fauna present (according to the appendices of the Convention, which are available online).

All species-level measures were consequently removed from the model.

Measures of Financial and Economic Benefits

No information was available to represent financial factors in the model, so the 'Maximise financial benefits' goal was removed from the model. Interestingly, the Tongariro NPMP mentions the substantial regional economic significance of the park, including the employment opportunities it creates, and the park's ecosystem services function as a soil and water conservation area with dependant hydroelectric power systems, town water supplies, and downstream recreational pursuits (Department of Conservation, 2006b). Research into the economic contribution from the ski fields on Mount Ruapehu in Tongariro National Park found that for every dollar spent by a visitor to the ski fields, 42 cents of income is generated for the local economy, and for every $10,000 spent by visitors, 0.47 jobs (seasonal and full time) are created (New Zealand Tourism Research Institute, 2002).

The Westland/Tai Poutini NPMP makes similar mention of the regional and economic benefits from Westland tourism (Department of Conservation, 2001). In an assessment of the economic contribution of conservation areas in the DOC's West Coast Conservancy, which includes Westland/Tai Poutini National Park, conservation lands were found to generate output of $222 million, support 12 % of regional value added, 13 % of regional earned household income, and 15 % of regional employment (Department of Conservation, 2004).

In a similar study, Fiordland National Park was found to have added NZ$228 million to the NZ economy in 2005 (Department of Conservation, 2006a). The Fiordland study is the only one that is concerned with the overall contribution of the park to the national economy. It is promising that such analyses are being undertaken in NZ because it means there is a real possibility of including economic information in future decision-making if the DOC were to adopt the model developed in this research.

Measures of Social Benefits

It was possible to determine levels for most of the social benefits measures, so this section of the model is the most comprehensive.

Scientific significance

A thorough database search of referred journals was undertaken using the Web of Science (version 4.2). The name of each park was used in a keyword search for articles published over the five years from start-2003 to end-2007. Citations and abstracts were checked for relevance to the natural and/or cultural environs of the current national park. Two of the NPMPs mention that the national park is of national scientific importance. However, these comments apply to the parks with the lowest number of refereed articles published over the five year period.

Significance for education

The significance of each national park for education is not evident in the NPMPs or from other data sources. Each of the national parks has a visitor centre specific to the park. Fiordland National Park has a second visitor centre maintained by the local community (Department of Conservation, 2007). This is likely to be a reflection of the vast size of the park, rather than the educational importance of it. The significance for education measure was excluded from the NZ model due to lack of meaningful information.

Cultural World Heritage Site status

Tongariro National Park was the first area in the world to receive UNESCO Cultural World Heritage Site status. It is the only national park in NZ with this status.

Historic landscape components

Each NPMP states the number of historic sites in the park that are either known, actively managed, or actively and passively managed. Some of the NPMPs list the specific sites. The total number of sites stated in the NPMP was taken to represent the number of historic landscape components occurring within the national park.

Māori spiritual significance

A new category, Māori spiritual significance, was added to the NZ model. The NZ NPMPs dedicate sizeable sections to discussion of the cultural, spiritual, and physical relationships of tāngata whenua (the Māori tribe or sub-tribe that has customary authority) with elements of the national park. This applies in particular to specific mountains, which the Māori view as creation deities.

In three of the four national parks, the spiritual significance of key features of the park to tāngata whenua are officially recognised. The Ngāi Tahu tribe has standing in the South Island of NZ, where Aoraki/Mt. Cook, Westland/Tai Poutini, and Fiordland national parks are located. A Tōpini is in place on the peaks of mountains in two of these parks. This derives from the tradional Ngāi Tahu custom of extending chiefly protection over a person or area. The Tōpini place an overlay of spiritual importance over the peaks (Department of Conservation, 2007). Tongariro National Park was established as NZ's first national park in 1887 when Ngāti Tūwharetoa, the tribe with standing in the region, gifted the sacred peaks of the three mountains that form the nucleus of the park, to the people of NZ to be protected in perpetuity. These peaks are seen by local tribes as the spiritual home of the people, and the 'pristine areas' of the park were declared in part to protect the sacredness of the peaks (Department of Conservation, 2006b).

The Māori spiritual significance measure has three descriptive labels, High – Moderate – Low. Aoraki/Mt. Cook, Fiordland, and Tongariro national parks were rated 'High' in accordance with the recognition of spiritual worth in place. The Westland/Tai Poutini NPMP discusses the important cultural bonds of Ngāi Tahu with the landscape, but there is not a Tōpini in place, so this park was rated 'Moderate'.

Visitor numbers

Estimates of the numbers of international visitors, aged 15 years and over, who visited selected NZ national parks at least once during their stay in NZ are available on the DOC's website. The Data are obtained from the international visitor survey which is conducted by the Ministry of Tourism. Data for 2007 was included in the model. The DOC also collects visitor information in visitor books throughout the country's backcountry hut network, and near the start of many walking tracks. This information includes both international and domestic visitor numbers. However, this data was not publicly available for the analysis.

Importance for recreation

The importance for recreation measure levels were determined from descriptions in the NPMPs. New Zealand does not have states, so the descriptive labels for the 'importance for recreation' measure were modified to reflect this.

Scenic significance

It was not possible to fairly determine the number of landscape types or importance of geological features from the NPMPs, so the descriptive 'importance for general sightseeing and tourism' scale used by Parks Victoria (c.2000) was adopted (see section 3.3.4). The scenic significance measure levels were determined from descriptions in the NPMPs.

Stakeholder participation

Consultation with tāngata whenua is a legal requirement in NZ and it is not clear from the NPMPs what degree of participation occurs. This measure was removed from the model due to data limitations.

Peaceful relations

The peaceful relations measure does not apply to an island nation so this measure was also removed.

Measures of Direct Threats to Natural Heritage

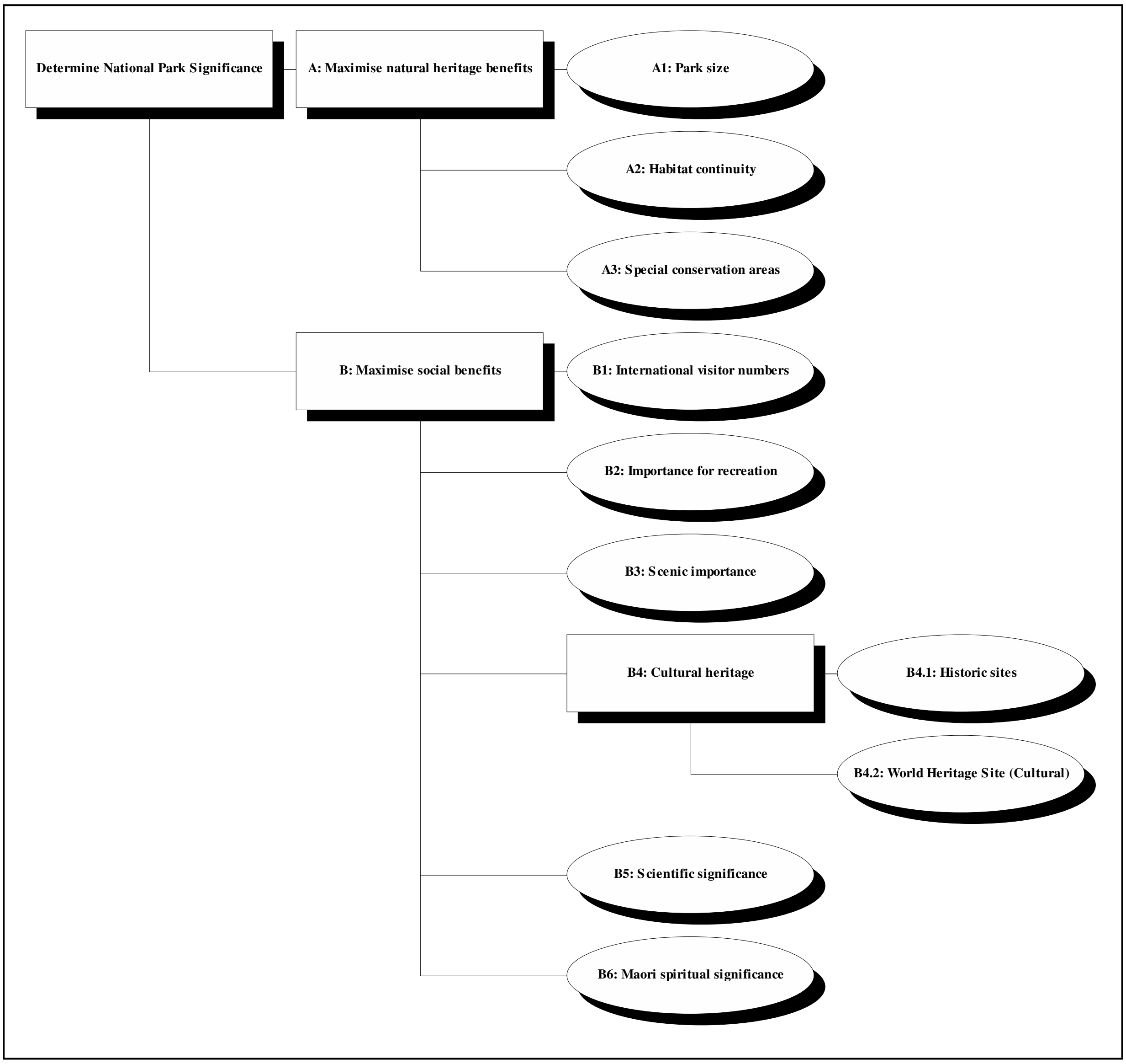
Information about threats within each park is limited in the NPMPs. For threat measures to be meaningful, the magnitude (scope and severity) of each threat within each park must be determined. This depth of information was not available, so the 'Minimise Direct Threats to Natural Heritage' goal was removed from the model.

The New Zealand Model

As a result of data limitations, the NZ model has only two secondary goals, 'maximise natural heritage benefit's and 'maximise social benefits'. There is one sub-goal, ten measures, and no measure categories. The full goal hierarchy of the NZ model is shown in Figure 5.26. The goal hierarchy for the NT model (Appendix C) is testament to the simplicity of the NZ model. With fewer measures, the influence of each measure on the final park ranking is much greater.

Figure 5.26

Goal Hierarchy of the New Zealand Model



5.3.2 ANALYSIS

The NZ model was assessed with the same preference sets as the NT model.

First, common unit conversions were undertaken. The SUFs for the 'park size' and 'historic sites' measures were modified to have a utility of 0.75 at the mid-point on the curve. The other measures were left with the default linear conversions.

Second, two preference sets were created using the SMARTER method for weighting. These sets are identical except that the first has a natural heritage bias for the overall goal weighting, and the second has a social bias for the overall goal weighting. For the cultural heritage sub goal, the cultural World Heritage Site measure was given preference over the number of historic sites. The ranking for the ‘maximise social benefits’ secondary goal is shown in Figure 5.27. In the rank ordering some of the measures were given equal importance. The ordering for the ‘maximise natural heritage’ secondary goal gave preference to park size, followed by special conservation areas and habitat continuity.

Figure 5.27
SMARTER Rankings for the ‘Maximise Social Benefits’ Secondary Goal in the New Zealand Model

Please enter the importance ordering for
B: Maximise social benefits

Importances must be between 0 and 6. Ties are allowed.
Lower numbers indicate more importance. 0 = no importance.

	Importance Order (1 = most)
B4: Cultural heritage Goal	1
B5: Scientific significance Measure	4
B1: International visitor numbers Measure	3
B2: Importance for recreation Measure	2
B3: Scenic importance Measure	2
B6: Maori spiritual significance Measure	1

Third, two preference sets were created using the AHP method for weighting. Like the SMARTER preference sets, one of the AHP sets has a natural heritage bias, and the other has a social bias.

The measure and goal weights are given for each preference set in Table 5.23. The bias weights are evident for the overall goal. Extreme weights were used to demonstrate how weight bias at this level of the assessment can influence the results.

Table 5.23

Measure and Goal Weights with each Preference Set for the New Zealand Model

Weighted element	SMARTER (natural heritage bias)	SMARTER (social bias)	AHP (natural heritage bias)	AHP (social bias)
Overall goal: Determine National Park Significance				
A: Maximise natural heritage benefits	0.7500	0.2500	0.8750	0.1000
B: Maximise social benefits	0.2500	0.7500	0.1250	0.9000
Secondary goal A: Maximise natural heritage benefits				
A1: Park size	0.6111	0.6111	0.6370	0.6370
A2: Habitat continuity	0.1111	0.1111	0.1047	0.1047
A3: Special conservation areas	0.2778	0.2778	0.2583	0.2583
Secondary goal B: Maximise social benefits				
B1: International visitor numbers	0.0917	0.0917	0.0639	0.0639
B2: Importance for recreation	0.1542	0.1542	0.1108	0.1108
B3: Scenic importance	0.1542	0.1542	0.1246	0.1246
B4: Cultural heritage	0.2792	0.2792	0.3198	0.3198
B5: Scientific significance	0.0417	0.0417	0.0317	0.0317
B6: Maori spiritual significance	0.2792	0.2792	0.3492	0.3492
Sub-goal B4: Cultural heritage				
B4.1: Historic sites	0.2500	0.2500	0.1250	0.1250
B4.2: World Heritage Site (Cultural)	0.7500	0.7500	0.8750	0.8750

5.3.3 RESULTS

The stacked rankings generated with each of the preference sets are presented in Figure 5.28, Figure 5.29, Figure 5.30, and Figure 5.31. In each of the graphs, the alternatives are presented in order of descending utility. The utility for the ‘maximise natural heritage benefits’ goal is always black on the graphs, and the ‘maximise social benefits’ goal is shown in red.

Figure 5.28

Park Rankings with SMARTER Weight Assessment biased towards Natural Heritage Benefits

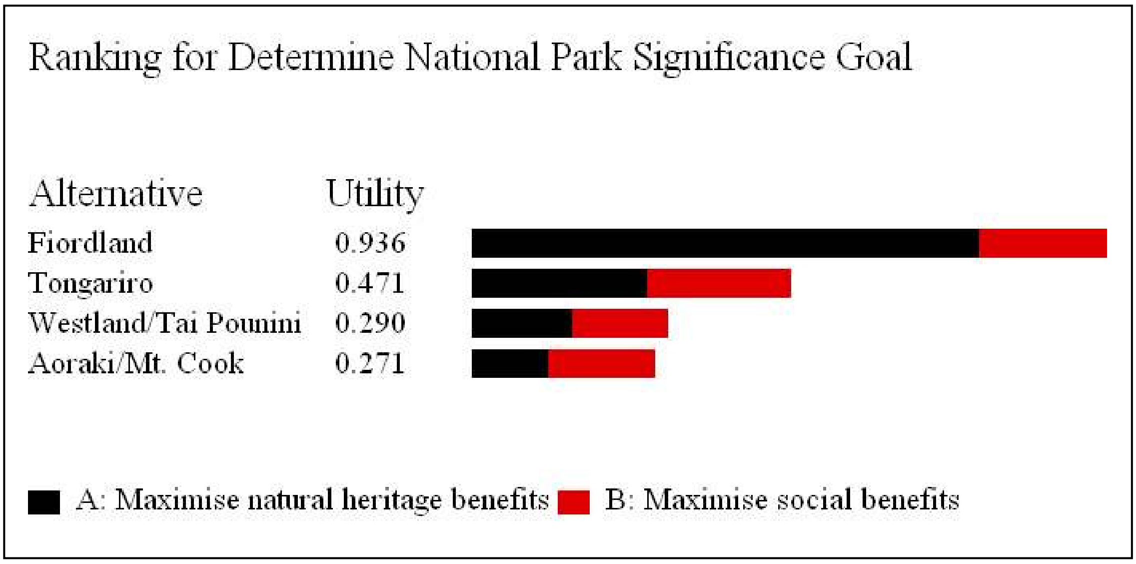


Figure 5.29

Park Rankings with AHP Weight Assessment biased towards Natural Heritage Benefits

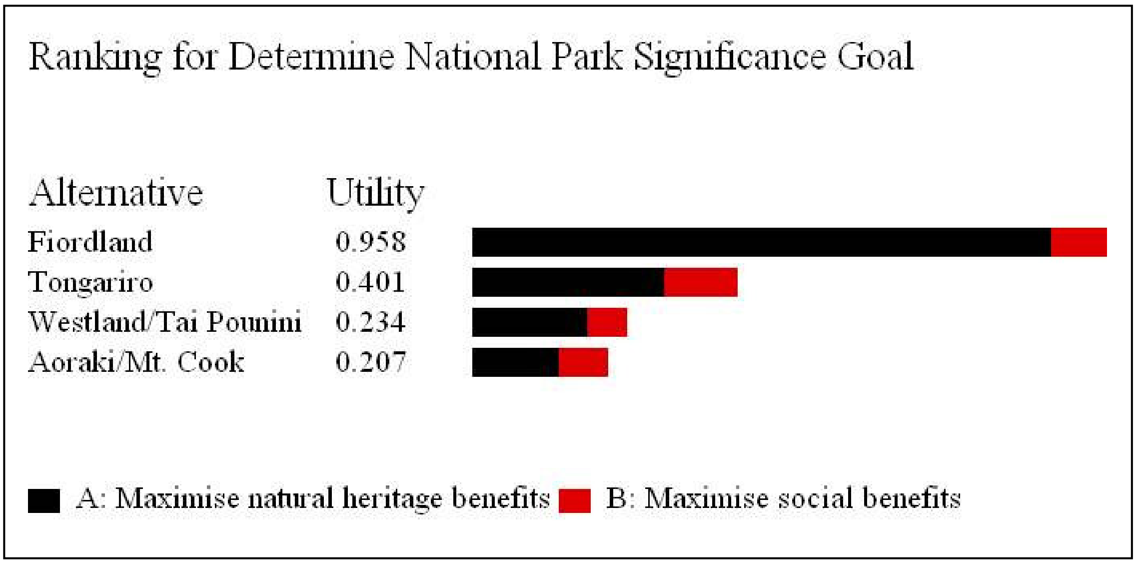


Figure 5.30

Park Rankings with SMARTER Weight Assessment biased towards Social Benefits

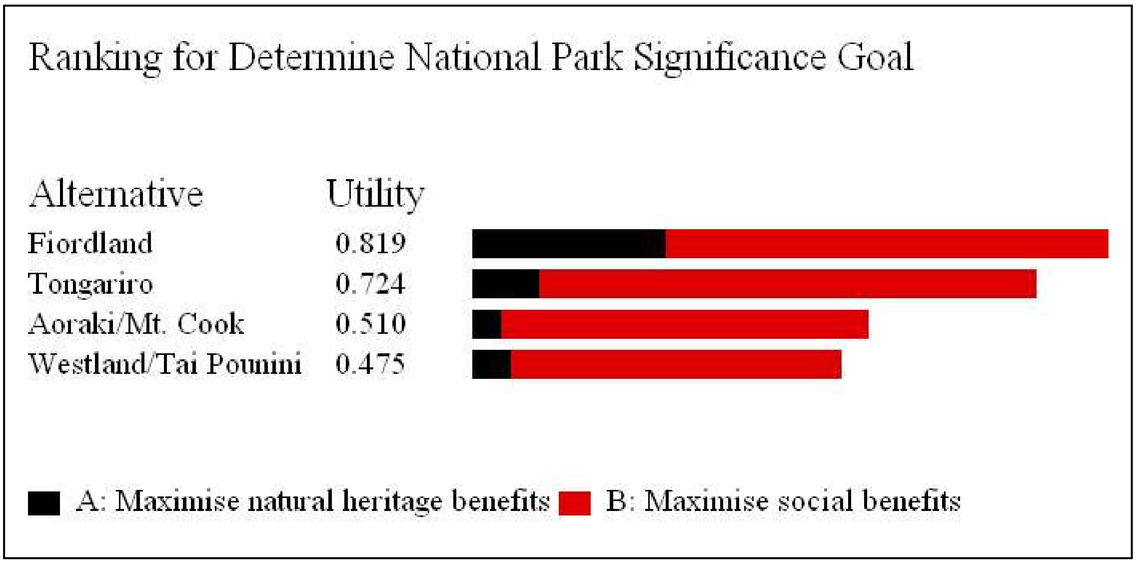
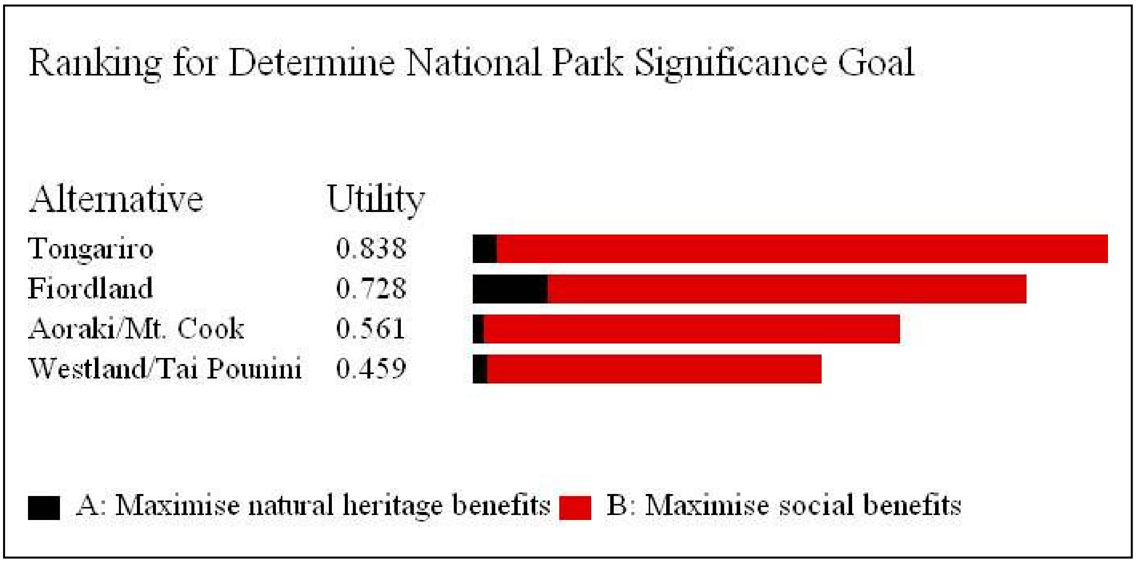


