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**INCORPORATING ECONOMIC, SOCIAL AND
ENVIRONMENTAL FACTORS INTO A DECISION
MODEL FOR SUSTAINABLE MANAGEMENT OF
NATURAL RESOURCES:**

**A CASE STUDY OF THE NINGALOO COAST,
WESTERN AUSTRALIA**

A thesis presented in partial fulfilment of the requirements for the degree

of

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ABSTRACT

There is growing demand for many of Australia's coastal areas to be conserved and retained in their natural state. The reconciliation of competing demands; such as residential, industrial, recreation, conservation and tourism; in a manner that ensures the sustainability of natural areas is a major issue facing coastal planners.

The Ningaloo coastal strip in Western Australia is a prime example of a fragile coastal environment, subject to increasing visitation, complex economic, social, environmental and institutional forces and a wide range of stakeholders. The challenge for managers and planners of the coastal strip is to determine an appropriate level of development and a management regime that meets the needs of stakeholders while still achieving the state government's goals in relation to coastal zone management. To meet this challenge, decision need to carefully balance human needs with the environment's ability to assimilate the pressures placed upon it.

This research integrates social, environmental and economic factors into a decision framework for the sustainable management of natural resources. This framework differs from existing frameworks in two ways; firstly, it specifically includes stakeholder analysis as an individual assessment technique and secondly, it focuses on rapid appraisal techniques. Three individual assessment techniques; environmental impact assessment, cost benefit analysis and stakeholder analysis; are incorporated into a multiple criteria analysis model. This model is applied to a case study of the Ningaloo coast, Western Australia.

The results show that a co-management arrangement between indigenous communities and the Department of Conservation and Land Management is consistently superior to other management options identified. Another favourable management option is sole management by the Department of Conservation and Land Management. When weightings that reflect an environmental perspective are used, low visitation scenarios are preferred.

The research concludes with land use and management recommendations for the Ningaloo coastal strip. This recommended management regime would involve some form of co-management between stakeholder groups and CALM, particularly the traditional Aboriginal inhabitants. The level of development would be low, with at most, a single wilderness lodge facility.

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LIST OF ABBREVIATIONS

CALM	Western Australian Department of Conservation and Land Management
CBA	Cost Benefit Analysis
CPI	Consumer Price Index
DOLA	Western Australian Department of Land Administration
DPI	Western Australian Department of Planning and Infrastructure
DSE	Dry Stock Equivalent
EAA	Equivalent Annual Annuity or Return
EIA	Environmental Impact Assessment
EPA	Western Australian Environmental Protection Agency
4WD	Four-Wheel Drive
NPV	Net Present Value
NROCA	Ningaloo Reef Outback Coast Association
RAC	Australian Resource Assessment Commission
SEA	Strategic Environmental Assessment
TEV	Total Economic Value
2WD	Two-Wheel Drive
WAPC	Western Australian Planning Commission
WATC	Western Australian Tourism Commission
WCED	World Commission on Environment and Development
WTO	World Tourism Organisation
WTP	Willingness-To-Pay

STATEMENT OF ORIGINALITY

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I declare that:

- This is an original report/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 SIGNATURE: 

DATE OF SIGNATURE: 30/01/03

1 INTRODUCTION

Throughout the world coastal environments are in demand for residential, industrial, tourism, conservation and recreational purposes. The issue of planning for coastal zone management and use is often complicated by a lack of knowledge and uncertainty surrounding environmental impacts, conflicting demands for multiple use and a wide range of stakeholders. The issues involved in coastal zone management typify many natural resource management problems.

The competing demands for coastal use are particularly illustrated in Australia, where 80 percent of the population lives close to the coast (Australian State of the Environment Committee, 2001). In particular, there is growing demand for natural coastal areas to be preserved as wilderness areas: to provide for recreation, nature-based tourism, ecosystem services and for the benefit of future generations. The already difficult issue of reconciling growing demand with finite supply of the natural coastal resource is complicated by the irreversibility of many forms of development. Finding acceptable solutions to these issues is one of the key responsibilities of coastal land use planning.

The Government of Western Australia has stated that their goal for management of the coastal zone is “to manage the coast sustainably for the long-term benefit of the community, by protecting environmental quality, biodiversity and features of cultural significance, and providing for social and economic needs” (WAPC, 2001, p. 18). This goal implies that any analysis of land use options for a coastal area must address the sustainability of alternatives according to three interlinked systems – society, economy and environment.

Traditional techniques to aid the decision making process have involved the application of tools developed within a single discipline, such as Cost Benefit Analysis (CBA) and Environmental Impact Assessment (EIA). A growing awareness of the interrelationships between social, economic and environmental aspects of natural resource management problems, and the ascendancy of sustainable development as a new paradigm have led to a broadening of the scope of decision aid techniques. This has occurred within individual fields, such as the incorporation of environmental impacts into CBA and the vast array of techniques to value non-market benefits from natural areas; but has also led to

interdisciplinary approaches that involve a systems perspective to the problem and the use of integrated assessment techniques.

The Ningaloo coast is a fragile coastal environment in the North West of Western Australia. The coast is still in a relatively natural condition due to its isolation and aridity. However the coast is adjacent to the Ningaloo Marine Park, which contains Australia's largest fringing coral reef, the Ningaloo Reef, and is subject to increasing visitation pressure. The Ningaloo Reef is in pristine condition relative to coral reefs worldwide, and is famous for its predictable yearly visitation by whale sharks, marine fauna, game fishing and ideal winter climate. The current Western Australian government has indicated its intention to obtain World Heritage listing for the Ningaloo Marine Park (Western Australian Labour Government, 2001 and MacTiernan, 2002c).

Wilderness camping is a popular activity along the coast, particularly for retired people from the southwest and eastern states, who camp for several months during the mild winter period. Most of the coastal strip is held as pastoral lease, with leases due to expire in 2015. Increased visitation is resulting in environmental degradation that indicates the current situation is unsustainable. The relatively undeveloped nature of the Ningaloo coast and the natural attractions of the area make it ideally suited as a nature based tourism destination.

Figure 1.1 The Ningaloo Coast, Warroora Station.



Source: N.Longworth, 2002.

Local and state government have made a first step towards addressing these issues with the development of the draft Carnarvon Coastal Strategy¹ (SMEC Australia, 2001), which outlines potential land use and management directions for the coastal region. The Coastal Strategy lacks in-depth analysis of the sustainability of options and examines only a narrow set of management arrangements. A large number of submissions by the public indicated dissatisfaction with the Strategy (WAPC, 2002).

The planning for the Ningaloo coast is occurring within the context of uncertainty over pastoral lease issues in Western Australia. All pastoral leases in the State are to be renewed in 2015, and proposals to exclude land from pastoral leases for public purposes were required to be made by the 7th December 2002. From this date, parties have two years to negotiate the details and management of excisions. A two-kilometre strip has been excised from pastoral leases along the Ningaloo coast for conservation purposes, however details and management arrangements are yet to be negotiated.

Decision makers must now determine a strategic direction for the coast and the details of possible management arrangements and appropriate levels of tourism development. This is a difficult process given the fragile environment, the interrelated nature of social, economic and environmental components and the wide range of stakeholders.

1.1 PROBLEM STATEMENT

The Ningaloo coast is a fragile coastal environment subject to increasing visitation pressure. Decision makers must decide on a future direction for land use and an appropriate management regime. The draft Carnarvon Coastal Strategy represented a first attempt, however it lacked in-depth analysis and a systems approach to sustainability analysis. Decision makers require timely information on the components of the system and the impacts of alternative management arrangements.

1.2 AIM

The aim of this research is to develop a decision model that incorporates economic, social and environmental factors in an integrated assessment framework. This model will provide

¹ Later renamed the Ningaloo Carnarvon Coastal Strategy, Stage One.

timely information to decision makers and stakeholders, and inform the debate over possible sustainable approaches to management and use of the Ningaloo coast of Western Australia.

1.3 OBJECTIVES

1. To identify and assess the economic, social and environmental impacts associated with land use and management alternatives of the project area using CBA and EIA.
2. To analyse stakeholder objectives and interests using Stakeholder Analysis
3. To integrate the individual assessment techniques, and assess the land use and management alternatives using a Multiple Criteria Analysis (MCA) framework.

1.4 IMPORTANCE OF RESEARCH

This research will develop an integrated framework that will be particularly suited to problems that require rapid appraisal. It will further existing integrated assessment frameworks developed by Nardini (1997) and van Pelt (1993a), by explicitly including stakeholder analysis as an individual assessment technique.

The Ningaloo coast is an important resource that is widely valued by the local, state, national and international community. Planning for the sustainable future of the coast requires an integrated approach and presents an important opportunity to involve a wide range of stakeholders. Current research on the coastal strip generally involves physical, biological and tourism research and there appears to be a lack of integrated assessment. This research will fill this perceived gap and provide useful information to decision makers and stakeholders over potential directions for land use and management of the coastal strip.

1.5 RESEARCH APPROACH

This research adopts an integrated research approach where three individual assessment techniques are integrated into a broader multiple criteria evaluation framework. These assessment techniques are EIA, CBA and stakeholder analysis. Impacts are identified and estimated using an adapted Leopold matrix; significant environmental impacts are then incorporated into attributes to be assessed in the MCA. A partial CBA that focuses on pastoral, tourism and recreation benefits provides information on the economic efficiency of

alternatives. Stakeholder objectives are identified and analysed using stakeholder analysis techniques developed from Grimble and Wellard (1997) and de Lopez (2001a).

Attributes (or criteria) for the MCA are developed from relevant literature, the results of the individual assessment techniques and discussions with stakeholders. Stakeholder consultation regarding the attributes is undertaken once a preliminary set of attributes is developed. Scores for the attributes are derived from the EIA and CBA results and from institutional indices and scales developed to address specific institutional and social aspects of the problem.

The research uses the MCA software TopDec (Ecoservices Pty Ltd., 1996) to assess options. This software utilises the weighted summation method of aggregating weighted scores, and offers two methods for determining weights. The TopDec software is particularly easy to use, and the results are transparent and easy to understand.

A weight set is derived based on the objectives explored in the stakeholder analysis and in light of the sustainability approaches adopted by the Australian national and state governments.

The sensitivity of the CBA and MCA results is tested. The CBA assumes an optimistic and pessimistic scenario to explore the sensitivity of results to assumptions. Sensitivity of the results to the chosen discount rate is also investigated. Several stages of the MCA process can result in method uncertainty. To explore these issues the sensitivity of the rankings to the weight set chosen, method of weighting, and scores is addressed. Sensitivity to scores is explored by assuming an optimistic and pessimistic scenario that reflects different expected environmental and economic outcomes.

The research approach adopted allows the integration of social, economic and environmental aspects of sustainability, together with institutional aspects. Limitations of the methodology mainly arise from the rapid nature of the assessment. The impact assessment is quite simple, and does not address dimensions of time, irreversibility and cumulative impacts. The level of stakeholder involvement is limited by time and geographical constraints. Despite these limitations, the methodology provides a useful framework for the assessment of the sustainability of land use and management alternatives for the Ningaloo coast.

1.6 OUTLINE OF THESIS

This thesis is structured into seven chapters; the coverage of these is outlined below.

1. Introduction

The introduction provides a brief background to the research and outlines the research problem, aim, objectives and research approach. The importance of the research is also addressed.

2. The Ningaloo Coastal Strip

This chapter provides background information on the biophysical, social, economic and institutional environment of the Ningaloo coastal region. The boundaries of the case study area are detailed alongside the regional context.

3. Literature Review

The literature review outlines relevant previous research. The review covers the economics of natural areas; focusing on institutions, property rights, public and private goods, and their relevance to management regimes for natural areas. Tourism demand for natural areas is explored, with a particular focus on nature-based tourism and its magnitude and relevance to the planning of natural areas. The chapter reviews the literature on sustainable development, focusing on the development of the paradigm and the different approaches to the concept. Finally techniques that are used to aid decision making with regard to natural areas are explored. These include EIA, CBA, stakeholder analysis and integrated techniques such as MCA.

4. Methodology

The framework adopted for this research is detailed in this chapter. Initially the conceptual framework is presented, which provides an overview of the role of the individual assessment techniques in relation to the MCA process. The methodology chapter is broken into three phases: designing the model, visit to sites and stakeholders and implementing the model. The first phase details the integrated assessment model that was developed. The methodology used for the individual assessment techniques is presented first and covers in

turn the stakeholder analysis, CBA and EIA. The MCA process is then outlined and covers the software used, development of alternatives and attributes, scoring, standardisation and weighting, and sensitivity analysis. The second phase outlines the visit to sites and stakeholders that was undertaken to verify the model, and some of the subsequent adjustments implemented. The third phase briefly outlines the implementation of the model.

5. Analysis and Results

The presentation of results follows the structure of the analytical framework developed in chapter four. Firstly the results of the individual assessment techniques are presented. These include the table of stakeholder objectives and then the results of the CBA and EIA. Following this, a further section of analysis details the scoring for the MCA attributes and provides information on how the results of the CBA and EIA were integrated into scores for the performance matrix. The final sections present the results of the integrated evaluation. Firstly the raw scores for the MCA are presented in a performance matrix and this is followed by the results from the evaluations using the TopDec software.

6. Discussion

The results of the integrated assessment are discussed in relation to the methodology adopted and other relevant research. Results of the individual assessments are briefly discussed. Following this the research methodology is discussed in relation to other integrated assessment frameworks, particular advantages of the adopted approach and limitations. Finally the chapter presents some policy implications that arise from the results of this research.

7. Conclusions and Recommendations

The main conclusions drawn from the research are stated and five specific policy recommendations for the Ningaloo coastal strip are outlined.

2 THE NINGALOO COASTAL STRIP

2.1 INTRODUCTION

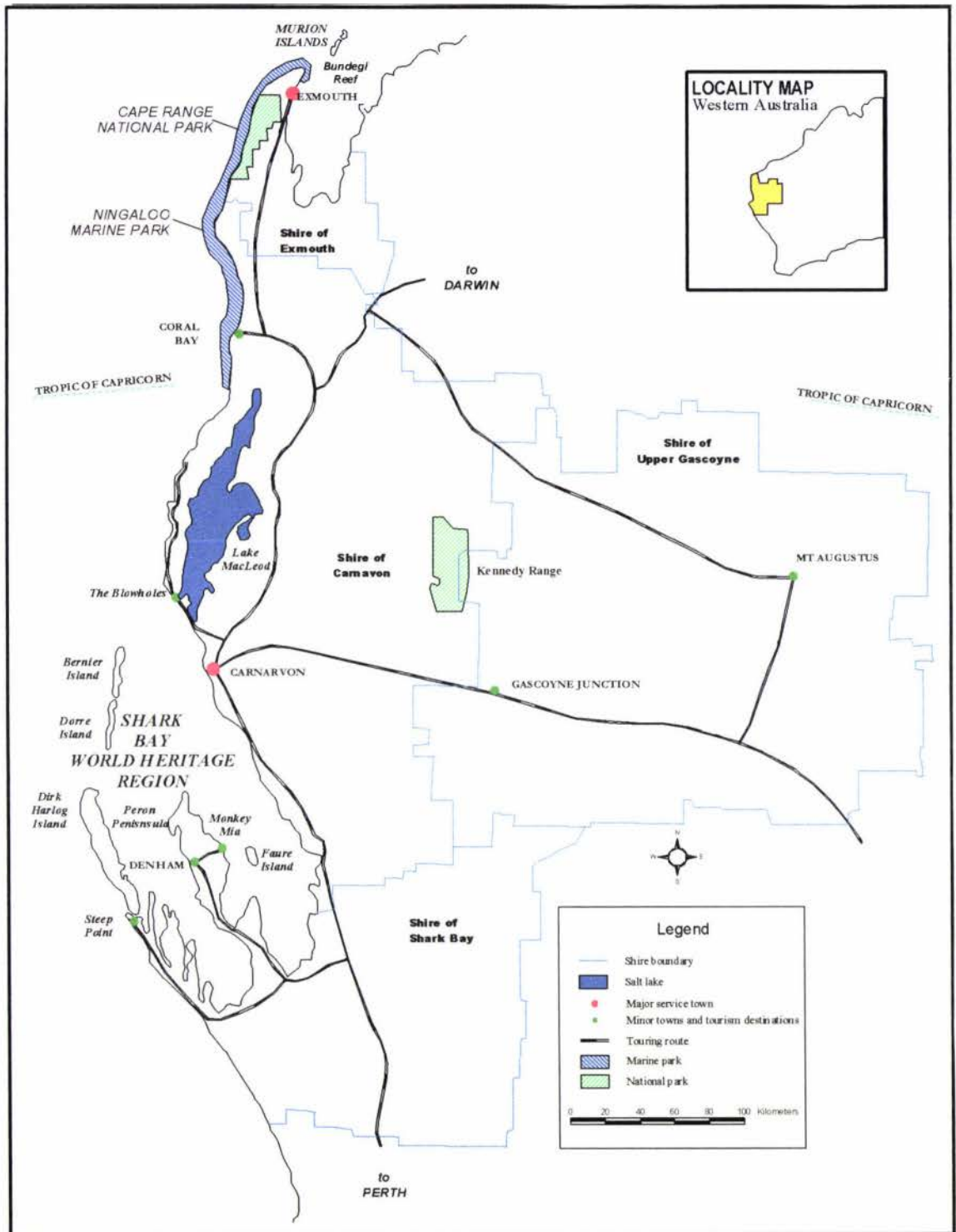
The Ningaloo coastal region is characterised by a semi-arid climate and vegetation, lack of surface water and a fragile dune system. The Ningaloo coastal strip is located at the base of North-West Cape in the Gascoyne region of Western Australia, approximately 1200 kilometres north of Perth (figure 2.1, p. 9). It is adjacent to the Ningaloo coral reef and Marine Park. Current land tenure is pastoral lease, and the stations are popular places for wilderness camping over the winter period. This chapter outlines the boundaries of the study area and the regional context, and provides background information on the coastal environment, land use, historical and cultural features, infrastructure and relevant planning policy.

2.2 REGIONAL SETTING

Two major towns and service areas are located within the vicinity of the coastal strip, and a smaller tourist village, Coral Bay, within the strip itself. Exmouth is located on the eastern side of the North West Cape peninsula and was gazetted as a town in 1963 to service the Harold E. Holt Naval communications base, a joint partnership between Australia and the United States. In 1992, the US withdrew from the partnership, creating a significant reduction in income in the region (Wood and Dowling, 2002). Exmouth has subsequently developed a significant nature-based tourism industry. The permanent population of Exmouth in 2000 was 2,202 (Gascoyne Development Commission, 2001). Carnarvon is the administrative centre of the Gascoyne region, and had a permanent population of 6,219 in 2000 (*ibid.*). Carnarvon is also a significant horticultural region, due to its proximity to underground water supplies provided by the Gascoyne river.

Coral Bay is an important tourist township and offers a range of accommodation, tourist activities and supporting services. The resident population of Coral Bay is around 180 residents during the busy season (SMEC Australia, 2001). Coral Bay is located at Maud's Landing. A large marina and resort is proposed for Maud's Landing North. Although falling within the two-kilometre strip, Coral Bay and the proposed resort are not included in this study, although it is acknowledged that future developments will affect the coastal strip.

Figure 2.1 Regional Setting for the Ningaloo Coastal Strip



Source: Adapted from Dowling (1997).

Current conservation estate within the region comprises the Ningaloo Marine Park and Cape Range National Park. The Ningaloo Marine Park extends from Amherst Point in the south

to the tip of North West Cape and encompasses both State and Commonwealth waters and is managed by the Western Australian Department of Conservation and Land Management (CALM). The Marine Park extends to 40 metres above mean high water mark, creating considerable overlap between CALM and pastoralists for the management of camping. The Ningaloo Marine Park protects the Ningaloo reef, Australia's largest fringing coral reef. Cape Range National Park covers 50 581 ha of the Cape Range peninsula near Exmouth (CALM, 1987) and is notable for its spectacular scenery, biodiversity and unique Karst (limestone) system.

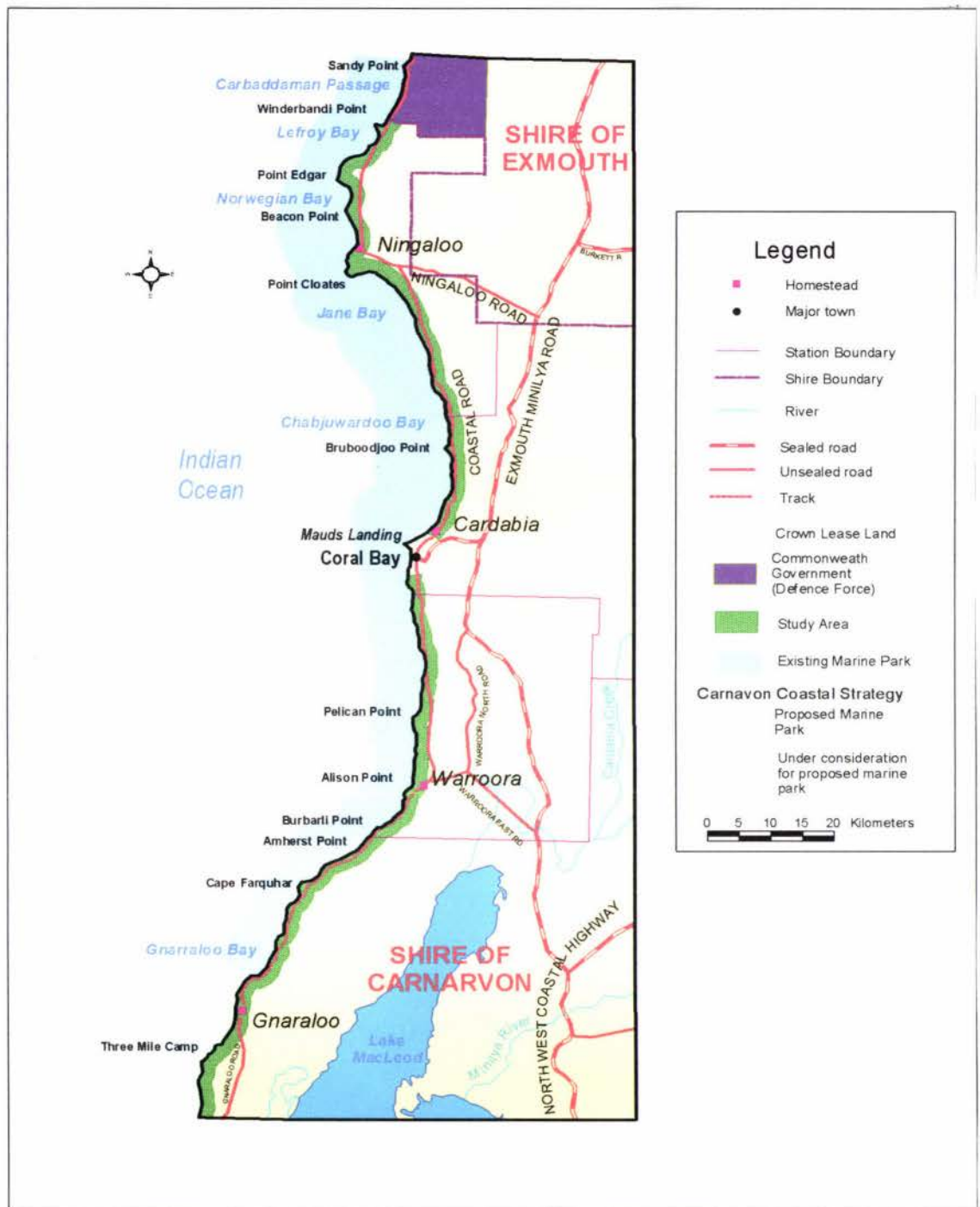
Cape Range National Park is separated from the northern boundary of Ningaloo station by a parcel of land under Commonwealth ownership (see figure 2.2, p. 11), which is currently a Royal Australian Airforce bombing range. South of Carnarvon lies the Shark Bay World Heritage Region (see figure 2.1, p. 9). This area is internationally famous for its ancient life forms (Stromatolites), coastal scenery and visitation by dolphins.