Figure 5.31

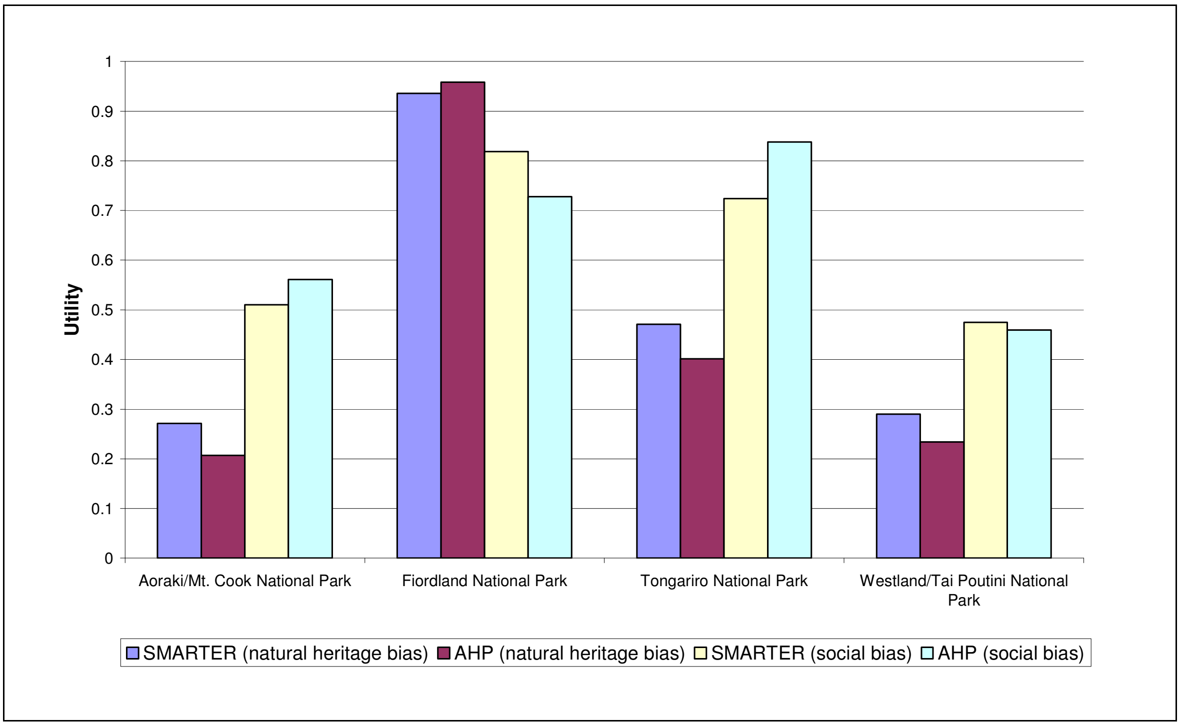
Park Rankings with AHP Weight Assessment biased towards Social Benefits



The overall utility of each park under each preference set scenario is shown in Figure 5.32, where the natural heritage and social bias scenarios are grouped together.

Figure 5.32

Comparison of National Park Utility under each Preference Set



Under the preference sets biased towards natural heritage, Fiordland National Park has the greatest utility by a significant margin. This is not surprising because it is the largest national park with the best habitat continuity and greatest number of special conservation areas. The only preference set that does not give Fiordland National Park the greatest utility is the socially biased AHP scenario. The weights for each of the measures under this scenario are given in Figure 5.33. The percentage weight is the nominal weight placed on the measure, and the effective weight represents the influence of the measure on the final ranking. The effective weight takes into account the combination of the nominal weight and the variation in measure levels amongst the alternatives. Here, the 'Māori spiritual significance' measure has the highest percentage weight. Three of the parks have the same 'High' descriptive level for the this measure. The 'World Heritage Site (Cultural)' measure has the second-largest percentage weight, but only one of the parks has this status, so the effective weight for this measure is greater than the 'Māori spiritual significance measure'. With this preference set, Tongariro National Park, which is the only park to have cultural World Heritage Site status, has the highest utility. This extreme example demonstrates the influence that the weight assessment phase of the analysis can have on the final ranking because Fiordland National Park consistently has the best levels for all but this one measure.

Figure 5.33

Percentage and Effective Measure Weights with the Socially Biased AHP Preference Set

Measure	Percentage Weight	Effective Weight
A1: Park size	6.4	8.949
A2: Habitat continuity	1.0	1.132
A3: Special conservation areas	2.6	4.189
B1: International visitor numbers	5.7	5.867
B2: Importance for recreation	10.0	4.045
B3: Scenic importance	11.2	4.547
B4.1: Historic sites	3.6	2.627
B4.2: World Heritage Site (Cultural)	25.2	40.844
B5: Scientific significance	2.8	2.310
B6: Maori spiritual significance	31.4	25.489

The other socially biased preference set using the SMARTER method, has less-extreme percentage weights. This means that Fiordland National Park, which has the greatest levels for all measures except the 'World Heritage Site (Cultural)' measure, has the greatest overall utility. The difference in utility between Fiordland and Tongariro national parks is smallest under this scenario.

5.3.4 ASSUMPTIONS AND LIMITATIONS

The pilot study here is severely limited by lack of data. The NPMPs do not provide inventory information, and without access to the DOC's natural heritage databases, both the natural heritage and threat measures of the model are severely compromised. The 'park size', 'special conservation areas', 'international visitor numbers', 'World Heritage Site (Cultural)', and 'scientific significance' measure levels are robust. The other measures are derived from observation (habitat continuity) and descriptive information that was not intended to be used for comparative purposes and the quality of this information, though consistently derived for each park, is compromised.

The majority of measure levels included in this analysis are derived from qualitative descriptions presented in NPMPs. Only four of a possible fourteen national parks were included in this analysis. The information regarding the physical and social characteristics of the four parks analysed is inconsistently presented in the NPMPs.

The analysis presented here should not be used by the DOC for any prioritisation exercises. Only a full model, complete with species-level measures, financial measures, and threat magnitude measures, analysed with a preference set reflecting the priorities of the DOC, should be used for such purposes.

5.4 SUMMARY

A Multiple Criteria Analysis (MCA) model was constructed using Logical Decisions® for Windows™ (LDW) software. The model combines natural heritage, economic, social, and threat assessment criteria with a transparent weight assessment procedure. Three weight assessment methods were trialled, and the 'simple multi-attribute rating technique exploiting ranks' (SMARTER) method and Analytic Hierarchy Process (AHP) method were selected because they have a robust theoretical foundation and are easy to use. A sensitivity analysis was undertaken to check that the model's results are consistent with the measures for each alternative. The model was tested using three hypothetical alternatives and the consistency of the resulting utility scores indicates that the model is robust.

The model was then applied to two pilot study situations, for the national parks managed by the Parks and Wildlife Commission of the Northern Territory (Australia) and the Department of Conservation (New Zealand). The implications arising from the pilot studies are discussed in Chapter Six, followed by conclusions and recommendations arising from the research in Chapter Seven.

6 DISCUSSION

In this chapter, the research findings are discussed. In the first section, the discussion relates to inadequate data and problems associated with institutional culture. In the second section, the usefulness of the MCA model developed in this research is considered.

National parks are quasi-public goods that need active management to fulfil the dual mandate of nature preservation and human recreation. Protected areas offer many benefits to society, but are only successful if their native plant and animal communities persist. Unfortunately, protected areas around the world are failing and one of the significant factors contributing towards this is inadequate funding. PAMAs need more income for management, but also need to allocate and distribute funds more effectively and efficiently.

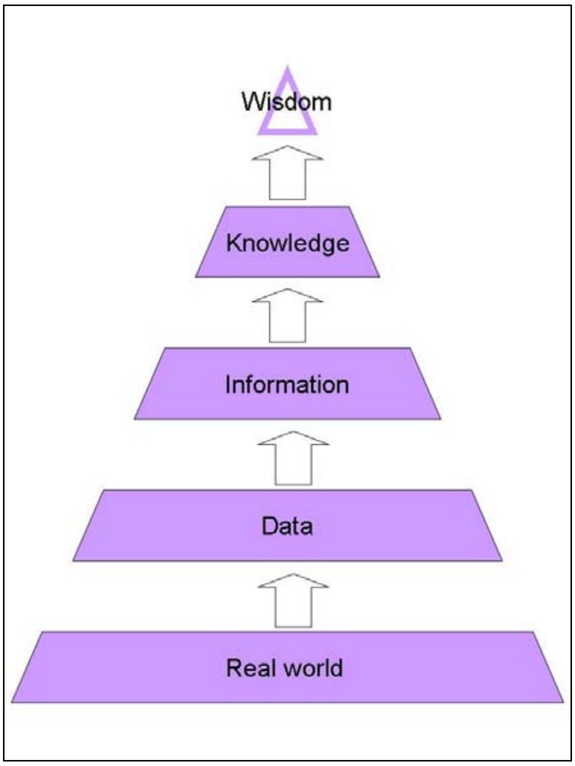
The largely anecdotal evidence suggests that resource allocation amongst national parks (and other protected areas) is *ad hoc* and lacks transparency. PAMAs have to decide how scarce resources should be allocated amongst competing demands. These decisions typically rely on heuristics instead of a clear, rational approach. When decisions are made this way, there is a tendency for lack of precision, consistency, public support and transparency. PAMAs are accountable to the public and have a responsibility to make robust and transparent decisions. The research set out to identify systems that could help decision-makers improve the transparency and robustness of decisions by ranking a country's national parks in terms of natural heritage, economic, and social significance. In other words, the model endeavours to quantify the ecological, economic, and social requirements of protected areas before making fiscal allocation decisions.

6.1 INADEQUATE DATA FOR DECISION-MAKING

The approach taken in this research was based on the assumption that PAMAs in developed nations have access to good quality data and information about the assets they manage. However, the pilot study applications of the model highlighted that this is not necessarily the case. The limitations of the political environment are such that inadequate baseline (inventory) data exists for national parks in the Northern Territory (NT) of Australia and in New Zealand (NZ).

First, some distinctions should be made about the nature of information (Figure 6.1). Data are recorded observations or measurements that describe an object, system, or process. Information is data that have been organised and integrated. The analysis, interpretation, and understanding of information leads to knowledge. The highest stage of data evolution is wisdom, which is achieved through the intelligent use of knowledge. Progress from data to wisdom is accompanied by increasing stakeholder involvement (Olivieri, 1996). The ideal state of park management is wise management, which is dependent on good quality data. The type and quality of data that PAMAs have access to has systemic implications for park management because 'what you measure is what you get' (Jollands, 2005, December).

Figure 6.1
The Nature of Information



Source: Adapted from Olivieri (1996)

Three types of data are important to park management: baseline or inventory data, which describe what is present; monitoring data, which records change over time; and research, which has specific targets, is usually small-scale, and is often presented as information and knowledge (Stork, Samways, Bryant, Cracraft, Eeley et al., 1996). Decision-makers need all three types of data, but usually only the latter is readily available (Weber, Hintermann, & Zangger, 2004). Significance assessment relies on baseline data and information, and recent monitoring updates. The integrated assessment attempted in the research set out to determine park significance in line with international environmental agreements, national responsibilities, and the wider protected area literature. To do this thoroughly, data and information about the natural heritage, economic, and social characteristics of national parks, as well as the pressures they are under to deliver these benefits to society, is required. The recurring challenge in undertaking this research was the poor quality and/or absence of datasets for many national park characteristics.

6.1.1 DATA QUALITY AND PERFORMANCE EVALUATION

Good decisions rely on sound, science-based data and information, so every PAMA needs a clear programme for inventory and monitoring (Stork et al., 1996). Any assessment of site significance rests fundamentally on the baseline data and information with which sites are measured (Gaston, Charman, Jackson, Armsworth, Bonn et al., 2006). Thus, it is imperative that the data is a good reflection of real conditions. Datasets should be objective, independent, and comparable. Data and information must also be accessible to managers through comprehensive, user-friendly information systems. Unfortunately, data collection is time consuming and expensive, so there is an inherent trade-off between cost and the accuracy and comprehensiveness of datasets.

Globally, biodiversity information is often scattered, difficult to obtain, and sometimes not available in the country for which it was collected. In some cases, good databases exist for certain regions/sectors, but are conspicuously absent in others. There is also variability in data quality, age, presentation, and ways in which datasets are maintained (McNeely, 1990). International-level databases like the World Database of Protected Areas (WDPA, created in 2002 and administered by UNEP and the World Conservation Monitoring Centre, involving pooled information from BirdLife International, Conservation International, Flora and Fauna International, the World Resources Institute, and WWF) have many limitations. The WDPA is restricted to incomplete natural heritage data. Information is often out of date because the database relies on updates from national organisations. Data limitations include commission errors, when a species is recorded as present in a protected area when it is absent or has a non-viable population, and omission errors, when species that do occur in an area are not recognised (Rodrigues, Andelman, Bakarr, Boitani, Brooks et al., 2003).

National and international law is increasingly requiring use of biodiversity information (De Lacy, Chapman, Whitmore, & Worboys, 2006; Olivieri, 1996). The Convention on Biological Diversity (CBD) – a courageous political document, but cumbersome legal text – has been widely criticised for lacking an effective directive for monitoring or for enforcing compliance (McGraw, 2002). National-level implementation commitments outlined in Article 7 of the CBD include identifying and monitoring components of biodiversity important for its conservation and sustainable use, and maintaining and organising data derived from identification and monitoring activities. These commitments are not binding, but function as targets to strive towards, with national strategies and action plans acting as one of the main mechanisms for implementation (Le Prestre, 2002).

Substantial infrastructure, economic input, and human resources are required to undertake biological inventorying and monitoring at national, regional, and global scales (Stork et al., 1996). Naturally, species of conservation concern often involve more intensive data collection. Trend monitoring should be based on reproducible methods that are statistically viable (Price, 2004; Weber et al., 2004). Monitoring is needed to track changes in biodiversity in unmanaged areas, and to evaluate the impacts of management action. Monitoring should be used to refine management actions and target biodiversity assets and processes that are of the greatest concern. Monitoring programs must be carefully designed in order to provide meaningful information to managers. This is often not the case because the purpose of the monitoring is not well defined, and/or the monitoring methods are employed at inappropriate spatial and temporal scales, resulting in data and inferences that are sub-optimal. Furthermore, it is hard to isolate all the variables in monitoring programmes where the population and natural history needs off the organisms being monitored are poorly understood (Possingham, Andelman, Noon, Trombulack, & Pulliam, 2001).

At the PWCNT, the ESRI® ArcMap™ Fauna Atlas data points are used by the Biodiversity Conservation group to infer the presence and absence of species in an area. However, the data has not been collected in a systematic way for this purpose. The database reflects surveys that recorded the presence of interesting species, as opposed to systematic surveys that sought to record all the species occurring within a pre-determined area. The Fauna Atlas can be used to infer absence to some degree, but does not account for seasonal variation in the presence of species. Until a comprehensive inventory is undertaken, the feedback from monitoring has limited impact. Through remote sensing of vegetation species, it would be possible to extrapolate information about the likely distributions of fauna species, based on known habitat preferences. Any remote sensing requires ground truthing, but given the size and intactness of the NT, remote sensing offers a practical and cost-effective option for improving species distribution information for both flora and fauna. Another problem in the NT is the standardisation of survey methods, as requirements differ markedly between the tropics, and the arid area south of the Barrimah line. The environments to the south are similar to the environments found in the state of South Australia (B. Sparrow, personal communication, 10 July 2006). Bioregional scale conservation plans based on the IBRA system are being undertaken to identify and survey inventory gaps, identify species of conservation significance, and identify features of interest to indigenous people (G. Leach, personal communication, 12 July 2005). However, the species distribution information from the Fauna Atlas is being relied upon for this. Discussion is occurring regarding a comprehensive monitoring strategy for the PWCNT (for example, Price, 2004).

In New Zealand, existing species distribution databases are limited. More than species 2800 are listed as threatened and species managers need to determine how to allocate resources to gain the maximise return for threatened species. Constraints include the complexities of species ecology, difficulties in undertaking effective threat management, and the large volume of species that need resourcing. The current process of determining threatened species management approaches and priorities is *ad hoc*. There is also little transparency regarding decisions on why certain species are or are not managed. Optimal resource allocation amongst threatened species starts with clear goals, followed by transparent, rule-based prioritisation. The optimal resource allocation solution is a function of project costs, probability of success, urgency of intervention, and importance of the species to people (Maloney, O'Connor, Joseph, Jansen, Cromarty et al., 2007). These decisions cannot be made without information on known species distribution.

A PAMAs access to technology should not be used as an excuse for the absence of an information management system. It is critical that information management systems are based on a good intellectual framework. A comprehensive and well-planned system can be modernised with technology at a later date (Olivieri, 1996). Managers need to gain familiarity with the different types of data, the ways in which it can be accessed and how it is collected and stored (De Lacy et al., 2006). Guidelines for deciding what kinds of data to collect and for establishing an information management system are provided by Stork et al. (1996), Olivieri et al (1996) and Possingham (2001). Wealthy countries should be able put more effort into monitoring and evaluation, but lack of resources does not mean that evaluation should be regarded as low priority. Rather, monitoring and evaluation may help poor countries to secure grants or other external financial support (Hockings, Stolton, & Dudley, 2000).

For each park, PAMAs should be reporting annually on progress towards management outcomes. However, in order to do this clear goals must be developed and linked to a programme of monitoring and evaluation. PAMAs need to develop management planning guidelines and performance standards, insisting on regular reports on the state of the country's protected areas and annual business plans for protected areas (Jones, 2000). Such plans would provide an opportunity for recording the economic benefits national parks provide to society, as these are often grossly underestimated and put a strong case forward for the continued financial support of protected areas (Dixon & Sherman, 1991).

Perfect information is ideal, but decisions need to be made before this ideal is reached. Current surrogates, existing data, and expert opinion will provide useful information in the interim, but comprehensive data collection and management systems should be established to ensure that future decisions can be based on better information (Maloney et al., 2007; Walker, Stephens, Lee, & Clarkson, 2007).