2.3 LOCATION AND BOUNDARIES OF STUDY AREA

The study area is a two-kilometre wide strip from mean high water mark that stretches from the northern boundary of Ningaloo station down to the Southern boundary of Gnaraloo station. The study area is depicted in figure 2.2 and encompasses the coastal strip of four pastoral stations – Ningaloo, Cardabia, Warroora and Gnaraloo. These four stations are members of the Ningaloo Reef Outback Coast Association (NROCA), a non-profit association that manages camping along the coast. The four stations therefore form a natural case study area.

The width of the strip was chosen for two reasons: this width would encompass most of the camping within this area and two kilometres was the area popularly believed to be proposed for exclusion (Irving, 15 October 2002), and subsequently excluded from pastoral renewal in 2015 (MacTiernan, 2002c). The coastal strip study area excludes the Coral Bay townsite and the proposed marina and resort at Maud's Landing North.

Figure 2.2 The Ningaloo Coastal Strip



Source: Adapted from SMEC Australia (2001).

2.4 THE COASTAL ENVIRONMENT

2.4.1 Climate

The region experiences a semi-arid climate. Annual rainfall along the coast ranges between 200-300mm with 40 percent variability, which is exceeded by potential evaporation of 1780-3050 mm per year (CALM, 1989).

The winter weather pattern occurs from May to October and is associated with periods of anticyclonic weather, which is broken by the eastwards passage of rain bearing frontal systems (Payne *et al.*, 1987). In winter, average daytime temperatures range from the low to high twenties (CALM, 1989). Wind speeds are typically between 11-20 kilometres per hour, with south and southeasterly winds prevailing in the morning and northerly through to easterly winds in the afternoon (DAL Science and Engineering Pty Ltd, 2002).

The summer pattern occurs from November to April and is associated with average daytime temperatures between the low twenties to low thirties (CALM, 1989). Rainfall in any one summer month is frequently zero (Payne *et al.*, 1987). Tropical cyclones occur in the region during summer, typically from January to March (WAPC, 1998). Tropical cyclones with wind speeds in excess of 40 to 50 knots occur every three to five years (Lourensz, 1981), while less intensive systems can be expected annually (WAPC, 1998). In 1999 the centre of tropical cyclone Vance passed 80 kilometres to the east of Coral Bay and produced the strongest wind gust speed (267 kilometres per hour) ever recorded on the Australian mainland. This cyclone caused significant damage to Exmouth. During summer, wind speeds are typically 11-30 kilometres per hour with wind predominantly from the south and southwest (DAL Science and Engineering Pty Ltd, 2002). However during spring and summer afternoon sea breezes can reach 45 kilometres per hour (WAPC, 1998).

2.4.2 Geomorphology and Landforms

The coastal strip falls within the coastal dune geomorphic district as defined by Payne *et al.* (1987) and is dominated by coastal dunes and undulating plains of shallow, calcereous sand over limestone or calcrete. The area is characterised by long-walled parabolic dunes and swales, narrow beaches and limestone plains. The draft Carnarvon Coastal Strategy (SMEC Australia, 2001) defines four geomorphic sub-regions: delta coast, dune coast, cliff coast and dune and cusped spit coast. A section of the coastal strip on Gnaraloo station is dominated

by the cliff coast sub-region and is largely composed of low limestone cliffs with rocky shores and occasional pocket beaches (*ibid.*). The rest of the study area can be classified as dune and cusped spit coast. This region features cusped forelands, which have developed in the lee of the Ningaloo Reef (Sanderson, 1997) and shore-parallel beach ridges adjacent to the shoreline backed by recent parabolic dunes (SMEC Australia, 2001).

Figure 2.3 Coastal Dunes on Warroora Station.



Source: N. Longworth (2002).

The coastal dunes are highly susceptible to wind erosion, which results in extensive northward developing blow-outs when foredunes or crests become degraded (Payne *et al.*, 1987). The largest deflation blow-outs in the area are associated with stock-watering points and vehicle tracks (SMEC Australia, 2001). Between Cape Farquhar and Alison Point (see figure 2.2), the coastal plateau is incised with a series of creeks which drain westwards to the shoreline (*ibid.*).

2.4.3 Water

The coastal strip lacks permanent surface water, and the main features of surface hydrology are Lake McLeod to the east of the coastal strip on Gnoraloo station and the intermittent streams that drain east from the Giralia Plateau (D.A. Lord and Associates Pty Ltd, 2000).

Groundwater occurs as unconfined groundwater, which forms the regional water table and is at atmospheric pressure, or as artesian groundwater, which is under pressure and rises when encountered in a bore (Payne *et al.*, 1987). Most of the shallow coastal groundwater is saline, however fresh unconfined groundwater occurs as a thin layer over saline in some seashore dune swales (D.A. Lord and Associates Pty Ltd, 2000). The artesian groundwater occurs mainly in the Birdrong Sandstone formation, with bores ranging between 100 and 1200 metres in depth (Payne *et al.*, 1987). Artesian groundwater from the Birdrong Sandstone is hot and saline (*ibid.*).

Groundwater recharge in the coastal strip is limited by the low rainfall and high evaporation rates (*ibid.*). The availability of water is a major constraint to the development of the coastal strip and the viability of nature-based tourism ventures.

2.4.4 Flora and Fauna

The flora of the coastal strip is dominated by low shrublands, perennial grasses, and short-lived herbs and grasses in favourable seasonal conditions (Payne *et al.*, 1987). Parabolic dunes are characterised by very scattered or close low shrublands, which are dominated by *Acacia coriacea* (weeping acacia), and other low shrubs (*ibid.*). Isolated patches of taller shrubs may occur, including *Acacia coriacea*, *Santalum spicatum* (sandalwood) and *Heterodendrum oleaefolium* (minga or rosewood) (Goble-Garratt and Associates, 2002). Perennial grasses include *Triodia pungens* (soft spinifex), *Cenchrus ciliaris* (buffel grass) and *Paspalidium tabulatum* (Payne *et al.*, 1987). Interdunal corridors and sandy swales support very scattered to moderately close low shrublands, usually with a high proportion of chenopod species and spinifex grasses (*ibid.*). Beach foredunes are mainly vegetated with *Spinifex longifolius* (beach spinifex) (Payne *et al.*, 1987 and Goble-Garratt and Associates, 2002).

The restricted limestone plains support low and wind-clipped vegetation; with plants distributed where there are pockets of sand or cracks forming rootholds in the limestone (Payne *et al.*, 1987). Particularly noticeable is the native fig, *Ficus platypoda*.

Much of the coastal strip has been colonised by buffel grass, *Cenchrus ciliaris*, which has replaced the native spinifex and other grasses. Humphries *et al.* (1991, cited in Humphries *et al.*, 1994) identified buffel grass as one of Australia's top environmental weeds. Buffel grass threatens native habitats by displacing native vegetation and altering the fire regime and is likely to reduce resources for native fauna (Humphries *et al.*, 1994).

Figure 2.4 An Extensive Area of Buffel Grass, Warroora Station



Source: N.Longworth (2002).

There has been little study of the fauna of the coastal strip. A recent desk-top based study of possible species richness for three habitats present in the coastal strip was conducted for the vicinity of Maud's Landing (Goble-Garratt and Associates, 2002). Table 2.1 presents the possible species richness for open beach habitat, coastal dune scrub and limestone platforms.

Table 2.1 Possible Vertebrate Species Richness for Three Habitats on the Coastal Strip

Species	Open Beach	Coastal Dune Scrub	Limestone platforms	Total Species Richness
Native Mammals	2	17	13	17
Introduced Mammals	3	6	6	6
Bird Species	48	61	58	102
Lizards	14	41	23	42
Turtles	3	0	0	3
Snakes	1	12	6	12

Source: Goble-Garratt and Associates (2002).

Of these species, the Red-tailed tropic bird (*Phaethon rubricauda*) and the loggerhead turtle (*Caretta caretta*) are listed on Schedule One of the Wildlife Conservation Act (1950) as fauna that is rare or likely to become extent. The peregrine falcon is listed on Schedule Four, as a species in need of special protection. During the 2001-2002 summer months, 130

loggerhead turtle nests were counted in an area five to eight kilometres north of Gnoraloo Bay (B. Gadowski, pers. comm., May 2002).

A large number of the bird species in table 2.1 are wading birds, which would only be seasonally present on shallow, sloping beaches. Open beach habitat provides perching and foraging habitat for birds and some of the larger lizards, and hunting and foraging ground for foxes and feral cats (Garratt and Goble, 2002).

Red and Euro Kangaroos (*Macropus rufus* and *M. robustus*) are present throughout the coastal strip. Introduced vertebrate pest species include goats, rabbits, foxes and feral cats. Goats provide additional grazing pressure that threatens the survival of native flora, and compete with native fauna for food, water and shelter (Biodiversity Group, Environment Australia, 1999a). Goats are currently controlled on pastoral land through mustering and trap yard systems. Foxes are a significant threat to small native mammalian fauna (mammals within the critical weight range of 35 to 5500 grams) and turtles (Biodiversity Group, Environment Australia, 1999b).

2.4.5 Ningaloo Reef

The Ningaloo Reef is 260 kilometres long and forms a discontinuous barrier enclosing a lagoon which varies in width from 200 metres to six kilometres (CALM, 1989). The width of the continental shelf is narrower in the vicinity of the reef than in any other location in Australia, which allows deep oceanic waters and their associated fauna close to the reef. The Marine Park represents a biogeographical transition zone, with many tropical species at the southern limits of their range, and some temperate species at their northern limits (*ibid.*).

The Ningaloo Marine Park is rich in species diversity; 501 fishes, 217 corals and over 600 molluscs were recorded in a survey in 1988 (*ibid.*). The Marine Park provides habitat for six species of whales and forms part of the migratory route of the endangered humpback whale (Australian Heritage Commission, 1997). Dugong are found in Norwegian Bay and the lagoon north of Bruboodjoo Point (*ibid.*). The Ningaloo Reef is internationally famous for its predictable yearly visitation by whale sharks (*Rhincondon typus*) the world's largest fish, and this occurrence is the basis for a significant tourism industry (Davis *et al.*, 1997).

2.5 LAND USE

The land tenure of the coastal strip is currently pastoral leasehold land and land use includes pastoralism, tourism and recreation (mainly camping). The pastoral industry has traditionally been based on Merino sheep, though some conversion to cattle is currently occurring. Pastoral operations began around 1889 when Thomas Carter settled in the region at Point Cloates. Prior to this, the coastal lands were used by adjacent station owners for shepherding runs during good seasons, as it was considered too dry for permanent occupation (Forrest, 1996). However by the late 1890s abundant ground water had been found in the Gascoyne and the coastal country became viable (*ibid.*). Sheep numbers in the Carnarvon Basin reached a peak in the 1920s and then fell sharply during the Great Depression. The large numbers of stock carried during the 1920s were never regained; large tracts of land had become degraded from overstocking, lack of vermin control and unpredictable seasons (Payne *et al.*, 1987).

The coastal strip is a very popular wilderness camping spot for locals and other West Australians from Perth and the South West. Numbers of campsites have grown considerably over the last few years. Table 2.2 presents aerial survey data on the number of campsites on Ningaloo, Cardabia and Warroora stations. Gnaraloo station has a special lease and operates a campground with ablution facilities and a small shop.

Table 2.2 Number of Campsites on the Coastal Strip, CALM Aerial Survey Data

	1995	1996	1997	1998		1999		2000		2001		2002
	Jul	Jul	Jul	Apr	Jul	Apr	Jul	Apr	Jul	Apr	Jul	Apr
Ningaloo	74	101	128	19	107	14	141	60	141	36	154	84
Cardabia	20	18	52	4	33	6	28	4	29	6	46	8
Warroora	56	76	110	18	96	15	92	27	105	22	121	43

Source: CALM, Exmouth District Office

Campers on Warroora and Ningaloo stations pay a fee, while Cardabia has previously not charged for camping. Campers use the station rubbish pits for disposal, and many have their own chemical toilets. Warroora and Ningaloo stations currently employ caretakers during the winter period to monitor where campsites are established, where toilet facilities are emptied and where firewood is collected (L. Horak, pers. comm., May 2002). Caretakers also collect camping fees. Campers purchase fuel, food, water and equipment in Coral Bay, Carnarvon and Exmouth (NROCA, 2002).

A large proportion of campers on Ningaloo and Warroora station are older people, who come up and camp in caravans for a period of three to five months over the winter period (D. Galloway, pers comm., May 2002). These campers often camp in the same campsites and have informal communities and a social schedule that includes exercise. An example of such an informal community is 14-mile bay on Warroora station. This community has Tai Chi classes on the beach at 9:00 every morning and a spit night on the first full moon in June, for which the pastoralists donate a sheep. Activities during the spit night include petanque and crab racing (M. Horak, pers. comm., May 2002). During August-September, there is a larger proportion of campers from the eastern states who have travelled through the centre of the country (J. Lefroy, pers. comm., May 2002). The July school holiday period is usually the peak season, when many family members join the established camps.

Gnaraloo campground generally attracts surfers and fishers and during the summer months a small number of European windsurfers (B. Gadowski, pers. comm., May 2002).

2.6 HISTORICAL AND CULTURAL FEATURES

2.6.1 Aboriginal Heritage

The Coral Bay region is associated in the literature with the Baiyungu peoples (Michael Robinson and Associates, 2002). Austin (1992 in Michael Robinson and Associates, 2002) noted that the Baiyungu (Payungu) country included Cardabia, Warroora and Gnaraloo stations. Brandenstein (1967 in Michael Robinson and Associates, 2002) placed a group he identified as the Baiong near Coral Bay and the Talainji to the north. Thomas Carter worked with the Talandjii during his occupancy of Yardie Creek Station in the 1890s. Forrest (1996) reports that the Talandjii people vanished from the North West Cape area at the turn of the century.

With the coming of the pastoral industry, the original Aboriginal occupants became associated with the pastoral stations in and near their traditional lands (Michael Robinson and Associates, 2002). The relationship between Aboriginal people and pastoralists was not always harmonious, and the Aboriginal population was reduced by disease and violence (*ibid.*). Despite this, the Aboriginal people have retained their connection to their lands. Cardabia station is now owned by the Baiyungu Aboriginal Corporation.

The draft Carnarvon Coastal Strategy reports between twenty and thirty sites of Aboriginal heritage significance recorded on the Register of Aboriginal Sites (maintained by the Aboriginal Affairs Department) and that the majority of these are middens and artefacts (SMEC Australia, 2001).

2.6.2 European Heritage

The coastal strip has many historic associations of regional significance for the European exploration and development of the North West Cape (Australian Heritage Commission, 1997). A large number of shipwrecks occurred in the Ningaloo Marine Park, eighteen were wrecked between 1811 and 1931 (CALM, 1989). The story of the survivors of the *Stefano* (wrecked in 1875) provides an interesting account of early European and Aboriginal relations (Rathe, 1990). An early explorer's diary records finding bones, (supposedly of the *Stefano* survivors), in a cave on Warroora station and burying them in the sand (Bush, 1879, cited in Rathe, 1990). Six wrecks are located near Point Cloates; a lighthouse and keepers quarters were constructed at Point Cloates soon after 1912. The structures proved unstable as they were constructed on a parabolic dune and were relocated several times. In the 1950s an automatic lighthouse was constructed south of the original lighthouse (CALM, 1989). The lighthouse and keepers quarters are in ruins, but provide an interesting historical feature.

From 1913-1955 whaling was carried out intermittently at Norwegian Bay (Ningaloo station, see figure 2.2). Initially the operation was carried out using factory ships; in 1915 whale processing facilities were constructed onshore but only operated for a year before being shut down (*ibid.*). Whaling recommenced for a period between 1922 and 1929 and 1949 and 1957 until whale quotas were reduced and the station was closed permanently (*ibid.*). There is little remaining of the whaling station.

2.7 INFRASTRUCTURE

2.7.1 Accommodation

In addition to sites for wilderness camping, many of the stations provide built accommodation in the form of shearers quarters. Accommodation offered at Gnaraloo includes the old homestead, fishing lodge, shearers quarters and cabins. A large proportion of the cabins are currently unfinished, and Gnaraloo station is completing these as funds allow (B. Gadowski, pers. comm., May 2002). The campground at Gnaraloo (3-mile

camping ground) provides toilets, hot showers, basic laundry facilities and a small shop. Warroora station is a frequent stop for backpacker tours and accommodation is provided in the shearers quarters.

2.7.2 Roads

The primary road network (see figure 2.2) includes the North West Coastal Highway, the Minilya-Exmouth road and the Coral Bay road. Access to Gnaraloo station is provided from the North West Coastal highway via the Blowholes road. Access to Warroora and Ningaloo stations is provided from the Minilya-Exmouth road and this is the main feeder road for tourist and service traffic to the study area. The Coral Bay road provides access to Coral Bay and Cardabia station. All three roads are sealed and currently provide adequate access to the area (SMEC Australia, 2001).

Access to Gnaraloo via the Blowholes road is sealed for the first 75km from the North West Coastal Highway to the coast, and unsealed for the last 75km along the coast. This last section of the road is usually useable by two-wheel drive (2WD) vehicles, though the condition does vary. Access roads to Warroora and Ningaloo stations are useable by 2WD vehicles, except during periods of heavy rain.

The north-south coastal road (see figure 2.2, p. 11) is generally a series of station tracks and some local government roads. The route from Gnaraloo to Warroora is a track and is currently closed to the public. The Warroora to Coral Bay section is a network of station tracks that provide four-wheel drive (4WD) access to coastal camping spots but which are unsuitable for 2WD vehicles (*ibid.*). The section from Coral Bay to Yardie Creek (in Cape Range National Park) is a local government road that is mostly accessible by 2WD vehicles except for a few sandy blow-outs.

The draft Carnarvon Coastal Strategy (SMEC Australia, 2001) summarises improvements to the coastal road network proposed in various government reports and strategy documents. These include to:

- upgrade the road between Ningaloo and Yardie Creek
- provide an access road from the Minilya-Exmouth road to Gnaraloo station
- upgrade the Quobba to Gnaraloo section
- look at reopening 4WD access between Gnaraloo and Warroora and

- phase out north-south coastal roads and provide access to coastal areas from the Exmouth-Minilya road

The draft Carnarvon Coastal Strategy suggested improvements were required to the following sections of the coastal road network: Gnaraloo to Warroora and Coral Bay to Exmouth via Yardie Creek (*ibid.*). For the section from Gnaraloo to Warroora, the Strategy proposed three options; maintain the current access tracks, construct a coastal road one to two kilometres from the coast, or construct an inland road and provide spur roads to coastal locations. A steering committee has been created under the Strategy to manage the development of the coastal roads network.

2.8 RELEVANT ENVIRONMENTAL PLANNING AND POLICY

2.8.1 Draft Carnarvon Coastal Strategy (Stage One)

The draft Carnarvon Coastal Strategy was released for public comment in July, 2001. The study area extends from Ningaloo station in the North to near Carnarvon in the south, bounded on the east by Lake Meleod, the Exmouth-Minilya road and the Ningaloo station boundary. The Strategy outlines three options for development; a high, medium and low-growth option, and each option is a combination of proposals for camping areas, day use areas, road networks and homestead tourism development. The preferred option suggested in the Strategy is a “medium-growth” option. Options were assessed according to how well they met the following development objectives:

- allows mainly self-reliant recreation
- development based on the capability of environment to sustain it
- allows the application of sound coastal planning principles
- results in improved management and
- provides for a range of tourism facilities and equity in coastal access

An evaluation matrix was used to assess the best option, with scores for each objectives summed to find a total score.

Over 1200 people made submissions on the Strategy. The Strategy document released is now considered as the first stage of the process, and the Strategy was renamed the Carnarvon-Ningaloo Coast Regional Strategy in September 2002 (MacTiernan, 2002b). In general, submissions showed greater support for the ‘low growth’ option on the basis that it

would retain the unique nature and appeal of the area (WAPC, 2002). Submissions stressed intergenerational equity as an important issue for the area (*ibid.*).

2.8.2 Exmouth-Learmonth Structure Plan

The focus of the Exmouth-Learmonth Structure Plan is to promote sustainable use that enables diversification of the economy while protecting the environment. The Structure Plan details three planning units; part of the Ningaloo pastoral lease is included in planning unit three. The major objective for this unit is to retain the wilderness values of the fragile coastal environment of the west coast (WAPC, 1998). The Structure Plan recommends that Cape Range be extended to include the Ningaloo lease in the long term, and supports a limited amount of ecolodge type tourism development. Three potential ecolodge sites on the Ningaloo pastoral lease are suggested: Winderabandi, Lefroy Bay and the Ningaloo homestead area.

2.8.3 Environmental and Planning Guidelines for Tourism Development on the North West Cape

The Environmental and Planning Guidelines recommend low-impact/small-scale tourism development on the west coast. Guidelines are provided for the following issues relevant to proposed tourism developments in the area: location, development scale, wilderness protection, foreshore setback, marine infrastructure, water availability, cyclones, flooding and drainage, sewage treatment, waste disposal, access, energy generation and construction and management (Department of Environmental Protection and Ministry of Planning, 1999). The purpose of the guidelines is to provide state agencies, local government, community and proponents with clear guidelines regarding tourism development, delineate limits of acceptable change and preserve, enhance and protect the environment.

2.8.4 Environmental Protection of Cape Range Province

This position statement produced by the Environmental Protection Agency (EPA) outlines the environmental values of the area and EPA objectives for its development. The province includes the coastal strip as far south as Amherst Point. EPA objectives for the province are to protect the environmental quality of all environmental systems and to ensure that all environmental systems are managed in accordance with the principles of ecologically sustainable development (EPA, 1999).

2.8.5 General Planning Policy Relevant to Coastal Areas

The State Planning Policy (WAPC, 1997) outlines the following strategies for protecting significant natural environmental and cultural heritage areas: incorporate CALM management strategies into future regional planning and development initiatives, review management plans for tourist sites near conservation areas, promote environmentally responsible tourist operations and protect significant environmental areas such as the area adjoining Ningaloo Marine Park.

The draft Coastal Zone Management Policy (WAPC, 2001a) provides an all of Government framework for coastal zone management. The Policy outlines the vision, goal, principles and objectives for coastal zone management. The goal for coastal zone management is to “manage the coast sustainably for the long-term benefit of the community, by protecting environmental quality, biodiversity and features of cultural significance, and providing for social and economic needs” (WAPC, 2001a, p. 18). Objectives for the coastal zone all aim to ensure biodiversity conservation, ecological integrity and intergenerational equity.

The Policy states that where possible foreshores will remain in or be returned to public ownership. It acknowledges the long connection of Indigenous Australians with the coast and proposes that their knowledge and values will be incorporated into coastal management arrangements. Consistent with this Policy, the Western Australian Planning Commission (WAPC) has also released a draft State Coastal Planning Policy (WAPC, 2001b), which outlines the requirements for planning decisions related to the coast.

3 LITERATURE REVIEW

3.1 INTRODUCTION

The complex nature of environmental problems, the range of stakeholders involved and the linkages between economic, environmental and social systems suggest that a range of disciplines should inform the decision making process. This chapter outlines economic concepts that are particularly relevant to the structure of management regimes for natural areas. The tourism demand for natural areas is explored, including the magnitude of the market, impacts, potential contribution to protected areas and the characteristics of nature tourists.

Sustainable development has become an overriding policy approach. The origins of sustainable development and alternative approaches present in the literature are outlined. The final sections focus on decision making techniques that are appropriate in light of sustainable development and the characteristics of environmental problems. Three individual techniques are addressed: EIA, CBA and stakeholder analysis. Finally, approaches that involve integrated assessment are presented.

3.2 THE ECONOMICS OF NATURAL AREAS

Under the conditions of perfect competition, the adjustment and equilibrating mechanisms of markets have a natural tendency toward Pareto efficiency. Pareto efficiency occurs where it is not possible to make anyone better off without making someone else worse off. This condition requires efficiency in resource allocation and consumption and an efficient product mix.

Despite the presence of transaction costs and imperfect information, for many goods, markets appear to efficiently allocate resources. Adam Smith's 'invisible hand' works to ensure that the thousands of individual decisions in response to price signals are, in aggregate, efficient. Under certain circumstances however, the market system fails to efficiently allocate resources. These circumstances generally involve either the attenuation of property rights, or characteristics of the goods themselves (Randall, 1987). These situations of market failure are pervasive in the context of environmental goods, and include public goods, externalities, imperfect competition and decreasing cost industries. Particularly relevant to the study of

natural areas and the provision of protected areas are issues relating to property rights and public goods.