6.1.2 FIEFDOMS AND INSTITUTIONAL CULTURE

Another key aspect of the data problem is characterised by agency structure and staff attitudes. Conservation practice can be viewed as a value-driven asset management business, focussed on maintaining the flow of benefits to society (Stephens, 1999). Indeed, this approach to conservation and protected area management is advocated by nature-NGOs and the conservation finance literature (for example, see Athanas, Vorhies, Ghersi, Shadie, & Shultis, 2001; Davies, 2003; Lockwood & Quintela, 2006; WCPA-IUCN, 1998). However, an integrated approach to conservation and protected management is not taken by most PAMAs for what appear to be reasons of ingrained culture and structural obstacles.

In New Zealand, the DOC administers conservation through a central office, 13 conservancy offices, and area offices that report to the conservancy offices. As financial transparency goes, the conservancies function like fiefdoms, operating with a level of autonomy. Projects are instigated from area office, conservancy, and national level in line with strategic documents. Spending within a conservancy is coded to activities like ‘weed control’, but not to specific geographical areas. Thus, the DOC cannot calculate how much it spends in any national park. International management planning guidelines for protected areas suggest that annual business plans be established for individual protected areas (Thomas & Middleton, 2003). The DOC as a national unit produces an annual business plan, but these are not prepared for individual protected areas. Without accurate spending information, it is not possible to evaluate management activities and make better decisions.

The fiefdom model of conservation management also has implications for social data collection in New Zealand. Visitor data is gathered via voluntary entry in visitor books located in all DOC huts and at the beginning or end of many popular walking tracks across the country. The visitor books are identical throughout the country, but the information is inconsistently coded and stored by different conservancies. In general, visitor research regarding New Zealand's protected areas lacks depth, and is time and site specific. The body of literature lacks longitudinal research, inhibiting trend analysis, with a tendency to address particular management questions. Methods lack consistency in questions/studies and across disciplines. The major research gaps are: comprehensive national monitoring, trend monitoring with predictive power, and systematic data collection. New Zealand needs a systematic approach to visitor monitoring in protected areas, including a research strategy and standardised data collection and interpretation methods (Booth, 2006).

Institutional culture also affects the attitudes of staff within an organisation. For example, the PWCNT moved from the Department of Planning, Infrastructure, and the Environment (DIPE), to the Department of Natural Resources, Environment, and the Arts (NRETA) in July 2005. One year on, staff were pleased about the change, feeling that it had psychological benefits due to a reduction in tension within a department that previously had competing interests. Now, the entire department is moving in the same direction, with legal initiatives to follow. Furthermore, the PWCNT benefits from closer contact with the Darwin Museum, which has an extensive natural history section.

In the NT, the joint management process is facilitating more involvement with Aboriginals and more focus on indigenous knowledge of species decline. For this research, the PWCNT has an ethno-ecologist and a zoologist working with Aboriginal elders. Traditional fire management is also better understood due to collaboration with Aboriginal elders. The PWCNT is increasingly including indigenous people in national park management, but otherwise remains focussed on biodiversity. There is a strong drive to protected representative examples of NT environments, but none for economic studies or research into ecosystem services benefits (W. Binns, personal communication, 11 July 2005).

The fiefdom management model and poor financial transparency aside, the DOC is moving towards integrated protected area management. It is considering commercial projects for carbon storage on conservation land, with two pilot studies focussed on carbon trading. The DOC also benefits from commercial sponsorship for species recovery. The DOC has developed a Natural Heritage Management System, with the intent of integrating (terrestrial) data systems and management tools to give managers more sophisticated information to help make the right decisions, linking outcomes to specific interventions (Department of Conservation, 2005). In 2007, the NZ government launched the Terrestrial and Freshwater Biodiversity Information System (TFBIS), which aims to support access to essential biodiversity data and information to achieve the goals of the New Zealand Biodiversity Strategy 2000. The DOC has collected baseline data in order to trace trends in the condition of historic sites and visitor assets (Department of Conservation, 2005). The DOC is also taking an interest in the economic values of conservation land, as demonstrated by the economic studies undertaken for some parts of the conservation estate. Furthermore, some of the national park management plans describe ecosystem service benefits provided by the national parks.

6.2 INTEGRATED ASSESSMENT AND NATIONAL PARKS

In a formal assessment of the extent to which scientific evidence is used in the formation of protected area management plans by major conservation organisations within the United Kingdom and Australia (excluding the PWCNT), it was found that scientific information is not the most frequently used source of information. Rather, the most frequently used information sources, in descending order, were: existing management plans, expert opinion from outside the compilation group, published reviews, books or handbooks, and documentation or personal accounts of traditional practices in land management. Scientific information is not being used systematically to support decision making largely because it is not easily accessible to decision makers. Combined with limited monitoring and evaluation of management activities, this results in the majority of decisions being experience, rather than evidence, based (Pullin & Knight, 2005). The reality of the situation, presumably worldwide, is that there is competition amongst parks for limited funds. PAMA decision-makers also have limited time, and rarely have a full and integrated understanding of park significance. Decisions are constrained by time, information, and funding.

An interdisciplinary approach to national park appraisal was taken in this research, with the intention of assisting decision-makers with decisions about how to allocate resources amongst competing assets. The problem was defined as having a large number of incommensurate performance criteria that need to be weighted and integrated. Multiple Criteria Analysis (MCA) was chosen as a decision-making framework, in which the problem was broken down into small, understandable parts; each part was analysed; and the parks were integrated in a logical manner to produce a meaningful solution (Malczewski, 1999). The key strength of MCA is that it makes the subjective part of decision-making transparent, through a formal weighting process (Beinat, 2001; Clemen, 1996).

Cartwright (1973) identifies four fundamental types of problem, suggesting that the type of problem governs the range of possible solutions and kind of strategies appropriate for the achievement of those solutions (Figure 6.2).

Figure 6.2
A Typology of Problems

		Nature of variables	
Number of variables		Calculable	Incalculable
	Specified	Simple problem	Complex problem
	Unspecified	Compound problem	Metaproblem

Source: Adapted from Cartwright (1973)

Simple problems have a calculable number of known variables, and compound problems have an open-ended number of calculable variables. Complex problems are qualified by a specified number of variables, where it is not possible to calculate all of the variables. Metaproblems feature lack of precision, characterised by an unspecified number of incalculable variables.

The problem addressed in this research essentially started with a metaproblem, asking “how do we measure national park significance for comparative purposes?”. As the important characteristics of national parks were identified in the research process, the problem type shifted to a complex problem, with a specified number of variables. In the model structuring phase the incalculable variables were discarded redefining the problem as a simple problem through the development of a comprehensive and rational solution.

The MCA model developed in this research acts as a bridge between academic theory and practical management. It provides a comprehensive list of the features important in comparing the significance of national parks, bringing diverse baseline data together and presenting it in a way that is easy for decision-makers to understand. The model's goal hierarchy was constructed to reflect a sound theoretical foundation and coincide with likely data availability. As shown in the pilot study applications of the model, the 'generic model' can be easily adapted in response to data and information availability. Hence, it can be used as a template to be modified and customised by other organisations.

The availability and quality of data are the main limitations in the 'objective' part of the assessment. Scientific uncertainty is recognised as the norm, rather than the exception for ecological problems (Guay, 2002). Decisions do not wait for perfect information and need to be made annually, so should be based on existing datasets. Ideally, assessments will involve comprehensive threat magnitude information, economic, financial, ecosystem services, and social data/information for each park in a network of protected areas. The model will still be useful without full economic and ecosystem services measures. The results from the NT model, for example, could be of great interest to decision-makers if they were based on accurate management costs, which decision-makers in the PWCNT do have access to.

The analysis process in Logical Decisions® for Windows™ is repeatable, transparent, and inclusive. As demonstrated in the pilot study examples, the measure weights determine the overall utility of each park. Weights can be elicited from relevant experts/managers in a Delphi focus group. The group must consist of credible experts with relevant backgrounds in order for the final decision to have the support necessary for implementation. For a group of four or more experts, the Logical Decisions® for Groups software should be used, where each member can enter weights into the programme using the different methods. The Multiple

Attribute Utility Method ‘SMARTER’, and the Analytic Hierarchy Process (AHP) were used to weight the measures. These AHP and Multiple Attribute Utility methods are well established in the environmental-MCA literature. The SMARTER method involves a simple rank ordering of measures for each goal and provides a quick and easy to understand introduction to weight assessment. For a more robust analysis, the SMARTER method should be followed by AHP method, which uses pairwise comparisons. It is also possible to enter pre-determined weights directly for the measures belonging to each goal. Making the weighting process explicit not only makes the analysis more robust, but helps decision-makers to to better understand the decision process.

The model combines the information from several criteria to form a single index. One of the limitations of this particular model is that it relies on an assumption of independence between criteria, which is not met in all cases. The consequence of dependencies between criteria include multiple counting of attributes (Regan, Davis, Andelman, Widyanata, & Freese, 2007). For example, there may be a correlation between management costs and visitor numbers.

The future development of the model is limited by the availability of data and information. As standardised measures of ecosystem services become available, the model will be able to incorporate ecological processes, like watershed protection. Many PAMAs analyse data and information in geographic information systems (GIS), and there is potential to integrate the MCA model developed in this research into a GIS. The integration of GIS and MCA systems opens opportunities to prioritise parks and other conservation units in a spatial, and potentially more comprehensive manner. PAMAs like South African National Parks and Parks Australia only manage a network of national parks and could successfully apply the MCA model as it is. However, the DOC, and to some extent the PWCNT, do not manage on a park basis, and may benefit from an integrated MCA and GIS system (for example, see Andersen, Thompson, & Boykin, 2004; Geneletti, 2004; Phua & Minowa, 2005; Woodhouse, Lovett, Dolman, & Fuller, 2000).

Sustainability decisions require ‘thick analysis’, meaning that economic efficiency, environmental effectiveness, equity (distributive justice) and political legitimacy (procedural justice) must be addressed (Adger, Brown, Fairbrass, Jordan, Paavola et al., 2003). The model presented here is a way of easily communicating data and information about the significance of national parks. It is intended to assist decision-makers when they review budget proposals and action plans for parks, by increasing their awareness of relative park significance in relation to transparent preferences. The model developed in this research reflects the economic, environmental, and equity characteristics of national parks. Procedurally, the model is cost effective to employ, assuming appropriate information is available.

The tool developed here brings a scientific rationale to allocation decisions that remain political. It is necessary to provide a pragmatic method for comparing the relative importance of different conservation units in a way that is robust. The wide scope, adaptability, and simplicity of the model should go some way to persuade decision-makers of its usefulness and acceptability.

7 CONCLUSION AND RECOMMENDATIONS

Recognising that the resource allocation decisions made by protected area management agencies (PAMAs) are often *ad hoc* and lack transparency, this study set out to develop a rigorous and practical model to assist PAMA decision-makers. Decision-makers in these agencies need pragmatic methods to facilitate effective and efficient resource allocation decisions.

In this study an applied approach was adopted to improve decision-making in conservation practice. Many academic disciplines play legitimate roles in addressing the resource allocation problem, including resource economics, conservation biology, geography, sociology, management, and decision science. The research was undertaken from a natural resource management perspective and attempted to transcend these disciplines and integrate them into a practical and robust model.

The approach taken in the research was first to identify parameters for a model to assist with resource allocation decisions, based on the characteristics of the resource allocation problem (Chapter Two). Potential criteria that could be employed in the model were then reviewed (Chapter Three). These included natural heritage, economic, social, and threat assessment criteria. One of the contributions of this thesis is that it brings these diverse attributes together within the context of comparing a set of protected areas.

Decision-making frameworks used in conservation and ecological economics to assist with decisions were then reviewed (Chapter 4). Here, the thesis contributes to the conservation biology literature by providing a clear typology for methods developed to identify new areas for protected area designation. Methods for assessing the effectiveness of protected area management, cost-based assessment frameworks, and multiple criteria analysis frameworks were also assessed in light of the decision parameters and Multiple Criteria Analysis (MCA) was chosen as the most appropriate framework to meet the needs of the proposed model. That is, the ability to handle incommensurate data, a facility for expressing the preferences of decision-makers for one criterion over another, and a robust theoretical foundation.

The decision model was then constructed and applied – in separate exercises – to national parks in the Northern Territory of Australia and New Zealand (Chapter 5). Specific MCA software, Logical Decisions® for Windows™, was chosen with which to develop, structure and analyse the proposed model. A comprehensive model was developed, tested, and tailored to the two pilot study situations, in which the influence of the weight assessment stage on the final ranking for each park was illustrated. A major contribution of the research is the MCA model, which represents a unique contribution to the fields of protected area management, conservation biology, and ecological economics.

This research represents an effort to broaden the mindset of PAMA decisions-makers regarding what should be explicitly taken into consideration when allocating funds amongst national parks. The model integrates a diverse range of natural heritage, economic, social, and threat assessment criteria into a single matrix. One of the key strengths of the MCA approach is transparent methods for expressing the relative importance of protected area attributes. The approach undertaken in this research is based on a strong theoretical foundation and has significant potential to help PAMA managers' make better informed resource allocation decisions.

Conclusions arising from the research relate to the resource allocation decisions made by PAMAs, methods for setting conservation priorities, data management, and the MCA approach adopted in this research.

7.1 RESOURCE ALLOCATION DECISIONS

The resource allocation decisions made by most PAMAs are *ad hoc* and lack transparency. This often results in widespread under-funding and inefficient management. These organisations are complicated by attempting to achieve too much, with unclear goals, and inadequate information for robust decision-making. As centrally financed organisations responsible for managing quasi-public goods, PAMAs have little accountability for delivering results.

PAMAs were traditionally concerned with managing national parks for environmental protection and recreation. Increasingly, protected area management is moving towards the provision of environmental, economic, and social net benefits. Integrated protected area management places additional pressure on PAMAs to deliver benefits to society. The conservation management literature urges managers to adopt business principles and set clear, measurable objectives to work towards. From a business perspective, protected areas can be viewed as assets that deliver wide-ranging benefits to society. In order to maximise these benefits and make more efficient and effective decisions, PAMAs need robust information that reflects the complexity of these assets in a simple and meaningful manner.

7.2 METHODS FOR SETTING CONSERVATION PRIORITIES

Existing methods for identifying conservation priorities display a bias for biological criteria at the expense of social and economic considerations. Decision-making frameworks have been developed to identify new protected areas, evaluate management effectiveness, and evaluate the effectiveness of conservation projects. These methods are inadequate for assisting PAMAs with decisions about how to allocate resources amongst protected areas. Decision-makers need models that integrate robust environmental, economic, and social information at scales that apply to protected areas. Furthermore, subjectivity is an inherent part of any decision-making and methods should make this subjectivity explicit. MCA techniques have provided rigorous decision-making aides in many disciplines and offer an opportunity to integrate incommensurate data with transparent, repeatable methods for expressing decision-maker preferences.

7.3 DATA MANAGEMENT AND PROTECTED AREA MANAGEMENT AGENCIES

The PAMA data limitations highlighted in this research support the comments made by authors like Cumming (2004) and Child (2004) that PAMAs need to establish clear and measurable goals and focus more effort on collecting and managing good data about the assets they are charged with managing. Data collection and management generally lacks vision and coherence and there is a clear need for comprehensive and integrated data collection, analysis, evaluation, and dissemination systems at all levels of protected area management. Existing databases typically reflect opportunistic biological data, instead of representing a comprehensive inventory of data and information for all park attributes. This means effort should be directed at collecting and maintaining economic and social data, as well as comprehensive natural heritage and threat-related information.

A philosophical shift is required by PAMAs to recognise the importance of economic and social data in conservation management. Many nations are signatory to the Convention on Biological Diversity (1992), but there is little evidence of an integrated approach to decisions about protected areas. Diverse economic and social data should be collected and explicitly incorporated into decision-making, otherwise the influence of social and economic considerations on management decisions will be unknown.

Economic data regarding the contribution of parks at different economic scales is currently limited. However, fields such as environmental and ecological economics are well-established, and, as international attention continues to focus on the economic benefits of natural systems, increasing direction will emerge regarding measures of economic benefits, including the ecosystem services contributions of protected areas. It is concerning that some PAMAs, like New Zealand's Department of Conservation (DOC), do not code spending to specific sites and do not know how much they spend in individual national parks. The approach presented in this research is not the only way that decision-making can be better informed, but by in ignorance of the costs of managing specific conservation units, the DOC has limited its options for better informing decision-making.

One of the underlying assumptions that can be inferred from both conservation practice and the park management literature is that the parks should not be compared in terms of cultural or spiritual importance (Bell, 1983; Melissa Fourie, personal communication, 20 August 2004). Discussion in the conservation literature focuses on acknowledging the 'intangible values' of parks (see for example Harmon, 2003), but little effort has been placed on expressing these for comparative purposes. The 'soft' social data and information is particularly complex because there is significant overlap amongst social categories and it is hard to make reasonable comparisons amongst areas where different cultures have standing. For example, some groups may be more vocal than others, or some may be secretive about the areas that have historical or spiritual significance to them.

The measurement of natural heritage benefits is also fraught with complication. Areas that have experienced more sampling due to good accessibility or flagship status will have more full and accurate records and may thus be found to represent more species than other areas, when the reverse is actually true. The species data limitations experienced in the Australian and New Zealand pilot studies bring the robustness of conservation importance analyses based on species richness into question.

PAMAs increasingly have access to Geographic Information Systems (GIS) to assist with management decisions and activities. Spatial databases offer important opportunities to store and analyse protected area information and, if used wisely, GIS has potential to improve protected area management.

7.4 THE USEFULNESS AND IMPORTANCE OF THE MODEL

The aim of this research was “to develop a rigorous and practical model to assist protected area decision-makers with the allocation of resources amongst national parks”. The model follows best practice in the conservation management literature and, given the realities of park management and difficulties posed when measuring park attributes, is as rigorous as possible. MCA has a strong theoretical foundation, as do the weighting methods employed. The practicality of the model has been a prime consideration in the selection of MCA as a decision-making framework, the selection of specific MCA software, and the inclusion of suitable criteria. The Northern Territory pilot study in particular illustrates the applicability and practicality of the model in a real protected area management context. The model fulfils the conditions of the research aim. Specific benefits and limitations associated with the model are outlined below.

7.4.1 BENEFITS

The approach taken in this research is based on a sound theoretical foundation. It highlights the usefulness of the MCA technique for reducing a complex array of attributes into a single model in a robust and transparent manner. The key strengths of MCA techniques are their ability to integrate incommensurate data and make decision-makers' preferences explicit.

The relevant literature is partially abstract, in that it does not accurately reflect what is happening in conservation practice. The model presented in this research was developed with practicality in mind. It brings complex data together in different forms and allows decision-makers' to better understand their decisions through the explicit expression of criteria weights. The model is important as both a process and a product. Decision-makers' will find the resulting rankings more beneficial if they understand the process by which data and information are integrated in the model. The MCA model presented here integrates diverse information about national parks and presents it to decision-makers in a simple form. The scope of the model is constrained by the availability of good quality data to PAMAs, but the approach has enormous potential to improve the effectiveness and efficiency of annual decisions and warrants further investigation.

The aim of this research was to develop a rigorous and practical model to assist decision-makers with the allocation of resources amongst national parks. There is sufficient evidence that the integrated decision-making model approach taken here aggregates complex data in a way that improves managers' ability to make better informed decisions concerning the allocation and distribution of resources. The model is a practical step towards overcoming the resource allocation problem. MCA has never been used in this context before and the model presented is the principal contribution of this research to conservation practitioners and in the fields of protected area management, conservation biology, and ecological economics

7.4.2 LIMITATIONS

The problem of inefficient resource allocation is relevant to all protected areas, under both public and private management. To keep the scale of the project manageable, the model was developed and applied to government-managed national parks; however, the model is intended for application to other types of protected area. The theoretical model provides a good starting point for PAMAs, but the pilot studies illustrate that it requires modification for real world situations.

The model does not present an argument for attracting more funding. It presents an efficiency approach to use existing funds more effectively. The model could potentially be used in the wrong hands; it could be modified to articulate the personal agenda or politics of a decision. However, there is a greater danger of the status quo prevailing. If some of the ideas presented in the model are not adopted, there is a strong chance that protected areas will continue to decline. Politics could influence the weighting process, but will be made explicit in the process. If used to justify exploitative development in lower ranking parks, it is hoped that the institution that is the 'national park' will be strong enough to exclude such development. An area is a national park because of some outstanding feature/s warranting protection, and this, it is hoped, should continue to over rule proposals for exploitative activities within national parks.