3.2.1 Institutions and Property Rights

Institutions are the humanly devised constraints that structure political, economic and social interaction (North, 1991, p. 97), often termed 'the rules of the game'. Institutions can be formal or informal and their main function is to enhance the predictability of human behaviour and reduce the transaction costs of human interaction. Formal institutions are rules that are externally enforced; they include constitutions, statutes, common laws, government regulations and property rights. Formal institutions define the political, economic and protection systems (Pejovich, 1998). Informal institutions include traditions, customs, religious beliefs, codes of conduct, taboos, ethnicity and other factors that influence the subjective perceptions that people form to interpret reality (*ibid.*). Informal institutions are part of heritage and culture and are transmitted from one generation to another via teaching or interaction.

Informal rules have a significant impact on the outcome of transactions; similar formal rules have produced different outcomes depending on the informal rules present (*ibid.*). In this regard, formal and informal institutions can exist either in harmony or conflict. Institutions evolve incrementally and their continuity connects the present and the future with the past (North, 1991).

To provide a useful incentive structure and enhance the predictability of human behaviour, institutions must be credible and stable. However, since social change is inevitable, institutions must also be able to adapt. Institutions therefore need to be able to accommodate change but restrict the rate of change and preclude changes thought to be undesirable (Randall, 1987).

Property rights are one important facet of institutions. A property right is the enforceable authority to undertake particular actions related to a specific domain (Commons, 1968 cited in Ostrom and Schlager, 1996). Rights are relationships between people with respect to things (Bromley, 1991). If someone has a right, then others have a duty to respect that right. Property rights depend on a collective authority to uphold them.

Pareto-efficient outcomes can be achieved with non-attenuated property rights (given other conditions conducive to efficiency). A set of non-attenuated property rights is completely specified, exclusive, transferable and enforceable (Randall, 1987).

Property rights research within the field of natural resource management has centred on the incentives shaped by systems of property rights and the implications of those incentives for patterns of environmental use (Stevens, 1991 cited in Hanna *et al.*, 1996). Hanna *et al.* (1996) and Bromley (1991) classify four common resource management regimes: private property, common property, state property and open access. Bromley (1991, p. 22) defines a resource management regime as “a structure of rights and duties characterising the relationship of individuals to one another with respect to that particular environmental resource”. Table 3.1 categorises the four common types of regimes.

Table 3.1 Common Resource Management Regimes

Regime type	Owner	Locus of control	Rights	Duties
Private Property	Individual	Individual	“Owners” have right to undertake socially acceptable uses. “Non-owners” have right to expect only socially acceptable uses will occur	“Non-owners” have duty to refrain from preventing socially acceptable uses. “Owners” have duty to refrain from socially unacceptable uses
Common property	Collective	Management group	Management group has right to exclude non-members. Individual members have rights to agreed use	Non-members have duty to abide by exclusion. Individual members of group have duties to maintain resource and constrain rates of use
State property	Citizens	Rules decided by agency on behalf of citizens	Agency has right to determine use/access rules	Individuals have duty to observe use/access rules
Open access	None	Everyone	No right but privilege of use	No duties

Source: Hanna *et al.* (1996) and Bromley (1991)

Hanna *et al.* (1995) suggest that most environmental problems can be seen as problems of incomplete, inconsistent, or unenforced property rights regimes. As table 3.1 shows, property rights regimes differ by the nature of ownership, the rights and duties of owners, the rules of use and the locus of control. The confusion over open-access and common

property regimes can be traced to Hardin's (1968) article "The Tragedy of the Commons". What Hardin describes as the commons is actually an open-access resource; Bromley (1991) claims this confusion is responsible for the widely held perception that common property inevitably leads to resource degradation.

The functions of property rights regimes include limiting use, coordinating users and responding to changing environmental conditions (Hanna *et al.*, 1995).

Early research into property rights advocated private property as the appropriate regime to prevent resource degradation (see e.g. Demsetz, 1967). However there is a rapidly expanding body of literature (see e.g. Hanna *et al.*, 1995 and Beaumont and Walker, 1996) that suggests other property regimes may be equally appropriate for environmental resource management. It is now widely recognised that no single type of property regime is appropriate for all environmental management problems.

The focus has shifted towards designing property rights regimes with the following characteristics: they are well specified, context specific, transferable, enforceable and congruent with societal objectives (Hanna *et al.*, 1995). Design of property rights regimes requires definition of stakeholders and their interests and rules for participation of those interests in management (Ostrom *et al.*, 1993 cited in Hanna *et al.*, 1995). A number of other design principles are reported in the literature², such as:

- rights and responsibilities should be as congruent as possible to minimise free-riding behaviour
- incentive structure of rules should reflect long-term sustainability goals for the ecosystem
- decision rules should be consistent with ownership
- a reliant system of conflict resolution, monitoring and enforcement should be in place and
- regimes that benefit from, and accommodate local knowledge are likely to be the most adaptable and enforceable

This literature on property rights and the design of regimes has important implications for the management of natural resources.

² See Hanna *et al.* (1995) for an overview.

3.2.2 Public and Private Goods

Samuelson (1954 and 1955) formalised the concept of public goods, however his definition related only to the condition of non-rivalness in consumption, where non-rivalry meant that consumption by one individual did not reduce the amount available for consumption by others. In effect, non-rivalry means that each individual has access to the total quantity of the good. According to Samuelson's definition, public and private goods can be placed on a spectrum with rival private goods at one end and non-rival public goods at the other. Subsequent literature introduced the concept of non-exclusiveness, where it is not possible to exclude people from having access to or using the good. The introduction of non-exclusiveness meant that the public/private good concept became two-dimensional. A pure public good had the characteristics of non-exclusivity and non-rivalry; a pure private good had characteristics of exclusivity and rivalry, and in between was a range of impure public goods.

Randall (1987) suggests that the public/private good concept is inappropriate and it is more useful to conceptualise non-rivalry in consumption and non-exclusiveness as two separate phenomena that may or may not occur together.

Non-exclusiveness is an attenuation of property rights and may occur for three reasons: physical properties of the good may make it impossible to exclude people, controlling access may be too expensive, or excluding people or limiting access may be socially unacceptable (Dorfman, 1993). Particularly relevant to the issue of natural areas and provision of wilderness areas and protected areas is that of social unacceptability. Frequently protected areas are non-exclusive because of the notion that such areas should be available to all people, and that such goods should be beyond the market. Free-rider behaviour is frequently associated with non-exclusivity. Due to an inability to exclude people, individuals can receive benefits without bearing proportional resource costs and this may lead to over-exploitation of resources. Other allocative results of non-exclusiveness include under-provision of the good and under-investment in management and conservation. Since non-exclusiveness can be a result of institutional choice, it is closely linked to property rights and regimes.

Non-rivalry is a physical attribute of the good itself. Environmental goods that are non-rival include air, scenic beauty and existence benefits derived from the existence of species and habitats. As a special class of goods that behave like non-rival goods, congestible goods are particularly relevant to the provision of recreation in natural areas. Congestible goods act like

non-rival goods up until a certain level where congestion sets in, and then additional users reduce the utility of all users. The enjoyment of wilderness areas and natural scenery can be classed as a congestible good, up until a certain level additional users do not reduce the benefits available to existing users. However past a certain point, when perceived overcrowding sets in, users' utility declines with additional use.

The analysis of the above market failure factors plays an important role in determining the optimal level of natural areas and appropriate management regimes.

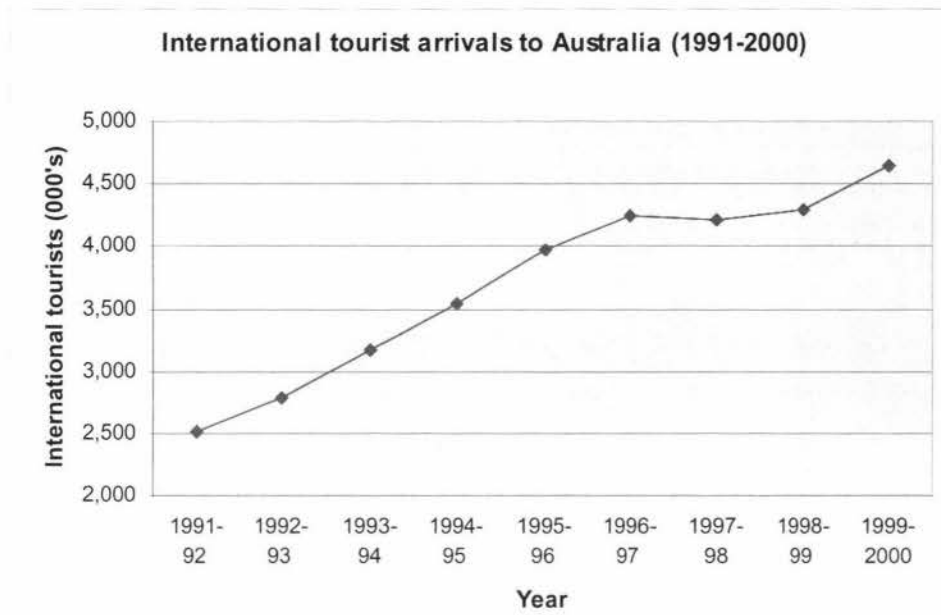
3.3 THE DEMAND FOR NATURAL AREAS - TOURISM

3.3.1 Mass and Alternative Tourism

Tourism has become one of the biggest international trade sectors. World tourism (measured in international arrivals) has increased from 25 million in 1950 to 664 million in 1999, which corresponds to an average annual growth rate of seven per cent (WTO, 2000). Tourism is one of the top five export sectors for 83 percent of all countries (*ibid.*) and accounts for nearly eight percent of total worldwide export earnings, higher than any other individual export category. Australia has experienced steady growth in international tourist arrivals; Figure 3.1 (p. 30) illustrates the growth over the last ten years.

The concept of tourism is linked to the evolution of leisure. France (1997) suggests that the separation of work and leisure is a modern phenomenon associated with the altered working patterns that arose from the social and economic changes of the industrial revolution, agricultural depopulation and growth of cities. Urry (1990, cited in France, 1997) notes that the advent of the paid holiday in the early twentieth century also altered the concept of leisure. The nineteenth century saw increasing numbers of people travelling as a result of increased leisure time, wealth and technological advances. However it wasn't until after the Second World War that tourism began to expand rapidly, as holidays became an integral and expected part of life (France, 1997).

Figure 3.1 International Tourist Arrivals to Australia (1991 – 2000)



Source: Australian Bureau of Statistics (2002).

The literature suggests a number of classifications of tourist types and these can be linked to types of tourism. Cohen (1972, cited in France, 1997) specified three types of tourists: drifter-explorer, individual mass tourist and organised mass tourist. More recently, Poon (1993) classifies tourists into 'new' and 'old'. Old tourists desire to escape from work to a sunny destination, while new tourists search for new experiences and wish to be independent. The models of tourist types are increasingly reflected in the classification of tourism into mass and alternative tourism.

A clear definition of mass tourism is lacking, frequently it is used as a point of reference for alternative forms of tourism (Hall and Wheeler, 1992 cited in Moscardo *et al.*, 2001). Other authors use the term to embrace all prevailing kinds of tourism to a destination (Moscardo *et al.*, 2001). General characteristics of mass tourism appear to suggest tourism on a large-scale with large firms, multi-national hotel chains and multinational decision making (France, 1997). Mass tourism is also associated with the four 's' words of tourism – sun, sea, sand and sex. Mass tourism can be linked to Cohen's (1972, cited in France, 1997) individual and organised mass tourists and Poon's (1993) old tourists.

There is now widespread recognition of the impacts of tourism on host areas. These impacts are frequently classified into economic, social and environmental impacts. Tourism is often regarded as a mechanism for regional economic development (Hall and Page, 2001), however

its actual use as such is problematic. The success of tourism for regional economic development will depend on a broad range of social, economic and political factors. Furthermore a successful tourism industry requires certain infrastructure, which may negate the benefits from tourism. Frequently the employment benefits of tourism in regional areas are much smaller than anticipated (Hall, 1994).

The range of social impacts associated with tourism in host areas include social dislocation, cultural changes and anxiety, social stress and changes in the social character resulting from the nature of the tourism, seasonality and the influence of foreign cultures (Hall and Page, 2001 and Lawson *et al.*, 1996). The environmental impacts of tourism are well documented, particularly those relating to protected areas. Buckley and Pannell (1990) categorise environmental impacts according to those associated with transport and travel, accommodation and shelter, and those associated with recreational activities themselves. Despite the vast literature on the (often negative) impacts of tourism, individual's opinions are often still favourable of the overall benefit of tourism to the community (Hall and Page, 2001). A survey of resident perceptions in the Gascoyne region of Western Australia found significant support for tourism, despite recognition of negative impacts (Dowling, 1993).

It is often perceived that negative impacts are mainly generated by mass tourism, based on the greater numbers of people and its more exploitative nature. This perception of mass tourism has led to the development of alternative forms of tourism. Alternative tourism is believed to be more sensitive; its aim is to minimise environmental, social, cultural and economic costs and maximise the benefits of tourism. Alternative tourism is associated with smaller numbers of tourists, locally provided accommodation and independent operators (French, 1997). Jones (1998, cited in Hawkins and Lamoureux, 2001) suggests the tourism market is becoming increasingly segmented and many new forms of tourism are developing, both mass and alternative types. Increasingly consumer preferences are expanding to alternative forms of tourism, often as an addition to more traditional tourism activities (Hawkins and Lamoureux, 2001). Jones (1998, cited in Hawkins and Lamoureux) states new consumers want to be involved, discover new experiences, interact with the community, learn more about and appreciate the destination at more than a superficial level.

A related concept to alternative and mass tourism is sustainable tourism. Originally perceived as a separate variant of tourism, it occupied a conceptual position in opposition to mass tourism. Clarke (1997, cited in Hardy and Beeton, 2001) identifies four changes in the

way sustainable tourism has been defined. The most recent position on sustainable tourism is that it is now seen as a goal applicable to all forms of tourism, regardless of scale. This implies that mass tourism should also strive to be sustainable. Muller (1997) suggests there are five angles to sustainable tourism, which form a magic pentagon. These are: economic health, subjective well being of locals, unspoilt nature and protection of resources, healthy culture and optimum satisfaction of guest requirements. The target situation is balanced tourism development, where all five objectives carry the same weight. Sustainable tourism has become a catchphrase for tourism development and is the subject of a vast literature in its own right.

3.3.2 Nature-Based Tourism

Boo (1990) defines nature tourism as visitation to natural areas that involves no consumptive use of those areas, while the Western Australian Nature Based Tourism Strategy (1997) defines nature-based tourism as any experience taken in the natural environment. Nature-based tourism can range from mass tourism (such as the Valley of the Giants Treetop Walk in Walpole, south-western Australia) through to ecotourism experiences. Ecotourism can be seen as a subset of nature-based tourism, although based firmly in the alternative tourism paradigm. The Australian National Ecotourism Strategy defines ecotourism as “nature-based tourism that involves education and interpretation of the natural environment and managed to be ecologically sustainable” (Australian Commonwealth Department of Tourism, 1994, p. 17), where sustainability also involves an appropriate return to the local community. The conceptual definition adopted by the World Tourism Organisation (WTO) for the International Year of Ecotourism includes all activity in natural surrounds with the prime objective of observing and appreciating natural and related cultural features, and a strong sense of conservation and environmental education (WTO, 2002). The WTO (2002) notes that very few destinations perceived as ecotourism destinations would actually qualify as such in a pure sense. Preece *et al.* (1995) suggest that ecotourism in Australia is actually a very small industry in comparison to the larger nature-based tourism segment, and not proportional to the profile given it in the media.

Blamey (1997) discusses the difficulties in obtaining an operational definition of ecotourism. Academic literature tends to distinguish between ecotourism and nature-based tourism, however in practice this is often an uncertain classification. Research into the characteristics of tourists often classifies ecotourism and nature-based tourism together. Preece *et al.* (1995) suggest elements of nature-based and ecotourism enter all segments of the tourism market

and form part of many travellers' experiences, and distinguishing between the two is a somewhat artificial classification.

Nature-based tourism is a significant worldwide market in terms of visitor levels and expenditure. Ecotourism and nature-based tourism account for approximately 20 percent of international travel, and is worth approximately US \$20 billion a year (WTO, 1998). In 1996 (March quarter) nature-based visitors accounted for 38 percent of all international visitors³ (Blamey and Hatch, 1998). In West Australia, nature-based tourism currently makes up 64 percent of total state tourism income, generating around three billion a year (WATC, undated).

There is considerable debate over the contribution that ecotourism and nature-based tourism can make to protected areas and biodiversity conservation. As a higher value market segment, ecotourism has the potential to provide economic benefits and lower environmental impacts than other forms of economic activity. Even if ecotourism does not provide direct funds to protected areas, it may provide benefits in terms of raising the opportunity costs of developing natural areas (Isaacs, 2000). Ecotourism has successfully contributed to conservation in special cases in Thailand, South Korea, Zaire, Labrador and Costa Rica (*ibid.*). However, as Wilkie and Carpenter (1999) note, the success of ecotourism in a given destination depends on a number of characteristics including: the presence of charismatic species, easy access, proximity to other attractions, unique landscapes and adequate infrastructure. In recent research, ecotourism experiences were found to strengthen pro-conservation attitudes of tourists and increase their willingness to pay for species preservation (Tisdell and Wilson, 2001). This provides a further avenue for ecotourism to support conservation.

Studies of the demographic characteristics of nature-based tourists and ecotourists generally indicate three distinguishing characteristics: higher than average income, higher education and a tendency to be middle-aged (Meric and Hunt, 1998 and Wight, 1996). This is supported by recent research by the WTO (2002), which suggests that the core market for ecotourism is made up of those aged 30-59 with higher education and above average income. Ecotourists want trips to be mixed with cultural and other activities, giving them a chance to meet local people, experience traditions and discover local products (*ibid.*).

³ Nature based visitors are defined as those who either went to a national park or participated in snorkelling, scuba, whale watching, horse riding, rock climbing, mountaineering, bushwalking, outback safaris or four-wheel drive tours.

The Australian Bureau of Tourism Research (Blamey and Hatch, 1998) undertook research into the motivations and characteristics of nature-based tourists in Australia. Although 38 percent of international tourists could be classed as nature-based tourists, only 23 percent of these indicated that the intention to visit natural areas was a major factor in the decision to visit Australia. The survey found that most nature-based activities were undertaken as part of an organised tour. The major motivations for participating in a tour included: seeing the natural beauty of the sites visited, a chance to see or experience something new, being close to nature, a different or unique way of experiencing nature and seeing wildlife. An educational/learning experience can be seen as a distinguishing characteristic between nature-based tourism and ecotourism. This was considered very important by 69 percent of nature-based tourists who undertook a tour.

The diversity of Western Australia's natural environment makes it ideally suited as a nature-based tourism destination. Western Australia has 12 000 species of flowering plants, a diverse range of habitats and spectacular and remote coastlines. The Nature Based Tourism Strategy (WATC and CALM, 1997) provides a framework to ensure the sustainability of nature-based tourism in Western Australia. The Strategy outlines five guiding principles: conserving the natural environment, involving and benefiting local communities, improving knowledge, providing quality products and services and fostering an effective and efficient industry.

3.4 SUSTAINABLE DEVELOPMENT

The concept of sustainable development was popularised in the Brundtland Commission Report 'Our Common Future' (WCED, 1987), although it first appeared in the World Conservation Strategy (IUCN, 1980) several years earlier. The Brundtland definition is widely quoted: "paths of human progress which meet the needs and aspirations of the present generation without compromising the ability of future generations to meet their needs" (WCED, 1987, p. 43).

Sustainable development became the catchphrase of the nineties, but it represented the latest step in a long evolution of public and academic concerns with respect to natural resources and the environment (Batie, 1989). Prior to World War II, the focus of environmental concern was on efficient utilisation of natural resources, as espoused by the Progressive Conservation Movement ideology (Batie, 1989 and Edward-Jones *et al.*, 2000). After World

War II, attention shifted to the aesthetic and amenity uses of natural resources. During this period, ecocentric views of the environment became more prominent, such as Aldo Leopold's land ethic. Growing interest in outdoor recreation led to increased demand for the preservation of natural areas. Recently, more attention has been given to the role natural resources and ecosystems play in maintaining healthy and stable life systems.

The changing awareness of the role and importance of natural resources is also reflected in the economic discipline, where the 'limits to growth' debate has a long history. Concern over the sustainable use of resources was first evident in the work of the classical economists, Malthus, Ricardo and Mill. Malthus and Ricardo suggested there was a finite and predictable limit to natural resources, which coupled with increasing population would inevitably lead to natural resource scarcity and a limit to economic growth. Malthus foresaw these limits in terms of the quantity of agricultural land available, whilst Ricardo believed that limits were in terms of the quality of agricultural land. Mill extended these ideas to include the effects of resource scarcity on the quality of life. Mill's concern over the impact on quality of life foreshadowed much later developments in the 'limits to growth' debate.

Interest in resource scarcity waned in the economic profession with the advent of neoclassical economics and its corresponding focus on short-run phenomena. In 1963 Barnett and Morse published 'Scarcity and Growth', which looked at the empirical evidence for the Malthusian and Ricardian notion of resource scarcity. The focus of this study was on exhaustible natural resources, for which the authors concluded society had successfully avoided increased scarcity. The study briefly mentions other natural resource problems such as pollution, and their impact on the quality of life.

Concern over the role natural environments play in maintaining life became more pronounced in Boulding's concept of a spaceship earth economy (1966). He highlighted the problems of ever increasing production levels, both in terms of finite resource use and environmental pollution. He likened the current economy to a 'cowboy economy', characterised by reckless and exploitative behaviour. He described a future economy as a 'spaceship economy', which would be self-sufficient and aim to minimise economic throughput. Boulding believed that it would not be long before the cowboy economy would be replaced, however it was problems of pollution rather than resource exhaustion that would bring this about.

In 1972 'The Limits to Growth' (Meadows *et al.*, 1972) was published and concluded that if current trends in population, industrialisation, food production and resource depletion continued unchanged, the limits to growth would be reached within one hundred years. Though criticised by many scientists and economists, the work was important in creating public awareness of the issue. Most criticisms of the model related to the relationships between the variables. When re-run with different assumptions that allowed for substitution and technological change, completely different conclusions were drawn (Nordhaus, 1973 cited in Ekins, 2000).

The economic debate over the limits to growth centres on three factors: the rate of technical progress, future changes in the composition of output, and the possibilities for substitution between capital (Lecomber, 1975). If these three effects add up to a shift away from the limiting resource or pollutant, then the limits to growth can be put back indefinitely (Ekins, 2000). Those who believe that technology and possibilities for substitution can overcome resource scarcity are often termed resource optimists. The degree of substitution between forms of capital, particularly physical and natural capital has become the crucial issue for economists in the sustainability debate.

Another perspective on the 'limits to growth' debate is provided from the physical and biological sciences, and is primarily associated with the work of Georgescu-Roegen (Cleveland and Ruth, 1997) and the ecological economics discipline. The first and second laws of thermodynamics⁴, and the analysis of energy and material flows in general, have implications for limits to growth. The materials balance principle states that matter can be neither created nor destroyed. Economic production at most involves the transformation of resources extracted from the environment, implying that all material extracted must eventually be returned to the environment. The creation of wastes at a rate greater than the environment can absorb is the definition of pollution.

The entropy law implies that economic activity transforms free or available energy into bound or unavailable energy (Cole, 1999). One of the life support services provided by the environment is the conversion of high entropy wastes back into resources, however current economic activity transforms energy at a rate greater than the environment can convert.

⁴ The first law of thermodynamics states that energy can neither be created nor destroyed but only converted from one form to another. The second law (entropy law) states that heat flows spontaneously from hotter to colder bodies and that this heat cannot be transformed with one hundred percent efficiency (Perman *et al.*, 1999).

Ecosystem interdependence also has implications for the limits to growth. Two concepts, stability (propensity of populations to return to equilibrium following disturbance) and resilience (ability of an ecosystem to maintain functional and organisational structure following disturbance) are critical to the services to the economy provided by ecosystems in the form of a resource and amenity base and waste sink. Economic activity generally reduces the complexity of ecosystems; the more complex an ecosystem, the more resilient.