There is much scope for improving the model, particularly with regard to social criteria and expressing threat magnitude. In addition, there is scope for developing interactions between criteria in the model. Uncertainty is an inherent part of decision-making, and decision-makers must accept that scientific knowledge with regard to natural areas is incomplete (Tisdell, 2002). Decisions need to be made

The model is not a silver bullet to make allocation decisions for decision-makers. Rather, it is a process to better inform decision-makers. Much is still up to PAMAs; they must decide about investment versus maintenance, long-term versus short-term funding, and whether the allocation is for a means to an end or an ends in itself. The model does

7.5 RECOMMENDATIONS

The recommendations arising from the study relate to data collection and management, decision-making by PAMAs, resource allocation decisions, and further research.

7.5.1 DATA COLLECTION AND MANAGEMENT

Access to good quality data about the environmental, economic, and social attributes of protected areas is limited at international, regional, national, and local levels. From an international perspective, the Convention on Biological Diversity gives inadequate guidance to member states regarding data collection and management. The pilot studies undertaken in this research highlight the absence of quality data and information about protected areas. It is particularly disturbing that these studies were undertaken in developed countries. Based upon these findings, it is recommended that the Convention on Biological Diversity Secretariat give a strong directive to member states regarding comprehensive methods for inventory, monitoring, database management, and information sharing. In support of this, it is recommended that international nature-NGOs continue to advocate for comprehensive data collection and management systems. Governments could be encouraged to adopt regular 'state of the park' reporting that focuses on the environmental, economic, and social benefits of protected areas, to encourage more efficient and effective management.

It is also recommended that PAMAs adopt comprehensive inventory and monitoring programmes that link into comprehensive and accessible databases. These databases should contain natural heritage, social, economic, financial, and threat data/information, and could potentially utilise Geographic Information Systems. The approach developed in this study provides preliminary guidance regarding types of data that would be useful to decision-making.

7.5.2 PROTECTED AREA MANAGEMENT PLANNING

Good data can feed directly into protected area management planning. The performance of many protected area management agencies (PAMAs) is constrained by a lack of clear goals to measure progress against. In setting clear goals and identifying ways to measure progress towards those goals, PAMAs may find it easier to identify data and information needs. It is recommended that International nature-NGOs develop advice for PAMAs about how to set measurable goals and evaluate management actions, and that PAMAs place priority on setting clear goals with measurable outcomes so that protected area management becomes results-focused

7.5.3 RESOURCE ALLOCATION DECISIONS

Resource allocation decisions by protected area management agencies (PAMAs) are often *ad hoc* and lack transparency. This situation could be improved if PAMAs were required to report on annual spending within individual protected areas and explain resource allocation decision-making processes in annual reports. PAMAs would then be encouraged to improve the robustness of resource allocation decisions. In light of this recommendation, it is recommended that the New Zealand Department of Conservation adopt a system that facilitates transparent reporting on spending within each conservancy.

The integrated approach presented in this research has potential to it to assist with better informed annual resource allocation decisions amongst protected area responsibilities. It is recommended that the model undergo further development with and by PAMAs with the intention of employing it to inform decision-making.

7.5.4 FURTHER RESEARCH

The approach taken in this study has significant potential and warrants further research. Recommendations for further research are threefold and relate to the criteria used to measure social, economic, and natural heritage importance, and threat magnitude; the relationships amongst criteria within the model; and, the modification of the model for specific PAMAs.

The model is limited by the availability of natural heritage, economic, social, and threat magnitude criteria. Further research is required to develop standards for measuring a number of criteria with comparative assessment in mind. In particular, research is required to develop genetic-level natural heritage criteria, ecosystem services and functions at local and national levels, and measures of spiritual significance. Many other criteria, particularly for expressing social importance and threat magnitude warrant further research.

Internationally, further research is undertaken to improve the integrated assessment approach taken in this study, both generally and for specific PAMAs. This may include research to better reflect the relationships between measures within the model, to apply the model to a wider range of protected area types, and to integrate a Multiple Criteria Analysis approach with a Geographic Information System.

It is recommended that, at a national level, PAMA policy makers and managers at the highest level collude with other protected area management specialists to discuss ways to further the approach presented in this research. This will involve developing and calibrating the model with standardised systems of data reporting, training staff, and implementing the model.

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APPENDIX A:

THE CONVENTION ON BIOLOGICAL DIVERSITY, ARTICLES 7 AND 8

5 June 1992

Article 7. Identification and Monitoring

Each Contracting Party shall, as far as possible and as appropriate, in particular for the purposes of Articles 8 to 10:

(a) Identify components of biological diversity important for its conservation and sustainable use having regard to the indicative list of categories stet down in Annex I;

(b) Monitor, through sampling and other techniques, the components of biological diversity identified pursuant to subparagraph (a) above, paying particular attention to those requiring urgent conservation measures and those which offer the greatest potential for sustainable use;

(c) Identify processes and categories of activities which have or are likely to have significant adverse impacts on the conservation and sustainable use of biological diversity, and monitor their effects through sampling and other techniques; and

(d) Maintain and organize, by any mechanism data, derived from identification and monitoring activities pursuant to subparagraphs (a), (b) and (c) above.

Article 8. In-situ Conservation

Each Contracting Party shall, as far as possible and as appropriate:

(a) Establish a system of protected areas or areas where special measures need to be taken to conserve biological diversity;

(b) Develop, where necessary, guidelines for the selection, establishment and management of protected areas or areas where special measure need to be taken to conserve biological diversity;

(c) Regulate or manage biological resources important for the conservation of biological diversity whether within or outside protected areas, with a view to ensuring their conservation and sustainable use;

(d) Promote the protection of ecosystems, natural habitats and maintenance of viable populations of species in natural surroundings;

(e) Promote environmentally sound and sustainable development in areas adjacent to protected areas with a view to furthering protection of these areas;

(f) Rehabilitate and restore degraded ecosystems and promote the recovery of threatened specie, *inter alia,* through the development and implementation of plans or other management strategies;

(g) Establish or maintain means to regulate, manage or control the risks associated with the use and release of living modified organisms resulting from biotechnology which are likely to have adverse environmental impacts that could affect the conservation and sustainable use of biological diversity, taking also into account the risks to human health;

(h) Prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species;

(i) Endeavour to provide the conditions needed for compatibility between present uses and the conservation of biological diversity and the sustainable use of its components;

(j) Subject to its national legislation, respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge, innovations and practices;

(k) Develop or maintain necessary legislation and/or other regulatory provisions for the protection of threatened species and populations;

(l) Where a significant adverse effect on biological diversity has been determined pursuant to Article 7, regulate or manage the relevant processes and categories of activities; and

(m) Cooperate in providing financial and other support for *in situ* conservation outlined in subparagraphs (a) to (1) above, particularly to developing countries.

Annex I

Identification and Monitoring

1. Ecosystems and habitats: containing high diversity, large numbers of endemic or threatened species, or wilderness; required by migratory species; of social, economic, cultural or scientific importance; or, which are representative, unique or associated with key evolutionary or other biological processes;

2. Species and communities which are: threatened; wild relatives of domesticated or cultivated species; of medicinal, agricultural or other economic value; or social, scientific or cultural importance; or importance for research into the conservation and sustainable use of biological diversity, such as indicator species; and

3. Described genomes and genes of social, scientific or economic importance.

APPENDIX B:

SELECTED PARK MANAGEMENT AGENCIES

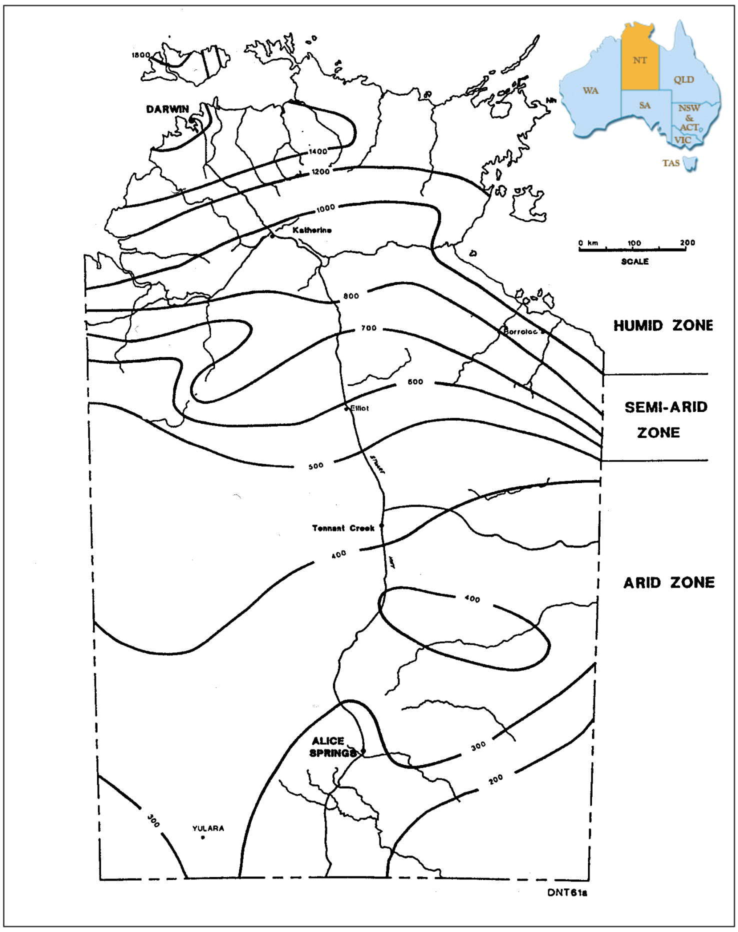
Protected area management agencies (PAMAs) in Australia, the Czech Republic, Nepal, New Zealand, and South Africa have been selected to illustrate the diversity of national park management contexts throughout the world. These countries were selected from the three groupings of market economies used by the United Nations for analytical purposes (United Nations Online Network in Public Administration and Finance, 2006). These are: developed market economies (Australia and New Zealand), economies in transition (the Czech Republic), and developing market economies (South Africa and Nepal). Where possible, the key threats to the sustainability of national parks, key legislation and policy, and funding situation for each PAMA are reviewed. Each PAMA acts in a unique institutional, political, socio-economic, and biological framework.

AUSTRALIA'S NORTHERN TERRITORY

The Northern Territory of Australia (NT) occupies 1.35 million km^2 of land, 71 839 km^2 of territorial sea (from the coast to 3 nautical miles offshore), 13,500 km of coastline, and is home to around 200 000 people (Northern Territory Department of Natural Resources Environment and the Arts, 2005). The NT is largely flat and extends from arid deserts and disconnected mountain ranges in the south to rainforests, wetlands, and tropical seas in the monsoonal north (Figure A). The rainfall in the north is strongly seasonal, while the variation in rainfall in the arid south is high and drought conditions are frequently experienced. Temperatures in the south are extreme, ranging from more than 40^{o}C in the summer months to -10^{o}C in the winter (Northern Territory Department of Natural Resources Environment and the Arts, 2005). Climate is the major determinant of environmental variation in the NT. Vegetation is characterised by extensive areas of hummock grassland and shrubland in the arid zone and Eucalyptus and Acacia woodlands in the humid zone (McLaren & Cooper, 2001). There are smaller areas of rainforest, mangroves, heathlands, swamps, and paperbark forests in the north. There is a rich fauna of birds, small mammals, frogs, reptiles, invertebrates and fish (Northern Territory Department of Natural Resources Environment and the Arts, 2005).

The environments of the NT remain in a largely natural state. This can be attributed to a small human population and consequently little habitat conversion. The Aboriginal cultural landscape has survived in the NT for over forty thousand years. Land tenure generally falls into three broad types: pastoral lands (c.45%), Aboriginal lands (c.50%), and conservation lands (c5%), although some Aboriginal land is managed as pastoral or conservation land (Northern Territory Department of Natural Resources Environment and the Arts, 2006).

Figure A
Map of the Northern Territory showing Climatic Zones



Source: Adapted from McLaren and Cooper (2001)

In Australia, protected areas are managed and/or administered by State or Territory Governments, rather than the Federal (Commonwealth) Government. However, the country’s World Heritage Sites are managed by the Federal

Government agency, Parks Australia[1]. This means that the flagship national parks in the NT, Kakadu National Park in the north and Uluru Kata-Tjuta National Park in the south are managed by Parks Australia. The Territory agency, the Parks and Wildlife Commission of the Northern Territory[2] (PWCNT), is responsible for the management of other protected areas in the NT, including 18 national parks. The NT's protected area network covers c.3.7% of the NT, comprising 90 individual parks and covering an area of approximately 50 000 km^2 (Northern Territory Department of Natural Resources Environment and the Arts, 2006).

In 1901 the Australian colonies joined in federation to form Australia. The Australian Constitution, declared at this time, is the basis for Australia's state-run national park system. Because environmental planning and management are not mentioned in the Constitution these responsibilities were to remain with each state government (Wescott, 1991). However, until recently the federal government ran the park systems in Australia's two territories. As of July 2005, PWCNT is part of the NT Government's[3] Department of Natural Resources, Environment, and the Arts[4]. Prior to this, PWCNT belonged to the Department of Infrastructure, Planning and Environment. Since July 2005 PWCNT has three branches:

1. The BioParks branch is responsible for the George Brown Botanic Gardens, Territory Wildlife Park, and Alice Springs Desert Park. These are educational facilities that aim to increase the understanding and appreciation of the natural and cultural environment of the NT;

2. The Park Management branch is responsible for the management of the NT's 90+ protected areas (excluding Kakadu and Uluru Kata-Tjuta National Parks), with the primary objective of monitoring, protecting, and preserving these areas through visitor, conservation and land management, education, protection of biodiversity, and control of feral animals; and,

3. The Biodiversity Conservation branch documents the flora and fauna of the NT, both within and outside designated protected areas. This information

[1] Parks Australia website: http://www.deh.gov.au/parks/
[2] The PWCNT website: http://www.nt.gov.au/nreta/parks/
[3] Northern Territory Government website: http://www.nt.gov.au/
[4] Department of Natural Resources, Environment, and the Arts website: http://www.nt.gov.au/nreta/

> provides the basis for decision making on biodiversity conservation planning and the sustainable use of wildlife, the recovery of threatened species, sustainable development, and the abatement of threatening processes.

The PWCNT operates under the Northern Territory Parks and Wildlife Commission Act (2004) and the Parks and Reserves (Framework for the Future) Act. The Northern Territory Parks and Conservation Masterplan gives sets out to ensure that the ecological health and intactness of the NT's land and sea is maintained for the future (Northern Territory Department of Natural Resources Environment and the Arts, 2005). The Masterplan gives the PWCNT broad strategic direction for development and management of the reserve system in the NT consistent with the National Reserve System Guidelines (Northern Territory Department of Natural Resources Environment and the Arts, 2006). The Masterplan focuses on setting priorities for biodiversity conservation, establishing partnerships in the conservation and sustainable use of biodiversity, and providing new direction for the NT's protected areas.

Legal recognition of Aboriginal rights to traditional lands began with the Commonwealth Government legislation Aboriginal Land Rights Act (Northern Territory). When national parks and conservation areas were claimed under this act, the need for joint management arrangements arose. Joint management means the establishment of a legal partnership and management structure which reflects the rights, interests and obligations of the traditional Aboriginal owners of the park, as well as those of the relevant government agency acting on behalf of the wider community. Garig Gunak Barlu National Park (NT) became Australia's first jointly managed national park in 1981. Following this, other national parks in the NT have entered into joint management agreements (Smyth, 2001). Statutory provision exists with the Northern Territory Parks and Wildlife Commission Act (2004) for joint management arrangements and community involvement in park management planning. The PWCNT is currently in the active process of entering into these arrangements with traditional Aboriginal owners in conservation areas across the NT. Smyth (2001) discusses different types of joint management arrangements in place in national parks across Australia and the potential advantages and disadvantages of joint management. Key elements of these arrangements are:

- Transfer of national park ownership to traditional Aboriginal owners in exchange for continuity into the foreseeable future of the national park status over the land and shared responsibility for park management;
- The rights of the traditional Aboriginal owners to occupy and use the parks are recognised and protected in legislation, and/or lease agreements, and/or plans of management. Sites of spiritual significance are protected in a similar way;
- Most arrangements have a small Board of Management comprised of 50% traditional owners and 50% government representatives; and,
- PWCNT is responsible for day to day management of the park.

Within each of the PWCNT's nine administrative districts throughout the NT, annual project plans are developed for native species management, fire management, exotic animal species management, weed management, visitor management, cultural values management, stakeholder engagement, and district management. As a requirement of the Territory Parks and Wildlife Conservation Act plans of management are developed for every protected area in the NT. These plans are replaced at least every ten years, and are reviewed after five years in case modification is required (Northern Territory Department of Natural Resources Environment and the Arts, 2006). Additional feedback on progress from year to year is provided through the Park Audit System. For each of the eight program areas, annual park audits are conducted for all parks to determine if targets and desired trends are being achieved. Audits are in place for the first six program areas. Audits for the stakeholder and district management programs are yet to be developed.

The NT's bird and mammal fauna is comprehensively described, but new species of fish, frogs, reptiles and invertebrates and plants continue to be discovered. Much of the NT's mammal fauna is nocturnal and/or inconspicuous and this group contains the most threatened species and the largest number that have become extinct over the last 100 years (Northern Territory Department of Natural Resources Environment and the Arts, 2006). The predominant threats to the nature of the NT are invasive species and fires. Buffel Grass, *mimosa pigra*, introduced by the pastoral industry is the most dominant weed species in the NT. Feral animal pest species include the cane toad, rock dove (feral pigeon), rabbit, fox, cat, donkey, goat, and water buffalo.

NEW ZEALAND

New Zealand is a mountainous island nation in the south-west Pacific Ocean comprising two large islands (the North Island is 113,729 km^2 and the South Island is 151,215 km^2) and many smaller islands. The country extends more than 1600 km along its main north-north-east axis and has a total area of 268,704 km^2. New Zealand has a long coastline (15,134 km) and its Exclusive Economic Zone is consequently more than 15 times the country's land area. Its climate is temperate with wetter conditions on the western side of the axial mountain range. New Zealand has a unique flora and fauna due to a long period of geographic isolation. Around 80% of flora is endemic to New Zealand. Native forests are evergreen and dominated by podocarps. Grasslands dominated by tussocks are found in sub-alpine areas and low shrublands are found between the forests and the grasslands. Prior to human arrival, 80% of the country was forested. Aside from three bat species (one now extinct), New Zealand has no terrestrial mammals. Instead, birds dominate most ecological niches. With the arrival of humans (Māori people from Polynesia and later European settlers) came widespread deforestation and mammalian predators that have had devastating effects on native bird populations (Craig, Anderston, Clout, Creese, Mitchell et al., 2000). Today, New Zealand's natural values are most threatened by introduced mammalian pests. Of particular note are the Australian Brushtail Possum, which is having devastating effects on New Zealand's indigenous forests, and mammals including stoats, rats, and ferrets that prey on native birds and insects.

New Zealand does not have a constitution. Instead, its founding document is the *Treaty of Waitangi,* an agreement signed in 1840 between Britain and Māori chiefs. The Treaty established New Zealand as a British colony. However, the English and Māori versions of the Treaty differ in respect to some important points of sovereignty and much controversy and political debate surrounds the Treaty today.

The protected areas of New Zealand are managed by the Department of Conservation[5] (DOC). Its mission is 'to conserve New Zealand's natural and historic heritage for all to enjoy now and in the future'. In addition to the management of New Zealand's 14 national parks (see Figure B and Table A) the DOC is responsible for managing/administering conservation parks (formerly called forest parks), reserves and conservation areas, protected indigenous forests, protected inland waters and wild and scenic rivers, indigenous/native wildlife, non-commercial freshwater fisheries, historic places on conservation land, marine reserves and the protection of marine mammals, and offshore islands set aside for conservation (Department of Conservation, 2006). This means that the DOC carries out all conservation management functions in all protected areas, as well as marine conservation and 'off-estate' advocacy for conservation.