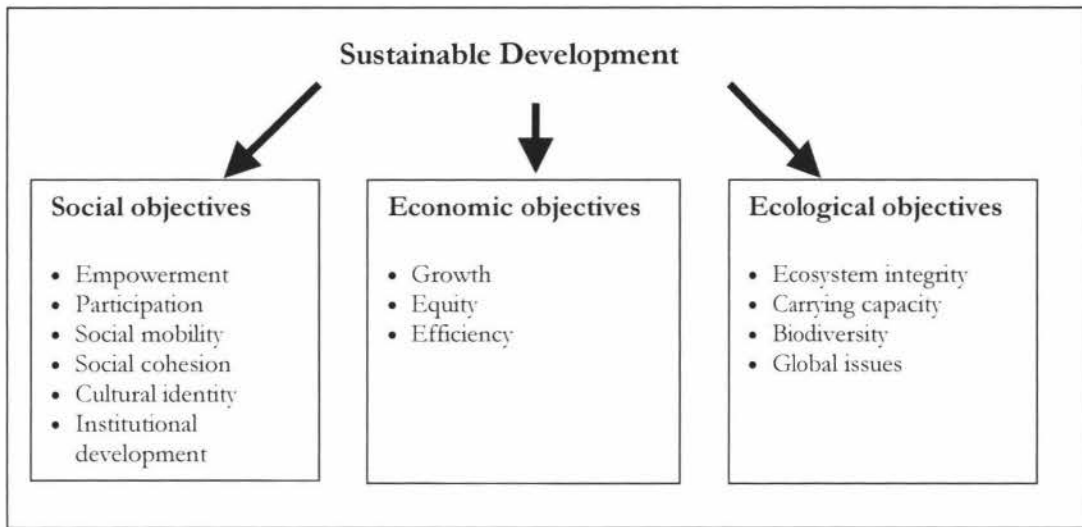
Biophysical limits to growth led Daly (1973) to advocate a steady state economy, which is characterised by a constant stock of physical capital and a constant level of population. Such an economy would develop qualitatively rather than quantitatively. Increasingly, the 'limits to growth' debate was focusing not on the exhaustion of non-renewable resources but on the life support functions provided by the environment and the amenity values derived from it.

The 1980s saw the 'limits to growth' arguments largely replaced by the notion of sustainable development, though many elements are similar. The proliferation of sustainable development definitions and concepts has created difficulties in the operationalisation of the concept. This has led to different groups using interpretations to suit their particular purposes (McManus, 1996), and confusion over the relationship between economic growth and sustainability (Ekins, 2000). One approach suggested is to view sustainable development as the juxtaposition of two objectives – sustainability and development (Lele, 1991). Here development refers to the reduction of widespread poverty, unemployment and inequality, guided by the principle of self-reliance (Sharpley, 2000), while sustainability is concerned with the global ecosystem's capacity to continually provide life-support functions and resources. Friend (1992) doubts the compatibility of resource conservation and economic development, and Lumley (1999) suggests that the term development is at the root of the definitional problem, since it means many things to different people depending on discipline and vested interests.

Another approach views sustainability as the ability of some function or activity to be sustained, and thus sustainable development refers to some vector of desirable social goals that does not decrease over time (Pearce *et al.*, 1990). The relationship to the environment is that the maintenance of a constant natural capital stock is a necessary but not sufficient condition for sustainable development. A sufficient set of conditions might include institutional requirements and systematic changes in social values (*ibid.*). This view of sustainability is widely held within the economics profession.

Finally, sustainable development can be viewed as the interaction between three systems: the biological, economic and social systems (Barbier, 1987). Here the aim of sustainable development is to maximise the goals across all these systems through an adaptive process of tradeoffs. An example of possible system objectives is provided in figure 3.2. The system concept of sustainable development is the basis for the triple bottom line; the simultaneous consideration of economic, environmental and social objectives.

Figure 3.2 A Systems Approach to Sustainable Development



Source: Adapted from Cambell and Heck (1997)

In spite of the different versions of sustainable development, the sustainable development paradigm allows for pluralism and dialogue between disciplines (Lumley, 1999). Ascher (1990, cited in Mirovitskaya and Ascher, 2001) notes that although people can act as if they have agreement about the concept even whilst pursuing incompatible agendas, the degree of incompatibility is probably less than amongst those who do not subscribe to the concept. Although it has been difficult to make sustainable development operational as a concept, it still has value as an expression of common interest and of an alternative belief system (Batie, 1989).

A common core within differing definitions and conceptions is the recognition of the limits provided by the biosphere, and the principle of equity (Cole, 1999 and Batie, 1989). Equity refers to both intragenerational equity (providing for the needs of the least advantaged in current society) and intergenerational equity (current generations should not compromise the ability of future generations to meet their needs and enjoy a healthy environment).

It is generally agreed (Cole, 1999) that the best way to ensure intergenerational equity is to ensure that the next generation has access to a stock of capital at least as large as the current stock. What constitutes the capital stock is the key distinction between 'weak' and 'strong' forms of sustainable development. Capital stock consists of natural, physical (or human built) and human capital. Pearce and Barbier (2000) suggest that all three types of capital contribute to human well being through supporting the production of goods and services and also directly through the appreciation of architecture and physical aspects of culture, aesthetically pleasing natural environments and the overall stock of human knowledge.

Proponents of weak sustainability require only that a constant level of the total capital stock be maintained, while strong sustainability requires that constant levels of the relative components of the capital stock are maintained, in particular a constant level of natural stock. The difference between the two forms of sustainability hinges on the level of substitution between physical and natural capital. Weak sustainability assumes that manufactured and natural capital are close substitutes. In contrast strong sustainability rests on the belief that for some classes of natural capital, substitution is not possible. The issue of substitution between forms of capital provides the link between the limits to growth and sustainability debates.

Despite the debate over different versions of sustainable development, Driml (1996, cited in Hardy and Beeton, 2001) suggests that the concept has advanced in two directions since the World Commission on Environment and Development (WCED) report:

1. Conceptual support at a local, national and international level
2. Technical advancement through defining how sustainable development may be implemented, including definitions and indicators.

In particular, the concept has seen broad acceptance at a policy level both internationally and nationally. The second world conservation strategy 'Caring for the Earth: A Strategy for Sustainable Living' (1991) further advanced the concept of sustainable development by acknowledging that sustainability could not be achieved only through technical solutions but must embrace a new ethic in human-nature and human-society relationships (Mirovitskaya and Ascher, 2001). Sustainable development at the international policy level was further addressed with Agenda 21, the major document produced at the Rio Earth Summit (United Nations Conference on Environment and Development) in 1992. The Agenda proposes a

set of actions to be taken by local, regional and global actors to implement change and work toward sustainable development.

The position of sustainable development at the forefront of the international stage has been paralleled at a national level, with many governments adopting a sustainable development policy after the Rio convention (Elliot, 1998 cited in Lumley, 1999). In 1992, the Australian government adopted a national strategy for ecologically sustainable development. This strategy adopted the following definition of ecologically sustainable development: “using, conserving and enhancing the community’s resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased” (Ecologically Sustainable Steering Committee, 1992).

The core objectives outlined in the strategy are: to enhance individual and community welfare through economic development, to provide for equity within and between generations and to protect biological diversity and maintain essential ecological processes and life support functions. The guiding principles suggest that decision making processes should integrate long and short-term economic, environmental, social and equity considerations and provide for broad community involvement. The Strategy outlines the roles that governments, business, community organisations and individuals should play in implementing ecologically sustainable development. Working groups reported on the sustainability of sectors of the Australian economy, however these reports resulted in little action being taken (Western Australian Government, 2002).

The Western Australian Government recently released its draft State Sustainability Strategy (2002). This strategy has defined sustainability as “meeting the needs of current and future generations through simultaneous environmental, social and economic improvement” (Western Australian Government, 2002, p. 24). Seven foundation principles are suggested and four process principles. The approach adopted is explicitly a systems approach to sustainable development, however the definition is restrictive in that if only two aspects of improvement occur (e.g. social and environmental improvement) the action is not sustainable. At a policy level this may be feasible, but achieving sustainability at the project level will be very difficult. The strategy outlines a set of decision aid techniques that are relevant to the analysis of sustainability. These include ecological economics, multiple criteria analysis, scenario planning, and value frame analysis.

Despite the variety of approaches to sustainable development present in the literature and the lack of agreement over which is best; sustainable development has been widely adopted in the policy arena. Many of these policies are ambitious and seem to lack recognition of the practicalities of implementing sustainable development, however they provide a foundation for more sustainable societies and outline techniques that are particularly appropriate for sustainability analysis.

3.5 TECHNIQUES TO AID NATURAL AREA DECISION MAKING

3.5.1 Environmental Impact Assessment

EIA was developed as a decision tool in the late 1960s in response to increasing awareness of environmental issues – the concern over problems of pollution and the increased demand for conservation of natural areas. The concept of EIA was first incorporated into statutory decision making in the United States National Environmental Policy Act (1969), and has since spread through most of the western world in the form of specific legislation or through the adaptation of existing environmental legislation (Gilpin, 1995).

The purpose of EIA is to provide a method for the full consideration of possible adverse impacts of policies and projects. Petts (1999) notes that confusion exists in the literature as to whether EIA is a tool to aid decision making or a decision process in itself. As a tool, EIA generally refers to the identification, description and assessment of direct and indirect effects of a project on the environment. As a decision process, EIA includes the decision making and monitoring phases of the decision process. A relatively new development in EIA is that of Strategic Environmental Assessment (SEA), which is usually related to the assessment of regional level plans and policies. SEA employs a slightly different set of techniques and the focus is on policy rather than specific projects. SEA was developed to address the issue of sustainability, and to ensure that this principle is carried down from the policy level to individual projects (Partidario, 1999).

The techniques employed in the EIA usually differ between preliminary assessment and full assessment phases. Preliminary assessment phases tend to use rapid appraisal techniques such as checklists, thresholds, criteria, matrices, networks and overlay maps (Jones, 1999). Generally some combination of these techniques is used, to overcome the limitations of individual techniques. At the full assessment level a wide range of techniques may be employed, some of which can be considered project appraisal techniques in their own right.

Such techniques include CBA, cost-effectiveness analysis, life-cycle analysis, risk assessment and social impact assessment. The use of geographic information systems is becoming common in EIA and there is also a move towards using decision support tools such as MCA, particularly in the Netherlands (Janssen, 2001).

Criticisms of EIA relate to both the overall process and specific techniques used in the assessment phase. A general criticism is that EIA often occurs at a stage when it is too late for the results to be incorporated into the creative project design stage (Nardini, 1997). In light of this, the role of EIA is often seen as legitimisation, justifying decisions that have already been made. Petts (1999) suggests that many of the criticisms of EIA relate to 'bad practice' and are not necessarily inherent in the process. Such bad practices include the bulkiness and unreadability of reports (Nardini, 1997), the implicit role of decision justification, and the degree of subjectivity and transparency in the assessment (Pastakia and Jensen, 1998). Pastakia and Jensen (1998) note that subjective assessment is not necessarily bad in that it might be complete and comprehensive, but the difficulty lies in the transparency and reproducibility of assessments.

In particularly complex decisions, EIA as a sole decision aid technique fails to adequately integrate environmental considerations with social and economic issues. Bateman (1999) suggests that economic valuation information may be a valuable addition to supplement the physical unit information utilised in EIA, and thus some hybrid of EIA and CBA would be desirable.

3.5.2 Cost Benefit Analysis

All societies are subject to scarce resources and must make decisions regarding the best use of resources. CBA is a decision aid technique that identifies courses of action that improve the allocative or Pareto efficiency of resource allocation.

The Pareto criterion is a welfare-based rule for accepting projects or actions that provide Pareto gains (Edward-Jones *et al.*, 2000). However it is inappropriate when a resource allocation makes some people better off and others worse off, which would apply for most, if not all projects. CBA is based on a version of the Pareto criterion – the Kaldor-Hicks potential compensation principle. Under this principle a project is economically desirable if those who gain from a project could potentially compensate those who lose and still remain better off. It would then be theoretically possible to achieve a genuine Pareto gain by

transferring some of the gains to those who lose, though this occurs rarely in practice (*ibid.*). The Kaldor-Hicks compensation principle is translated into practical terms by the requirement in CBA that economic benefits must be greater than economic costs (the net benefit rule).