Following the establishment of New Zealand's first national park, Tongariro national park, in 1887, the national park and reserves system grew rapidly. Early efforts to protect land concentrated on mountainous areas with minimal public opposition to protection and little alternative economic value. Only since the 1960s has there been emphasis on protecting significant lowland forest areas, wetlands, and coastal areas (Green, 1992).

The DOC services the New Zealand Conservation Authority and 14 regional conservation boards. The Authority provides independent advice to the Minister of Conservation and the Director General. Its members are appointed by the Minister. The regional conservation boards provide advice to the Authority and the Director General. The Department has a hierarchical structure with a Head Office and three Regional Offices. Each Regional Office oversees a number of Conservancy Offices, which, in turn, oversee a number of Area Offices (Department of Conservation, 2006).

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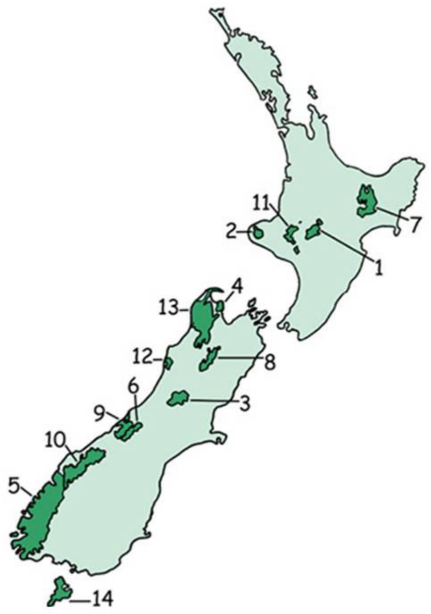
[5] Department of Conservation website: www.doc.govt.nz

Figure B
Map Showing the National Parks of New Zealand



Source: Adapted from Kiwi Conservation Club (1999)

Table A
Details of the National Parks of New Zealand

National Park	Size (ha)	Year of establishment	UNESCO World Heritage Status
Arthur's Pass	114,394	1929	No
Abel Tasman	22,541	1942	No
Egmont	33,543	1900	No
Fiordland	1,257,000	1952	Yes – natural
Kahurangi	452,000	1996	No
Mt Aspiring	355,543	1964	Yes – natural
Mt Cook (Aoraki)	70,728	1953	Yes – natural
Nelson Lakes	101,753	1956	No
Paparoa	30,560	1987	No
Rakiura (Stewart Island)	163,000	2001	No
Te Urewera	212,673	1954	No
Tongariro	79,598	1887	Yes – natural and cultural
Westland Tai Poutini	117,607	1960	Yes – natural
Whanganui	74,231	1986	No

The legislation governing national parks in New Zealand has evolved since the establishment of Tongariro national park and the administrative structure has been refined and simplified on a number of occasions, namely 1952 and 1980 when the National Parks Act modified (Department of Conservation, 2006; Thompson, 1976). The DOC currently administers 25 Acts of Parliament and has functions under several others and reports to the Minister of Conservation. The most notable acts are the Conservation Act 1987, National Parks Act 1980, Wildlife Act 1953, and Reserves Act 1977. The DOC was established in 1987 with the passing of the Conservation Act 1987, which sets out the majority of the DOC's roles and responsibilities with regard to the conservation of natural and historic resources (Department of Conservation, 2006). The National Parks Act provides for managing all national parks and the creation of new national parks. The General Policy for National Parks (2005) also provides guidance for managing national parks. The country's first national parks had an emphasis on mountain areas. Since the 1980s, emphasis has been placed on developing a more representative national park system that includes other ecosystems, particularly lowland ecosystems. The Wildlife Act (1953) covers the protection and control of wild animals and birds, and the management of game, including permits necessary to deal with certain wildlife. The Reserves Act (1977) has three main functions: the provision of reserves, preservation of representative natural ecosystems, and the preservation of access to waterways for the public.

The DOC gains strategic direction from a number of policies and plans, notably (Department of Conservation, 2006):

- The Statement of Intent, a document that sets out management actions for the coming year and directions for a four year term;
- Conservation management strategies, 10-year regional strategies that provide direction and priorities for the management the conservation land and waters, and species that the DOC has responsibility for;
- Species recovery plans, plans that set priorities and management direction for threatened species; and,
- Pest management strategies, plans that provide direction for the control of pest numbers.

The DOC is guided by more than 300 policies, standards, best practice documents and standard operating procedures (Department of Conservation, 2005b). The

DOC is required to ensure that conservation values are considered in historical grievance claims under the Treaty of Waitangi where there are issues involving ownership or management of marine and terrestrial species. The DOC also works with other Crown agencies to minimise biosecurity risks (Department of Conservation, 2006).

The management of national parks in New Zealand is influenced by specific legislation, policies, strategies and plans; as well as international environmental agreements, advice from UNEP and nature-NGOs, the principles of the Treaty of Waitangi and the abovementioned strategic documents where relevant. The legislation and policies that guides national park management in New Zealand are hierarchical in nature and are shown in Figure C.

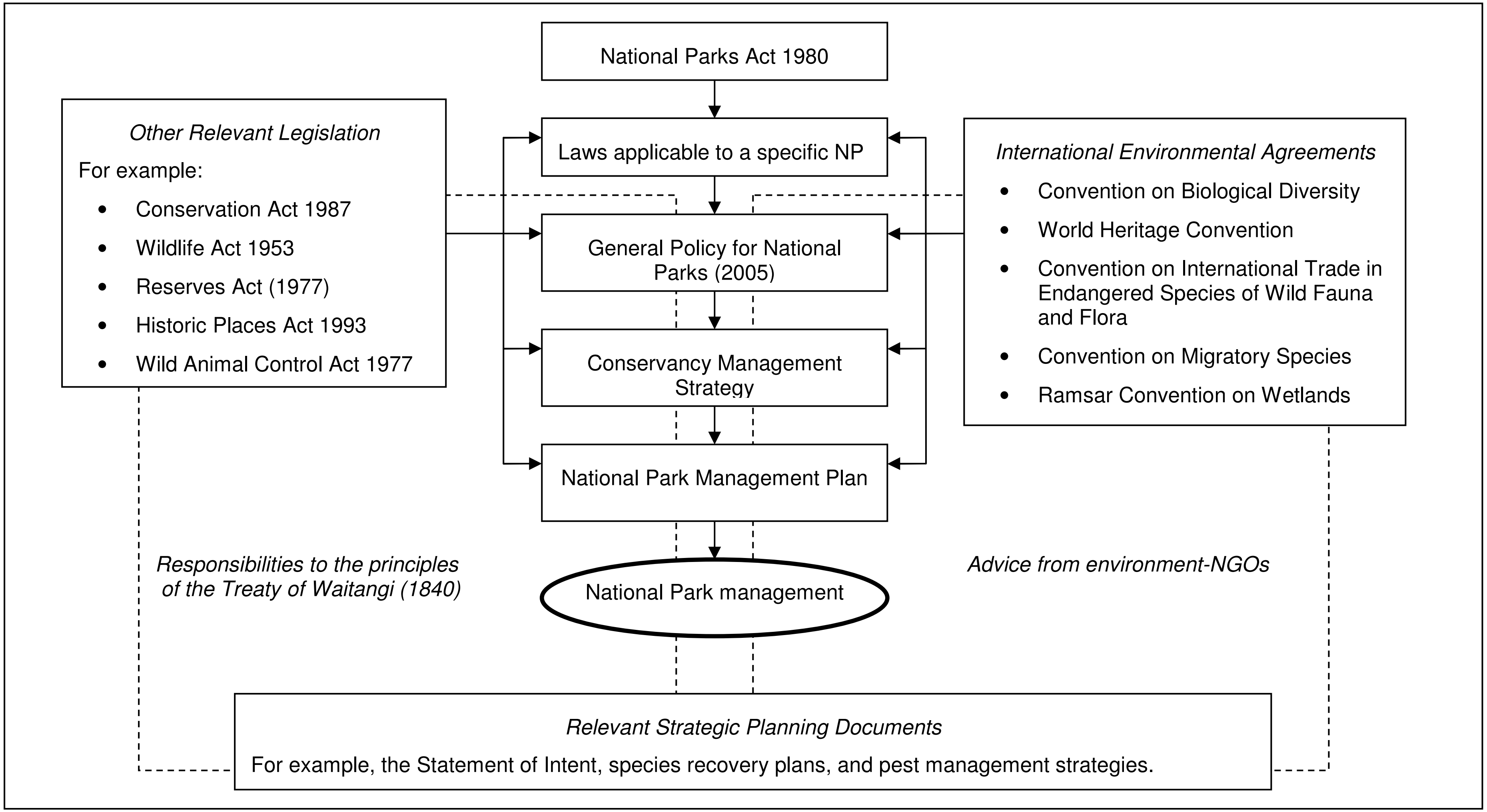
For the 2005-2006 financial year, the DOC's budget was $280.8 million, of which 47% was allocated for nature conservation, followed by recreation at 41%, and management of historic sites at 2% (Department of Conservation, 2005a). By law, the DOC cannot set fees for entry to any area of public conservation land. Fees and charges may be set for the provision of facilities and services, and for the issue of concessions, permits, and other consents.

Facility fees can be charged for the use of any hut or campsite facility, but not for use of the track system. There is a national system of fees for these facilities, and generally charges are levied by category.

The DOC maintains and operates a network of back-country huts and campsites through the country. These are divided into various categories depending on the level and quality of facilities at each. Nine of the tracks are international tourism icons under a 'Great Walk' brand, and the huts on these tracks are charged at a rate that ensures full cost recovery for their provision. This means there is no government subsidy towards the provision of Great Walk huts. However, for the other categories of huts and camps there are varying levels of subsidy (WCPA-IUCN, 2000). In 2005 visitor infrastructure included 12,900 km of walking tracks, 990 backcountry huts and 306 campsites with a combined value of approximately NZ$400 million (Department of Conservation, 2005a).

Figure C

Legislation and Policy as it influences National Park Management in New Zealand



Concessions are necessary for running commercial activities such as tourism, agriculture, horticulture, telecommunications and commercial filming in an area managed by the DOC. Permits are required to take, hold, release, or kill protected species and to collect and/or undertake research on plants, animals, or geological samples. Permits or licences are also required for fishing and some hunting activities. Revenue from ‘external’ sources is retained by the Department, this is an incentive for the DOC to maximise revenue generating activities and the recovery of costs. By law, concession fees may be set at market value as a percentage of Gross Income, having regard to special circumstances (WCPA-IUCN, 2000). In 2005, the number of concessions managed by the DOC for tourism-related business activities was 889. The total number of concessions may reach up to 4000 in any one year as many of them are one-off activities like filming permits and telecommunications installations (Department of Conservation, 2005a).

The DOC has recently invested in a series of regional economic studies (Department of Conservation, 2004a,2004b) that identify the economic activity that is dependant on conservation land administered by the DOC within a region. It was calculated that in 2004 Abel Tasman National Park alone employed 370 full-time equivalents and earned NZ$45 million for the Nelson-Tasman regional economy (Department of Conservation, 2004a).

Native species management involves species recovery, control of exotic pests and habitat maintenance (Department of Conservation, 2005a). Projects such as animal pest control (possum, goat and deer control), weed control, structural maintenance, and hut and trail maintenance undertaken at the Conservancy and Regional Office levels are selected based on a scoring procedure. For example, in selecting which weed control projects to fund, all of the proposed projects are scored on a range of factors. These might include the ecological importance of the site, the potential for the weed to spread to nearby ecologically sensitive areas, and the weed’s dispersal potential throughout the region/country. The scores for each factor are added together to give an overall score. A cut-off score is set and only projects with scores above the cut-off are funded (Guikema & Milke, 1999).

SOUTH AFRICA

The Republic of South Africa is a large country of 1,221,037km^2 located on the southern tip of the African continent. The country has nine provinces and is bordered by Namibia, Botswana, Zimbabwe, Mozambique and Swaziland. Lesotho is an independent enclave to the east. South Africa has 2,500km of coastline. It has the largest population of mixed racial background, whites, and Indian communities in Africa. Black South Africans constitute just less than 80% of the country's population. Tension between the white minority and black majority culminated in segregation under Apartheid, which ended in 1994. South Africa has the largest and best developed economy on the continent.

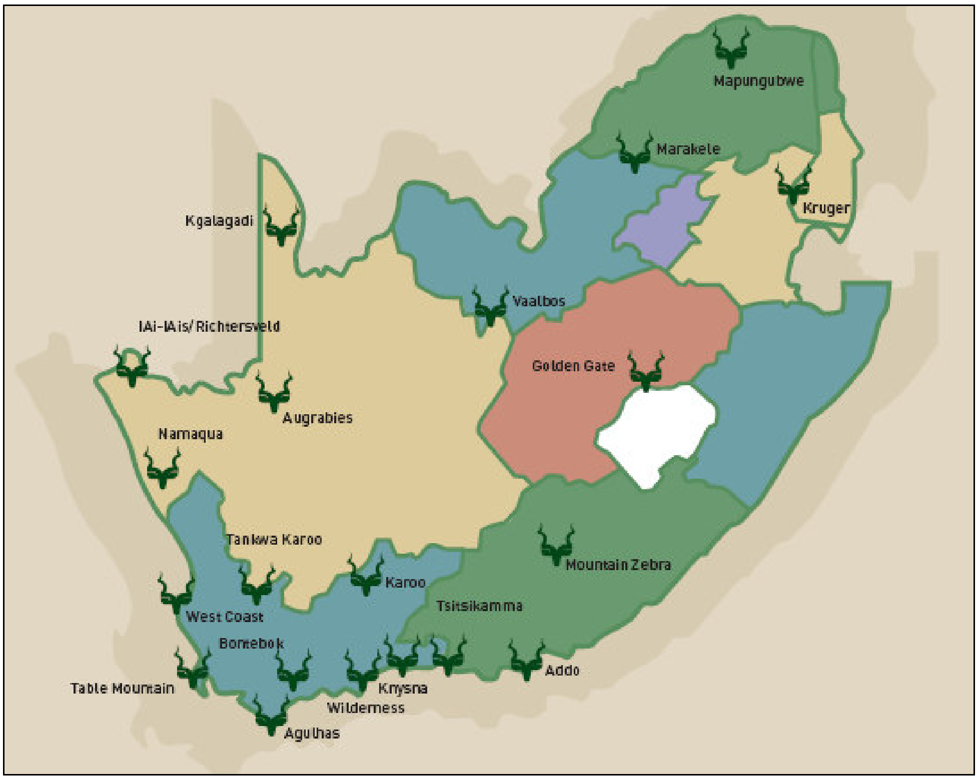
South Africa has a variety of climatic zones, from deserts to subtropical areas. There is also considerable variation in topography, including lowlands, mountain escarpments, and a flat high plateau. This climatic and topographical variation is responsible for rich plant diversity. South Africa is estimated to contain approximately 10% of the Earth's plant species. The country is dominated by grassland, which becomes sparser to the north-west due to low rainfall. To the north-east, grass and thorn savannah changes to a denser bush savannah. South Africa has many flowering plants, but little forest. Numerous species of charismatic megafauna are present, particularly in the bush savannah areas where species include big cats, many types of antelope, rhino, giraffe, hippopotamus, hyena, zebra and elephant.

There has been widespread habitat loss throughout the country due to overpopulation and sprawling development. Exotic flora species pose the greatest threat to biodiversity. Other threats include habitat loss through fires, and wildlife loss through disease and poaching. Another threat to natural habitats is the overabundance of species like elephants, which cause major habitat modification by turning woodland into savannah. Thus, a challenge for national park managers is to gain public support for the culling of some populations.

In 1910, the Game Reserves and general wildlife preservation were the responsibility of the Transvaal administration. In 1926 the National Parks Act (No.

56) was passed and the first board of South African National Parks (SANParks) was appointed. SANParks[6] is a government parastatal agency responsible for the management of South Africa's national parks. Other protected areas are managed by provincial government agencies. SANParks is responsible for 3,751,113 ha of protected land in 20 national parks (see Figure D), including four transboundary national parks. Under Apartheid, the focus of the agency was biological conservation and good records exist. In the first decade of democracy, following major political changes in 1994 the national parks have been made more accessible to tourists so that conservation of these areas remains a viable contributor to social and economic development in rural areas. SANParks generates 75% of its operating revenue (SANParks, 2005).

Figure D
Location Map for the South African National Parks



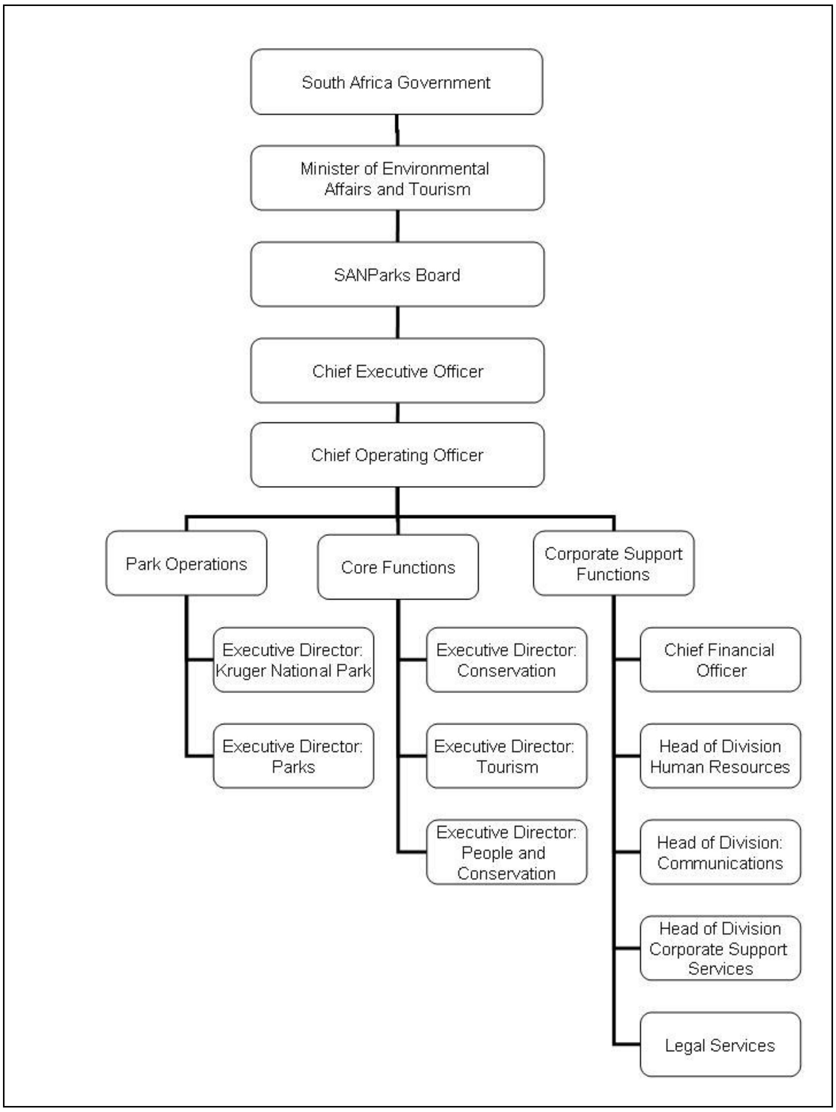
Source: SANParks (2005)

The Minister of Environmental Affairs and Tourism appoints the South African National Park's Board, which is the highest decision making body of SANParks (Figure E). The agency has a Head Office in Pretoria and staff at all twenty

[6] SANParks website: www.sanparks.org/

national parks. It also provides accommodation in fifteen of the parks and day visit services in all of the national parks. Visitors pay a fee to enter the national park and commercial activities such as tours and day/night drives, restaurants, and curio shops are found within most parks.

Figure E
SANParks Organisation Chart



Source: SANParks (2005)

According to the National Parks Act (1976) the role of SANParks is to control, manage, and maintain South Africa's national parks and to utilise its revenues for that purpose. Leading from this directive, SANPark's vision is 'to develop and manage a system of national parks that represents the biodiversity, landscapes, and associated heritage assets of South Africa for the sustainable use and benefit of all'. Thus, South Africa's national parks are managed according to three primary objectives (SANParks, 2005):

1. To conserve a representative sample of the biodiversity of the country;

2. To maintain a relationship of community upliftment and capacity building amongst people living in the areas in and around the parks; and,

3. To provide a recreational outlet to the public to experience and enjoy the wonders of the parks.

These objectives are reflected in the structure of SANParks core functional Departments: 'Conservation Services', 'People and Conservation', and 'Tourism' as shown in Figure E.

The Conservation Services Department provides SANParks with the services needed to manage national parks for the conservation and sustainable use of biodiversity under the *Protected Areas Act (No. 57, 2003)*. According to SANParks (2006), this Department consists of the following units:

1. Park Planning and Development – responsibilities include planning the overall system of national parks, acquisition of land for new/expansion of existing national parks, the development of Management Plans (a requirement under the National Environment Management: Protected Areas Act, 2003), compilation of Conservation Development Frameworks to guide visitor use and facilities development, Integrated Environmental Management Systems and Environmental Auditing, Land Restitution, and, capacity building;
2. Transfrontier Conservation – SANParks is responsible for the implementation of four transfrontier parks and one transfrontier conservation area;
3. Veterinary Wildlife Services – Responsible for game capture and relocation, population control, wildlife sales (revenue generation), enhancing the conservation status of rare and abundant species, disease research, and capacity building;

4. Air Services – responsible for providing the specialised aircraft maintenance and flying skills necessary for wildlife census and capture; and,
5. Scientific Services – responsibilities include environmental monitoring and research on key themes considered necessary for national parks to meet their key objectives, coordinating research projects conducted by external scientific institutions in national parks, integrating best available biodiversity data into park management through interactions with external researchers and research institutions, maintaining inventories of biodiversity in national parks, including species checklists for vertebrates and higher plants, and the mapping of landscapes, geology, soil and vegetation, identifying and averting threats to biodiversity in national parks, ensuring that development within parks takes place in a manner that does not compromise biodiversity conservation, and, identifying biodiversity conservation priorities for park expansion.

The People and Conservation Department is responsible for support for the conservation of natural and cultural heritage through strengthening relationships with neighbouring park communities and enhancing access to parks, cultural resource management and promoting of indigenous knowledge, environmental education, awareness and interpretation, social science research, and youth outreach (SANParks, 2005). Following South Africa's change to a democratic system of government, SANParks is in the process of directing the benefits of its activities to all South Africans, rather than the more wealthy sections of society.

The financial resources generated by tourism are necessary for SANParks to meet its conservation and community objectives. The Tourism group are responsible for the activities visitors undertake in the national parks, the facilities they use, the marketing and advertising of the parks, and information provision to tourists (e.g. birding information, accessibility, malaria information). Park run accommodation is offered in 15 of the national parks and those without park run accommodation have privately run accommodation on the park fringes (SANParks, 2005). In 1999, SANParks reviewed its commercial operations and found inadequacies in comparison to similar private tourism operations. As a result, SANParks chose to focus on its core business—managing biodiversity—and transfer the management of commercial operations like lodges/hotels, restaurants, shops to private operators. A phased approach to commercialisation was adopted. The commercialisation process aimed to generate additional revenue for SANParks and force long-term business relationships with historically disadvantaged people living in the park localities and private operators (de la Harpe, Fearnhead, Hughes, Davies, Spenceley et al., 2004).

THE CZECH REPUBLIC

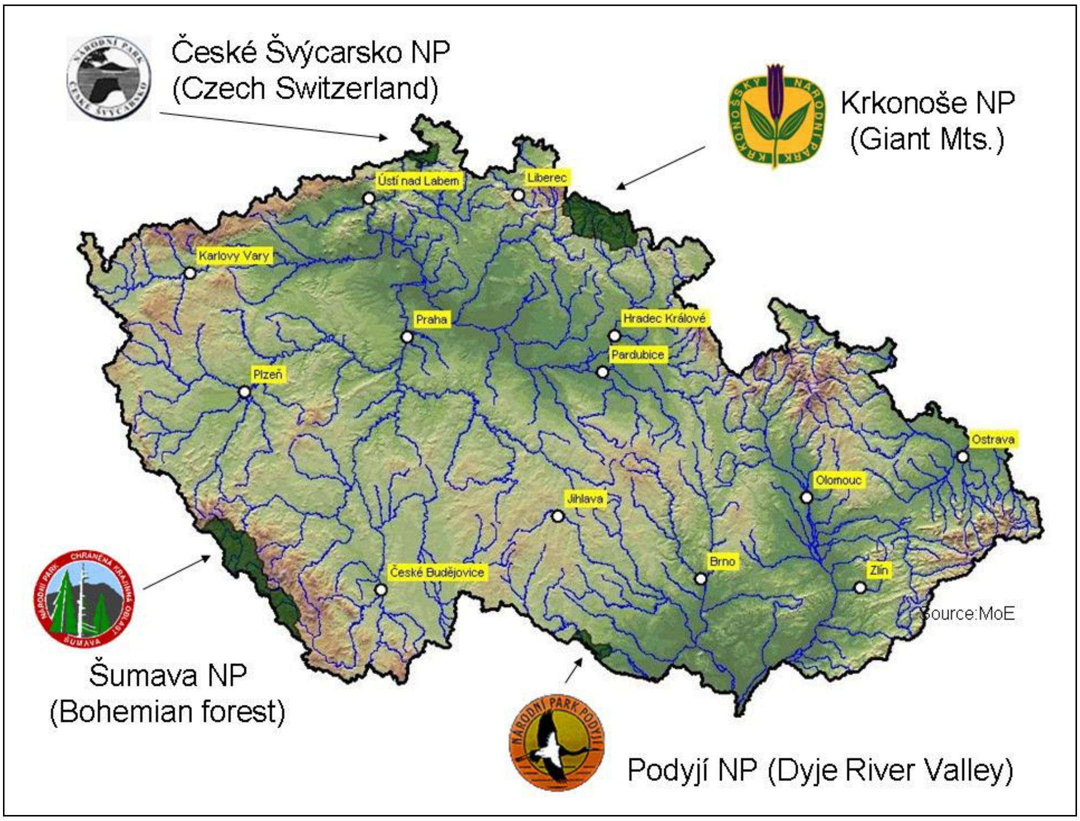
The Czech Republic in central Europe is a landlocked country of 78,864km^2. It is bordered by Germany to the west, Poland to the north-east, Slovakia to the south-east, and Austria to the south. The Czech Republic has a varied landscape of lowlands, highlands, and mountains and, consequently, a diversity of geological and biological phenomena. Typical landscapes include alluvial forest and river flood-plains, wetlands and peat bogs, forest-steppes, extensive areas of broadleaved and coniferous forests, areas of karst and caves, castellated rocks, alpine meadows, and Arctic-alpine tundra (Ministry of the Environment of the Czech Republic, c.2004). The climate is temperate, with warm summers and cold, cloudy, humid winters. The landscape has been inhabited for millennia, but some natural areas are still intact. Animals and birds including the wolf, wildcat, lynx, big bustard, and grouse can still be found in the wild (Ministry of Foreign Affairs of the Czech Republic, 2006).

The Czech Republic's protected area network includes four national parks and twenty-five protected landscape areas (Ministry of the Environment of the Czech Republic, c.2004). The latter are extensive IUCN category IV areas that are largely forest or grassland ecosystems in which economic use occurs in different zones of intensity. The four national parks of the Czech Republic (see Figure F and Table B) are all located on along the country's borders and co-operation with neighbouring countries is a focus of park management as each national park is part of a transboundary arrangement.

All of the parks have buffer zones, are members of the EUROPARC Federation, and are included in the proposed European Ecological Network (EECONET) as core areas (Ministry of the Environment of the Czech Republic, 2005). Traditional inhabitants have not been forced to leave their territories and there are inhabitants in all of the country's national parks (Ministry of the Environment of the Czech Republic, c.2004).

Figure F

Map of National Parks of the Czech Republic



Source: Ministry of the Environment of the Czech Republic (2005)

The conservation of nature and landscape in the Czech Republic, both within and outside protected areas, is governed by the *Landscape Conservation Act (N. 114/1992)*. The Ministry of the Environment of the Czech Republic[7] (MoE) founded the four national parks and appointed four administrations to manage each national park. The Protected Landscape Areas are managed by the Agency for Nature Conservation and Landscape Protection of the Czech Republic, and both this organisation and the national park administrations report to the MoE. The MoE has a number of roles in national park management: it provides finances for each Administration's management activities, undertakes specific acts of state

[7] Ministry of the Environment of the Czech Republic website: http://www.env.cz/AIS/web-en.nsf/

administration, co-ordinates international relationships, and gives methodical guidance.

Table B

Details of the National Parks of the Czech Republic

National Park	České Švýcarsko (Bohemian Switzerland)	Krkonoše (Giant Mountains)	Podyjí (Dyje River Valley)	Šumava (Bohemian Forest)
Administration	Správa Národního parku České Švýcarsko	Správa Krkonošského Národního parku	Správa Národního parku Podyjí	Správa Národního parku a chráněné krajinné oblasti Šumava
Established	2000	1963	1991	1991
Size (ha)	80	363	63	681
Transboundary partner	Germany (Sächsischer Schweiz National Park)	Poland (Karkonoski National Park)	Austria (Thayatal National Park)	Germany (Bavarian National Park)
Other designation/s	-	UNESCO Biosphere Reserve, Important Bird Area, Ramsar status	European Diploma from the Council of Europe	UNESCO Biosphere Reserve
Surrounding area	Protected Landscape Area	Buffer zone	Buffer zone	Protected Landscape Area
Funding	Fully government funded	Partially government funded	Partially government funded	Partially government funded

Under the Landscape Conservation Act (N. 114/1992), which was amended in 2004 to include the European Union's legislation requirements, the Administration of each national park is responsible for:

1. The execution of special acts of state administration in nature conservation and landscape protection, agricultural land resources protection, and fisheries protection;

2. The execution of user rights on government-owned lands, especially rights for game keeping and hunting;

3. Professional activities related to conservation including coordination of research and monitoring and development of management plans; and,

4. Public education and relations, including visitor centres, information provision, visitor facilities, and awareness/educational activities (Ministry of the Environment of the Czech Republic, 2005).

Because the environments of the national parks differ significantly, forest management, game management, and fisheries are governed by internal MoE directives rather than blanket policy (Ministry of the Environment of the Czech Republic, 2005). The Act stipulates three zones of protection in each national park, delimited according to natural characteristics. These range from strict protection (zone I), to valuable secondary ecosystems (zone II), and man impacted and exploited ecosystems (zone III). The aim of zone III is to support permanent habitation, services, agriculture, tourism and recreation that is consistent with the principles of the national park's mission (Správa Národního parku a chránené krajinné oblasti Šumava, 2006).

Under the *Act* national park administrations propose management plans, issue decrees on Visitor Rules (provisions on utilisation of the national park for the purposes of education), set fees, grant permission for research activities, and establish councils (initiative and consultative authority). Fees may be collected for driving or staying with motor vehicles in the parks, or for entry into selected parts of the national park that are outside of built-up municipalities. These fees mush be approved by the MoE and become an income stream for the administration. They have jurisdiction over the territories of national parks and their buffer zones. Compensation for complications of agricultural or forest management are granted by the relevant nature protection authority from state budget funds. The forests in a national park cannot be used as timber forests, but rights to hunt or fish can be granted (Ministry of the Environment of the Czech Republic, 2005).

MANAGEMENT OF THE KRKONOŠE NATIONAL PARK

The Krkonoše mountain region is characterised by socioeconomic problems and it has proved challenging to balance socioeconomic needs in a national park on the verge of ecological collapse. In response to these problems the area was declared a UNESCO Biosphere Reserve in 1992 with the following aims: conservation of the variety of species; high-quality research and monitoring; and, sustainable long-term regional development. The process of fulfilling these aims involved the implementation of a zoning system for development intensity in and around the national park. About 300 permanent inhabitants live in the first and second zones of the Krkonoše National Park (4,400 and 4,000 ha respectively), nearly 5000 in the third zone (27, 900 ha), and 21,500 people in the transition zone (Správa Krkonošského Národního parku, 2006).

Tourism is the only potential source of prosperity for the national park's inhabitants and closest neighbours. With careful planning, tourism has the potential to provide jobs, stimulate the local economy, and earn foreign exchange. It is strongly felt that national park status should be an economic advantage for local inhabitants rather than an obstacle. The area is intensively used for both summer and winter recreation. Visitor facilities include many hotels, boarding houses and recreation chalets. The bulk of the 5-7 million visitors per annum arrive during the winter months.

Krkonoše National Park Administration has a staff of 340 people and is managed with a budget of c.300 million Czech crowns, of which 80% is spent on forest management, and 20% on nature conservation and all other activities (Správa Krkonošského Národního parku, 2006). Several universities and institutions undertake research into the national park's geology, geomorphology, climatology, botany, zoology, forestry and agriculture. The Krkonoše National Park Administration undertakes long-term monitoring programmes and is equipped with a chemical laboratory and up-to-date GIS facilities.

The greatest threats to the natural values of the national park are air pollution and excessive tourist numbers. Krkonoše National Park was listed by IUCN in 1984 as one of the world's most threatened protected areas because of the effects of air pollution on the Norway spruce forests 900 metres above sea level. This damage is exacerbated by population explosions of conifer pests. Most of the pollution sources are situated in adjacent areas of the Czech Republic, Poland, and Germany (Správa Krkonošského Národního parku, 2006). Krkonoše National Park and the adjacent national park in neighbouring Poland (Karkonoski National Park) are listed in the group of the most visited national parks in the world. Damage to the sensitive mountain ecosystems includes trampled paths and earth erosion, damaged flora, tons of waste products, noise and emissions from transport, and excessive building (Správa Krkonošského Národního parku, 2006). The Šumava National Park Administration identifies the same major threats to the natural values of Šumava National Park and is assessing the carrying capacity of the park for tourists in order to develop a sustainable tourism plan (Správa Národního parku a chránené krajinné oblasti Šumava, 2006). The Podyjí National Park Administration is also developing visitor regulations (Správa Národního parku Podyjí, 2006).

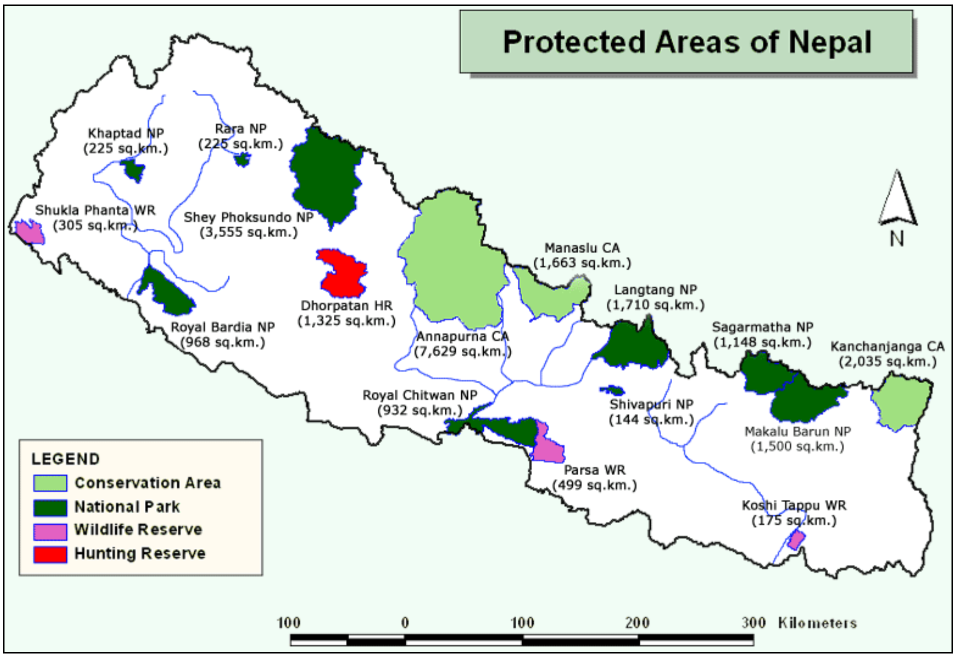
NEPAL

Nepal is a land landlocked country of extreme contrasts in climate and geography, ranging from lowlands with sub-tropical jungles to arctic conditions in the Himalayan highlands. Because of extreme changes in altitude over short distances and monsoon rainfall on some mountain slopes, Nepal experiences a large array of climatic zones supporting a diversity of plants, birds, and animals (Visit Nepal Network, 2006). These include 847 species of birds, 640 species of butterflies, 6,500 species of flowering plants, and 175 species of mammal. Endangered wildlife species include the Royal Bengal Tiger, Greater One-horned Rhinoceros, Asian Elephant, Gaur, Swamp Deer, and Black Buck (Department of National Parks and Wildlife Conservation, c2001).

The Department of National Parks and Wildlife Conservation[8] (DNPWC) is part of the Ministry of Forests and Soil Conservation. Under the National Parks and Wildlife Conservation Act (1973), the DNPWC is responsible for the management of Nepal's nine national parks, as well as wildlife reserves, conservation areas, and hunting reserves (Figure G and Table C). These protected areas represent close to 18 percent of Nepal's total land area. In addition to the National Parks and Wildlife Conservation Act (1973), wild flora and fauna are also protected under the Forest Act, the Aquatic Fauna Act and the Environment Protection Act (Department of National Parks and Wildlife Conservation, c2001).

[8] Department of National Parks and Wildlife Conservation website: www.dnpwc.gov.np/

Figure G
Map showing the Protected Areas of Nepal



Source: Nepal Safari (2005)

Table C

Details of the National Parks of Nepal

National Park	Established	Size (ha)	Other designation/s	Buffer zone
Khaptad	1984	25,500	-	-
Langtang	1976	171,000	-	-
Maklu Barun	1992	233,000	-	-
Rara	1976	10,600	-	-
Royal Bardia	1988	96,800	-	32,700 ha of forests and private lands declared in 1997
Royal Chitwan	1973	93,200	UNESCO World Heritage List (1984)	75,000 ha of forests and private lands declared in 1996.
Sagarmatha	1976	114,800	UNESCO World Heritage List (1979)	-
Shey Phoksundo	1984	355,500	-	-
Shivapuri	2002	14,400	Important Bird Area (BirdLife International)	-

The DNPWC aims to conserve the country's major representative ecosystems and unique natural and cultural heritage, and protect valuable and endangered wildlife species. It also encourages research for the preservation of wild genetic diversity

(Department of National Parks and Wildlife Conservation, c2001). These objectives are pursued with an emphasis on species conservation and participatory management through the following activities:

- Conservation of endangered and wild species;
- Scientific management of wildlife habitat;
- Creation of buffer zones around protected areas for sustainable forest management;
- Regulated eco-tourism with an emphasis on improving the socio-economic condition of local communities; and,
- Public education to create awareness of the importance of wildlife (Department of National Parks and Wildlife Conservation, c2001).

The DNPWC has initiated cooperation with India for its Transboundary protected areas. It also has relationships with several national and international organizations for training the Department's staff (Department of National Parks and Wildlife Conservation, c2001).

The greatest threat to the natural values of Nepal's national parks is resource use by people living near the borders of national parks. In addition, the livelihoods of farmers can be threatened by an over abundance of wildlife (Seeland, 2000). In response to this pressure, the Fourth Amendment to the *National Parks and Wildlife Conservation Act* was passed in 1993, allowing the DNPWC to establish buffer zones around forested protected areas frequented by locals for resource use (Nagendra, Tucker, Carlson, Southworth, Karmacharya et al., 2004). Buffer zones are potential tools for reducing encroachment on protected areas by providing rural people with major forest products such as timber, fuel wood, and fodder (Hjortso, Straede, & Helles, 2006).

In 1995 the DNPWC began implementing the Park People Program in the Royal Chitwan National Park and other protected areas with financial and technical aid from the United Nations Development Programme. The programme was later renamed the Participatory Conservation Project. This programme aims to improve the socioeconomic wellbeing of the buffer zone communities and the state of the parks and their surrounding forests (Nagendra *et al.*, 2004). Local people are also involved in the provision of tourist activities for economic gain, such as elephant safaris and guided nature walks. The Nepalese Government has also made legal provision for running hotels and lodges in and around protected areas to improve socio-economic conditions for local people (Department of National Parks and Wildlife Conservation, c2001).

A population of nearly 300,000 people reside in the buffer zone of Royal Chitwan National Park (Hjortso et al., 2006; Nagendra et al., 2004). Within this buffer area, villagers run livestock for milk production and some village communities generate biogas as an alternative energy source to fuel wood. Participatory approaches towards co-management have been implemented in the Royal Chitwan national park buffer zone over the past decade. User groups in the buffer zone manage forest areas in accordance with guidelines that allow communities to keep their own accounts. The major income earned by buffer zone user groups is from tourism. This income is supplemented by smaller income from annual user fees and the sale of forest products, namely firewood. The user groups must spend 40% of their income on conservation, 30% on community development, 20% on income generation and skill development, and 10% on administration. Local people are allowed to enter the Royal Chitwan National Park to collect building material for only ten days per year. Complete protection of the buffer zone forest has been adopted with significant incomes derived from ecotourism. However, local decision-making power is limited, and buffer zone management has been reliant on international donor agencies (Nagendra *et al.*, 2004).

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APPENDIX C:

GOAL HIERARCHY OF THE NORTHERN TERRITORY MODEL

The goal hierarchy of the Northern Territory model is presented here. Each figure reveals another layer of detail.

Figure 0.1

The Overall Goal and Secondary Goals

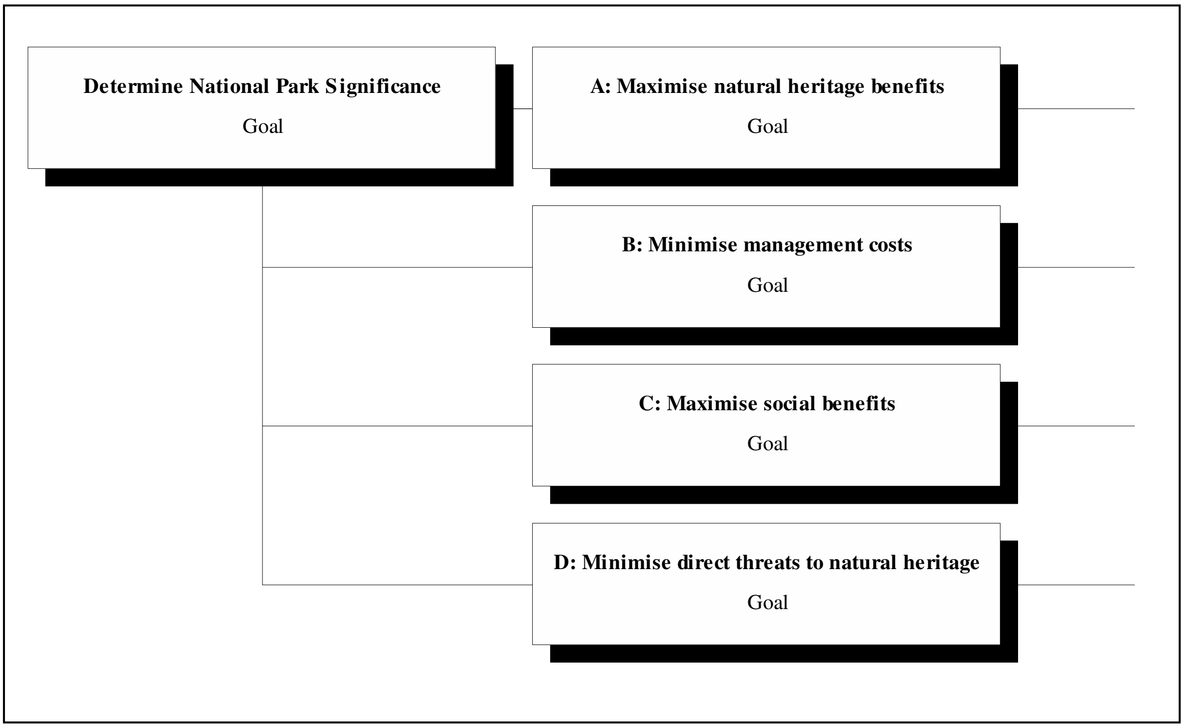

Figure 0.2

Measures belonging to the 'Maximise Natural Heritage Benefits' Secondary Goal'

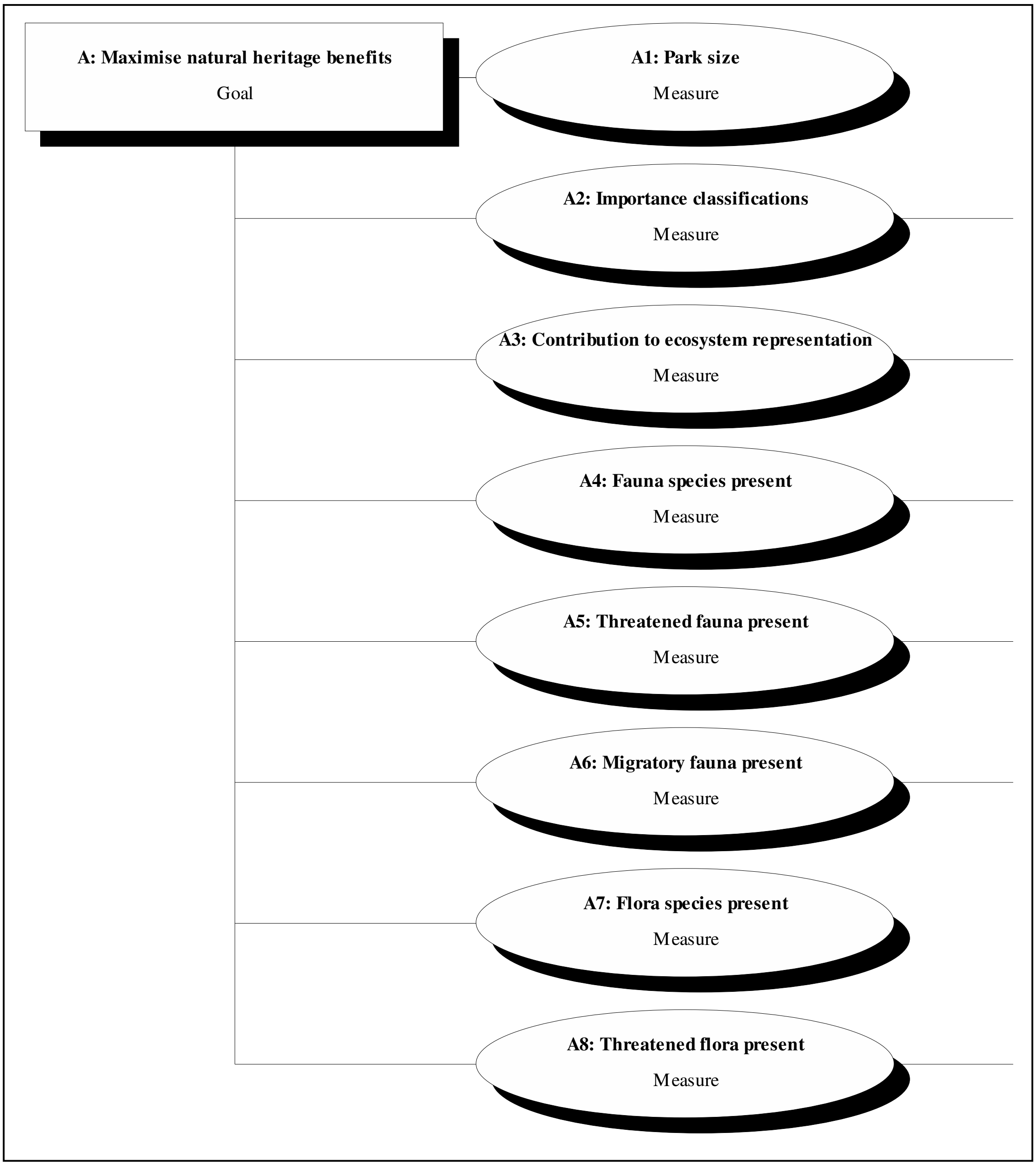

Figure 0.3

Measures belonging to the 'Minimise Management Costs' Secondary Goal

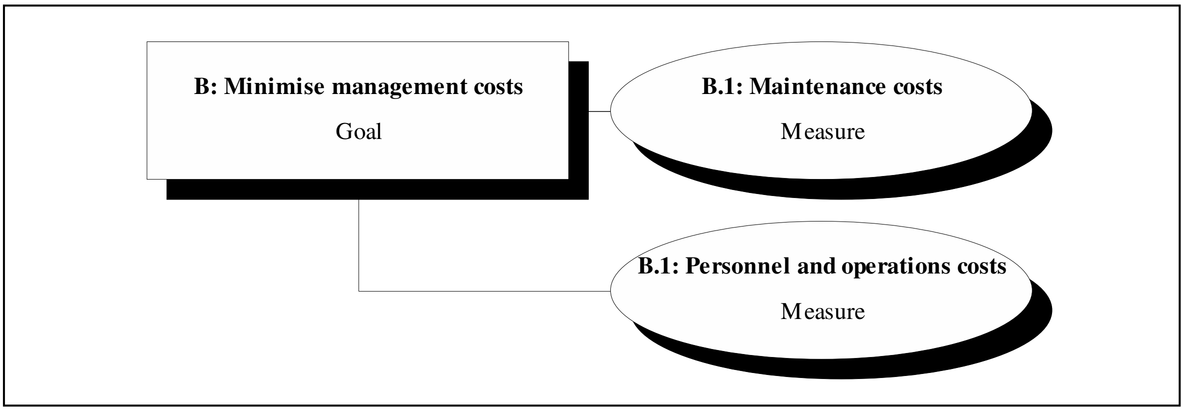

Figure 0.4

Measures belonging to the 'Cultural Heritage' Secondary Goal

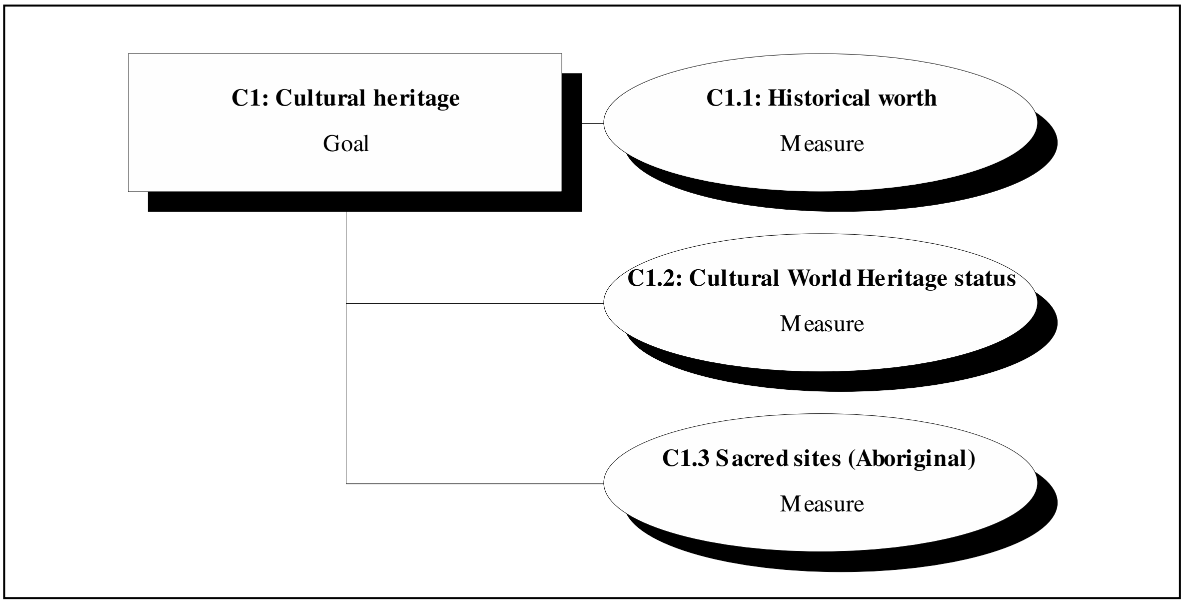

Figure 0.5

Members of the 'Minimise Direct Threats to Natural Heritage' Secondary Goal

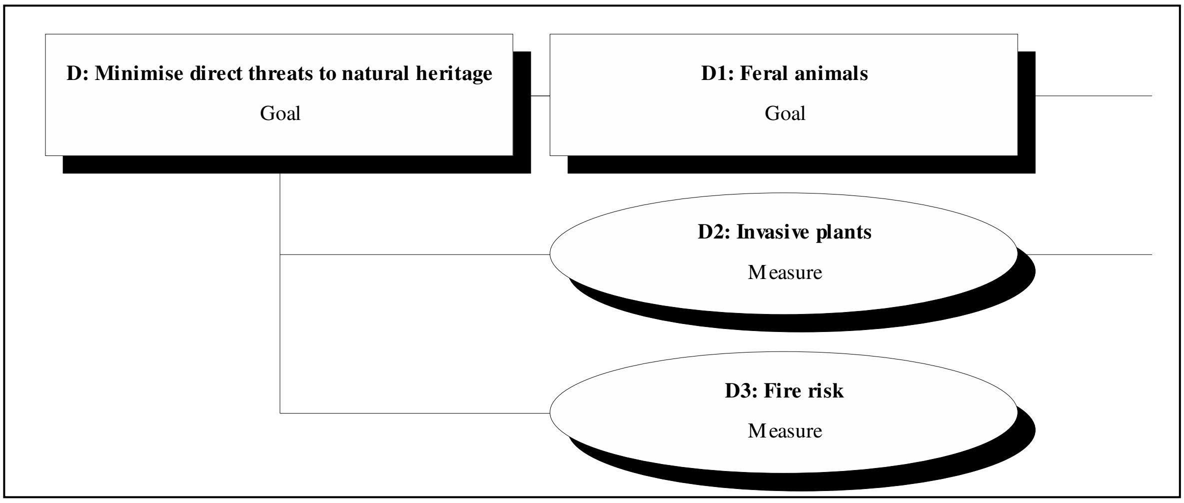

Figure 0.6

Measure Categories for the 'Importance Classifications' Measure

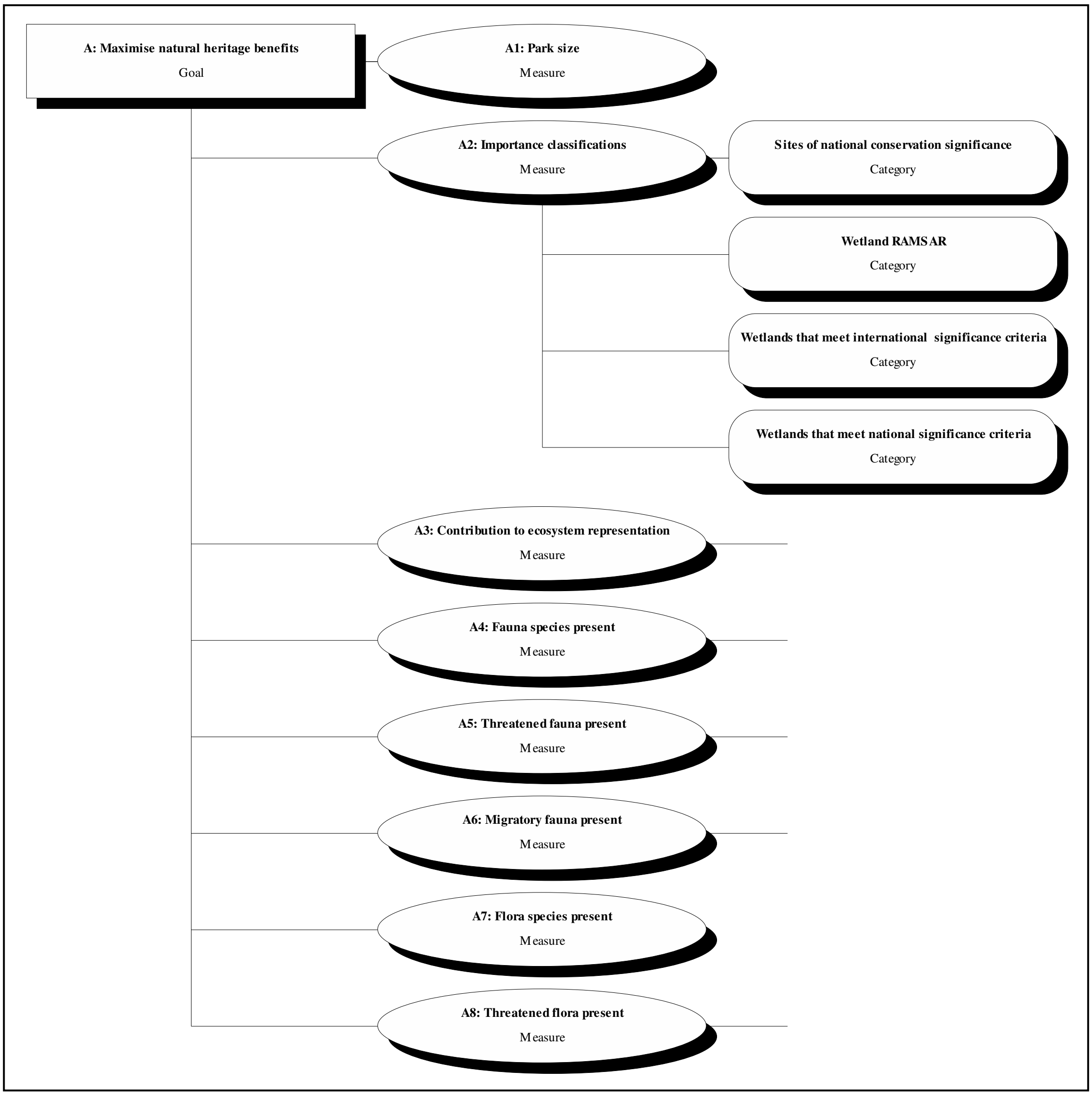

Figure 0.7

Measure Categories for the 'Ecosystem Representation' Measure

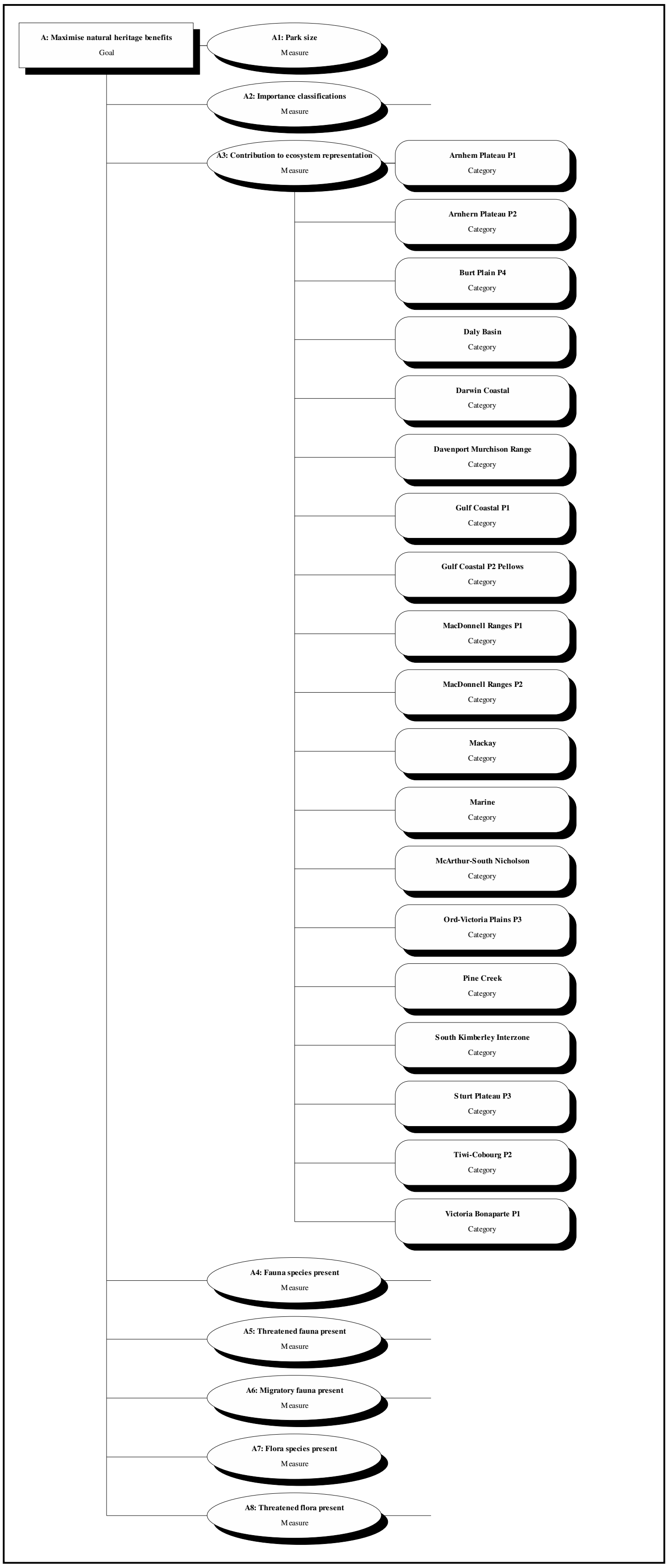

Figure 0.8

Measure Categories for the 'Fauna Species Present' Measure

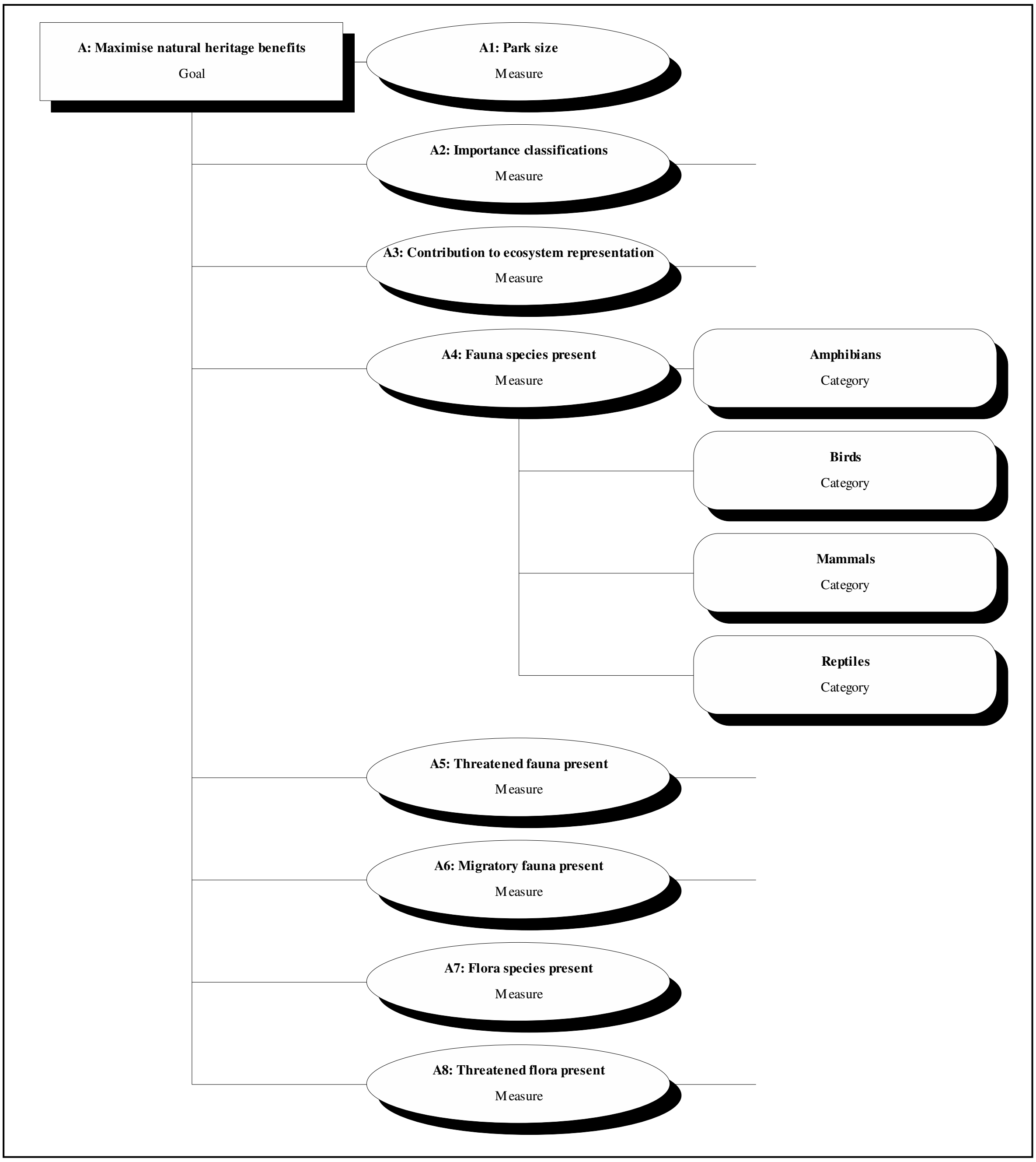

Figure 0.9

Measure Categories for the 'Threatened Fauna Present' Measure

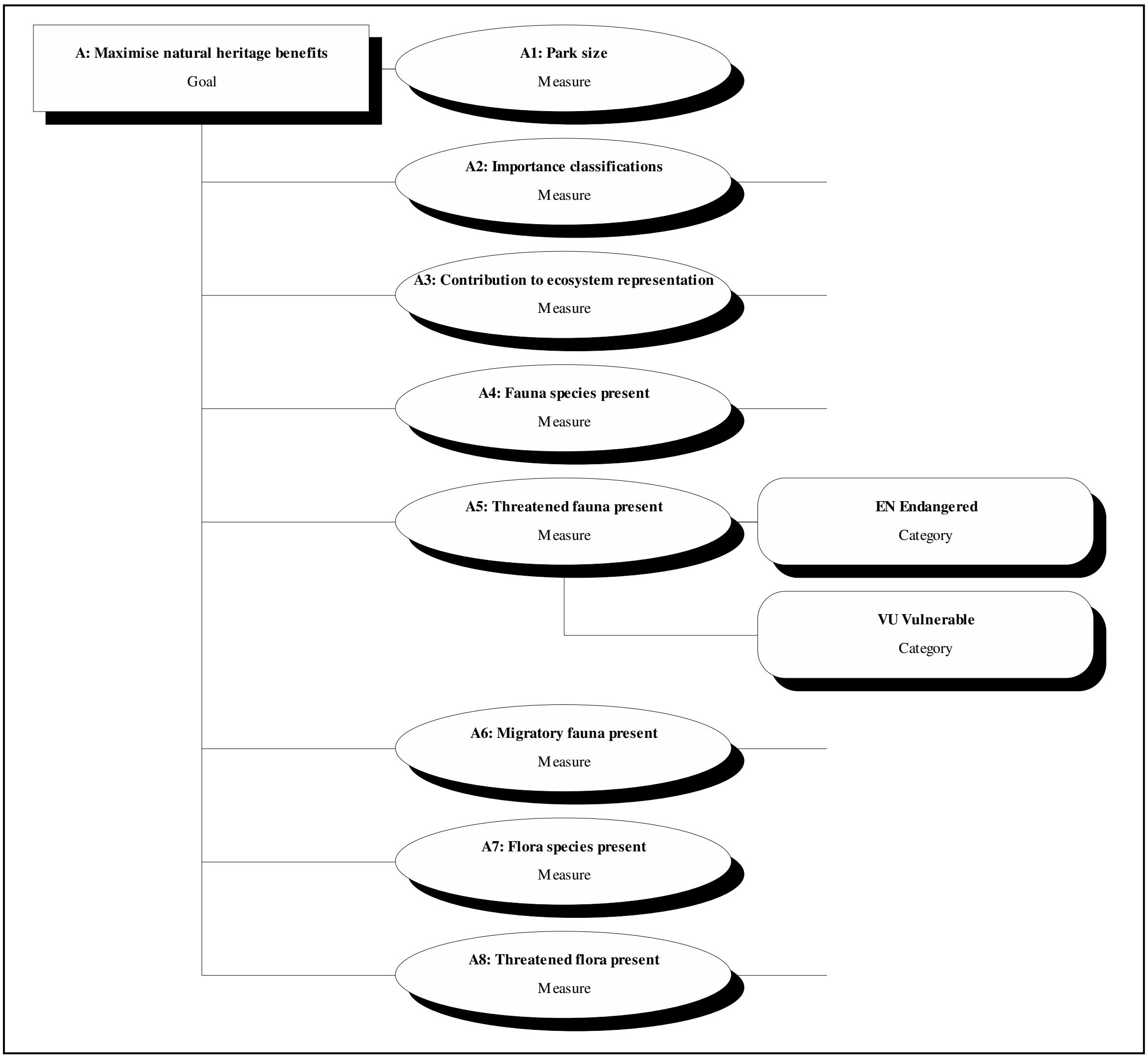

Figure 0.10

Measure Categories for the ‘Migratory Fauna Present’ Measure

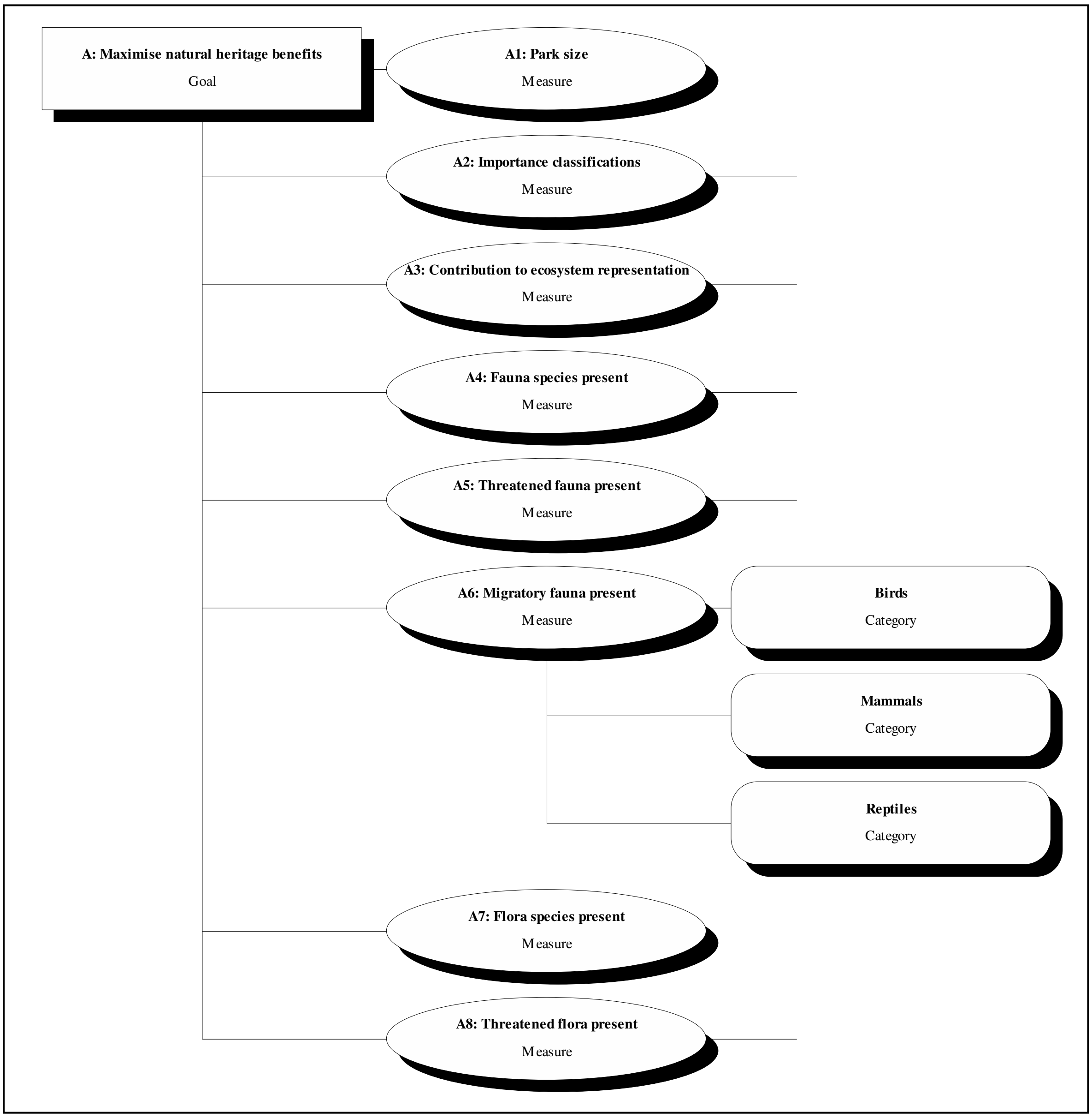

Figure 0.11

Measure Categories for the 'Threatened Fauna Present' Measure

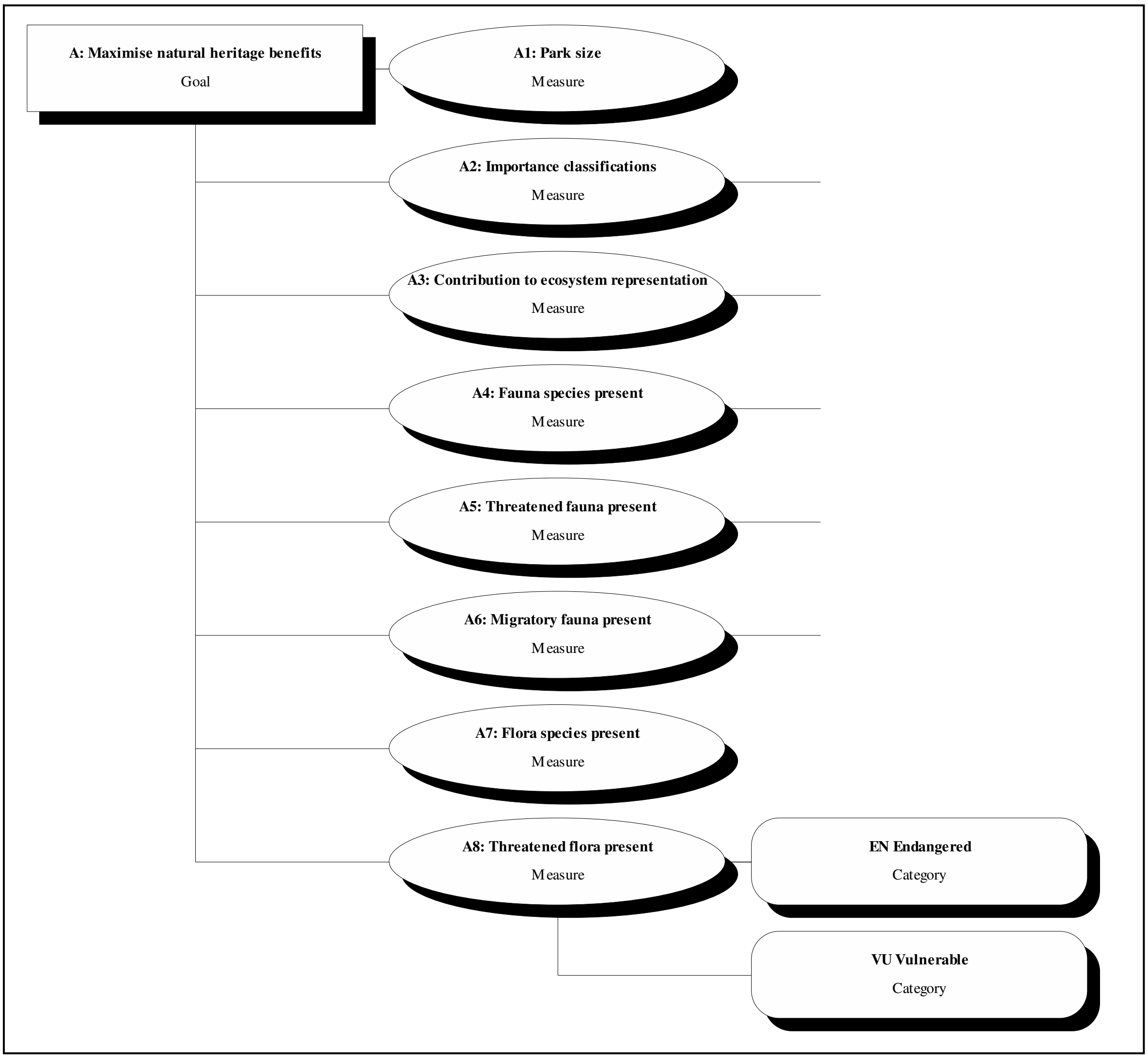

Figure 0.12

Measures belonging to the 'Feral Animals' Sub-goal

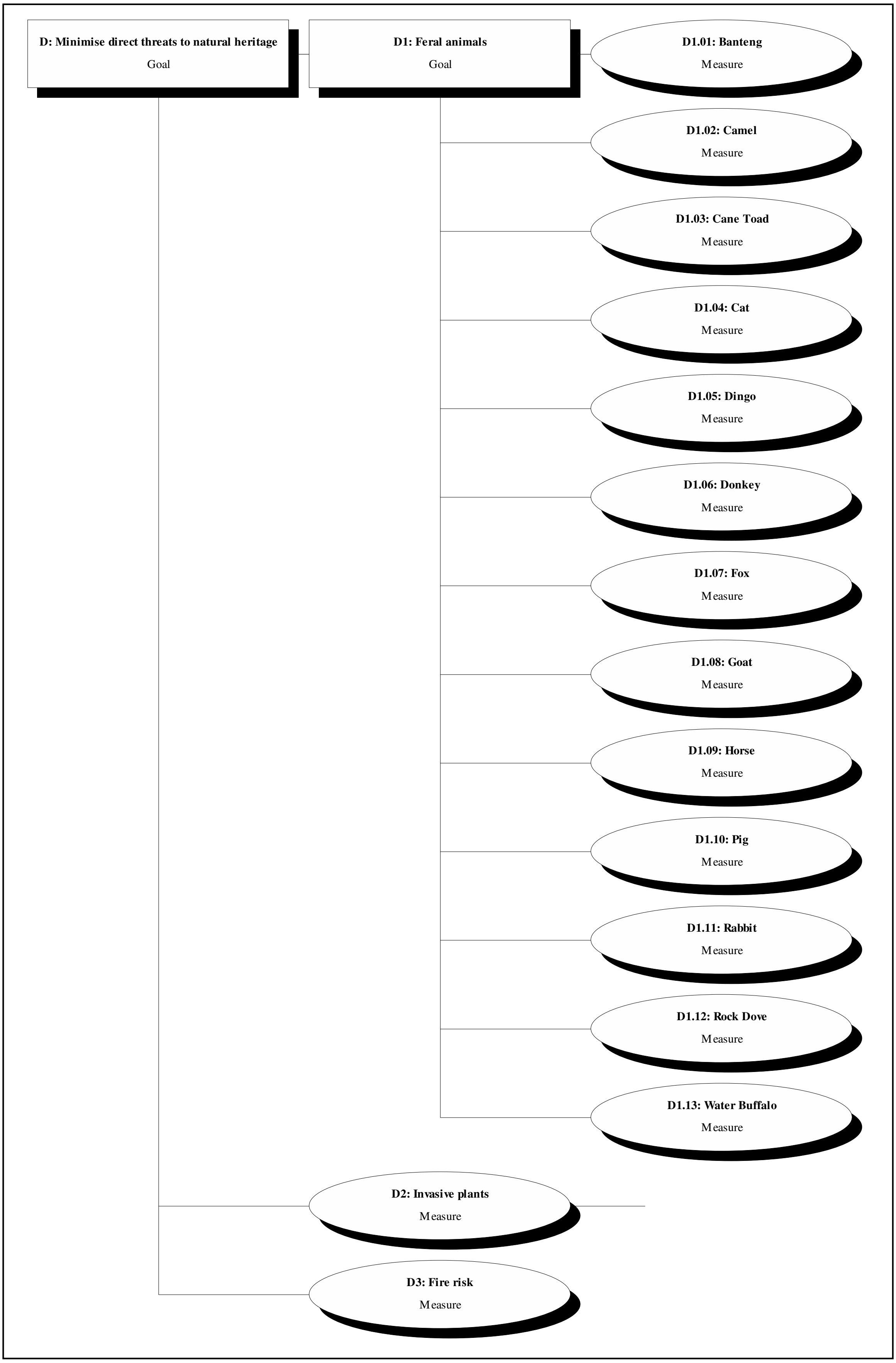

Figure 0.13

Measure Categories for the 'Invasive Plants' Measure