CBA is based on neoclassical economic theory, which emphasises the notion of individual consumer sovereignty (Hufschmidt *et al.*, 1983). Economic values arise from meeting individual preferences, and resources should be allocated according to what people want (Pearce and Barbier, 2000). This is an anthropocentric view, where values are derived from human needs and interests. Pearce (1998) notes that this neoclassical basis is the subject of the most widespread criticism of CBA regarding the assumption that social decisions should reflect what self-interested individuals want. Sagoff (1988) argues that public choice should rest upon choices made by individuals in a citizen mode, who act out of concern for the public good, rather than individuals acting in a self-interested manner. In response to this criticism, Pearce and Barbier (2000) point out that neoclassical economics places no restrictions on the motivations behind preferences and that in addition to self-interest, valid motives include altruism, bequest and existence. Pearce (1998) suggests that neoclassical theory is consistent with weak anthropocentrism; values are of people but do not need to centre on humans.

Economic value is defined by the maximum amount an individual would be willing-to-pay (WTP) for a good or service. WTP consists of the price paid and the additional amount that the consumer is willing to pay over and above the price, termed consumer surplus. WTP takes the existing distribution of income as given, however WTP is related to ability to pay and thus is biased towards the prevailing distribution of income (Pearce and Barbier, 2000).

The concept of economic as opposed to financial costs and benefits rests on the notion of opportunity cost, the value of the next best alternative or use. A consumer's WTP for a good reflects what is foregone through not purchasing something else (Department of Finance, 1997). In the case of inputs, opportunity cost is the value in its next best use.

If markets are competitive, pricing equal to marginal cost implies that costs and benefits are equated with their opportunity costs, since allocative efficiency is maximised when the marginal benefit derived from the last unit of consumption is equal to the marginal cost of production. Therefore in competitive markets, prices reflect economic value. However all markets are rarely competitive, particularly for environmental goods and services. The CBA

process then involves adjusting market prices to represent the true value to society (opportunity cost); adjusted prices are termed shadow prices.

The framework for conventional CBA was largely in place by the 1960s (Pearce 1998) and the literature shifted towards methods for finding monetary valuations in contexts where markets did not exist. Much of this has occurred in relation to the concept of total economic value of environmental assets. Total economic value of an environmental asset consists of its use value and non-use value. Non-use value can be further broken down into direct use value, indirect use value and option value. Following Maunasinghe (1993) the following descriptions of these value categories are provided:

Direct use value: The contribution that an environmental asset makes to current production or consumption. Includes food, biomass, recreation and health.

Indirect use value: The benefits derived from functional services that the environment provides to support current consumption and production. Includes ecological functions such as recycling of nutrients and filtration of polluted water.

Option value: The premium people are willing to pay to avoid the risk of not having it available in the future. Includes future direct and indirect values.

Existence value: The satisfaction from merely knowing that an asset exists, although the valuer has no intention of using it.

For environmental goods and services, markets exist for only a few of these values. A number of methods have been developed to estimate these particular values and total economic value in monetary terms. Bateman (1999) classifies monetary assessment methods into pricing and valuation approaches. Pricing approaches are less theoretically sound but are generally simpler and easier to apply, and inform about the cost of obtaining a good, which is only a proxy for its value. Pricing approaches include opportunity cost, cost of alternatives, mitigation behaviour, shadow project costs and dose-response methods. Valuation approaches are further broken into stated preference and revealed preference methods. Stated preference approaches ask people directly about their valuation of environmental goods and services and include contingent valuation, contingent ranking and stated preference or conjoint analysis methods. Revealed preference methods obtain value

information by observing purchases of market priced goods, which are necessary to enjoy the environmental good in question. These include travel cost and hedonic pricing methods.

Costs and benefits that occur through time are aggregated through the procedure of discounting. This procedure and the choice of discount rate are subject to renewed debate (Edward-Jones *et al.*, 2000). Generally a positive discount rate is justified for the following reasons:

1. Individuals' preference for immediate consumption due to either impatience or uncertainty surrounding future benefits.
2. Future consumption counts for less if there is any positive rate of growth in the economy. This assumes that future consumption is greater than current and that there is diminishing marginal utility of consumption in the future.

Perman *et al.* (1999) distinguish between two discount rates; the utility (or pure time preference) discount rate and the consumption discount rate, where the relationship between the two is:

$$r = \rho + \eta g$$

Where:
r = consumption rate of interest
 ρ = pure time preference rate
 η = diminishing utility of consumption
g = growth rate of consumption

Arrow *et al.* (1996) conclude that from the first principles approach there are two reasons for the discount rate; one cares more about current consumption (reflected in the ρ term) or one believes that future consumers will be better off (reflected in the second term ηg). Perman *et al.* (1999) suggest that the second conclusion is intuitively reasonable in that if an economy is growing over time, a unit of consumption in the future will be worth less to a typical consumer comparative to the current period. If additional units of consumption are worth less in terms of marginal utility, then additional units of consumption are worth less the higher the initial level of consumption.

In criticism of this assumption, Easterlin (1997, cited in Edward-Jones *et al.*, 2000) suggests that utility of consumption is related to relative as opposed to absolute levels. Utility depends on consumption relative to others rather than absolute levels. This would reject the social time preference discount rate. Another criticism regarding the assumption that the future will be wealthier is that this depends on the ability of basic capital to compensate for

ecological services. This argument is linked to the degree of substitutability between types of capital, a keystone of the sustainability debate.

Another approach to the discount rate involves that of social opportunity cost, which represents the return on investment elsewhere in the economy that is displaced by the marginal project in question (Department of Finance, 1997). Discount rates based on the opportunity cost approach are usually higher than those based on the social rate of time preference (Markandya and Pearce, 1994).

The debate over discounting has emerged in the context of environmental issues, particularly sustainable development. Those that oppose the practice of discounting do so on two grounds; discounting discriminates against the interests of the environment and discounting is associated with a particular ethical stance that is not consistent with intergenerational equity. The first proposition is based on the notion that high discount rates encourage early depletion of natural resources; however as Markandya and Pearce (1994) note, the actual relationship between discount rates and the profile of resource use is ambiguous. Low discount rates increase the likelihood of investment projects being accepted, and thus increase the use of natural resources. High discount rates may encourage early use of natural resources, but at the same time less investment projects are accepted. High discount rates also tend to discourage investment in primary industry type projects, which generally have lower rates of return and are often more likely to be environmentally damaging (Edward-Jones *et al.*, 2001). In relation to the second proposition, higher discount rates encourage investment projects with costs profiles that are weighted towards the future and benefit profiles that are weighted towards the present. This may not be consistent with intergenerational equity.

Attention has now shifted to methods other than the discount rate for addressing intergenerational equity and incorporating sustainable development into project appraisal and CBA (Markandya and Pearce, 1994 and Hanley and Spash, 1993). Van Pelt *et al.* (1990) suggest the following possibilities for incorporating sustainability as an overriding constraint in CBA:

1. Prior to undertaking a CBA, sustainability is independently assessed on the basis of ecological indicators, so that CBA becomes a second-tier measure.

2. Following Cooper (1981, cited in van Pelt *et al.*, 1990), CBA calculations should be calculated for all years and onwards, instead of only the first year and onwards. If any calculation shows a negative return the project should be rejected even if the overall return is positive.
3. Compensating projects could be designed that regenerate resources. Instead of the Kaldor-Hicks potential compensation criterion, actual compensation would occur in physical and not monetary terms. Compensating projects could be either environmentally or economically compensating, depending on whether a strong or weak sustainability criterion is chosen. In practice, designing a compensating project for every investment undertaken would be impractical; Markandya and Pearce (1994) suggest a portfolio approach, in any portfolio of investment projects there should be compensating investments in resource regeneration.

Where sustainability is not an overriding criterion but can be substituted to some degree against other objectives, van Pelt *et al.* (1990) suggest alternative approaches are called for. Munda (1996) suggests that CBA approaches represent only a partial point of view, since they are derived from one institution: markets. For complex environmental management issues, CBA as a sole aid to decision making is not adequate.

3.5.3 Stakeholder Analysis

Stakeholder analysis is now widely used as an important method for increasing information for decision making and increasing the acceptability and commitment to decisions (Welsh and McGin, 1998). The concept is used in business management, project appraisal and planning and natural resource management.

Stakeholder analysis has its roots in stakeholder theory, which had developed as an alternative approach in business management and ethics. Jones *et al.*, (2002) describe stakeholder theory as the body of literature that has emerged over the last fifteen years in which the idea of 'stakeholder' plays a key role. Freeman's seminal book 'Strategic Management, a Stakeholder Approach (1984) formalised the stakeholder approach to the firm, though the idea emerged in several related themes prior to the 1980s. The origins of the stakeholder concept can be found in the fields of corporate social responsibility, corporate planning, systems theory and organizations theory. Jones *et al.* (2002) suggest stakeholder theory rests on two basic premises; to perform well, managers must pay attention to a wide range of stakeholders, and

that managers have an obligation to stakeholders, where stakeholders as a group extends beyond shareholders. The first premise appears to have originated in the field of corporate planning, while the second is directly related to the concept of corporate social responsibility.

Stakeholder analysis within the fields of development, project appraisal and natural resource management has developed quite separately to that of stakeholder theory. Although most articles in these fields make a brief mention of the origins in the stakeholder theory of the firm, this is generally the extent of the linkages between the two. As Welsh and McGin (1998, p. 187) note, "there is little cross-fertilisation between business management writers and those who advocate stakeholder analysis for programme evaluation". Although the fields have developed separately, the definition of a stakeholder has remained similar in both fields. Freeman (1984) describes stakeholders as any group or individual that can affect or is affected by the activities of the firm. In a recent example of a natural resource based approach to stakeholder analysis, de Lopez (2001a, p. 48) proposes the following definition in the broader context of natural resource projects; "a stakeholder is any group or individual who can affect the achievement or is affected by the achievement of conservation project objectives".

There are fewer similarities between the corporate management and natural resource approaches in the classifications of stakeholders. Within the field of corporate management, stakeholders are traditionally classified according to their potential for cooperation with, or threat to the organisation (Freeman, 1984). The development/natural resource literature suggests classifications according to primary and secondary stakeholders (Overseas Development Agency, 1995 cited in Grimble and Wellard, 1997), active and passive stakeholders (Grimble and Wellard, 1997), and standard and interest groups (Lahdelma *et al.*, 2000). A further extension in this literature is classification according to two dimensions, relative importance and influence (Overseas Development Agency, 1995 cited in Grimble and Wellard, 1997) and potential for conservation and influence (de Lopez, 2001a). These two dimensional classifications recognise the potential of stakeholders to be a threat to project outcomes through the dimension of influence.

Two distinct approaches to stakeholder analysis within the field of natural resource management are present in the recent literature. The first approach can be found in the work of development agencies (particularly the World Bank and Overseas Development Agency) and focuses on the social aspects of stakeholder analysis and its use as a tool in project

design, particularly for the avoidance and management of conflict (Grimble and Wellard, 1997). This approach will here be termed the agency approach. MacArthur (1997) further breaks this approach into two general applications – involvement of stakeholders in participatory methods of development, and the use of stakeholder analysis to assure sound implementation of development projects. The second approach is associated with the work of Grimble and others (see e.g. Grimble and Wellard, 1997), and will be here termed the Grimble approach. This approach sees stakeholder analysis as a tool for analysing situations and predicting consequences and the focus is not only with project cycle activities but also with gaining an improved understanding of the natural resource management problem (Grimble and Wellard, 1997). The agency approach is concerned with the practicalities of consensus building and developing workable projects, while the Grimble approach uses stakeholder analysis as a tool for understanding the economic interests and inherent conflicts in natural resource management (*ibid.*).

Both approaches suggest that participatory methods in project design have played an important role in the development of stakeholder analysis. MacArthur (1997) notes the wide range of degrees of participation, from informing people likely to be affected by a decision, through to participation that includes some element of empowerment. Involvement of stakeholders in the planning and decision-making phases became popular from the mid eighties, and this necessitated consideration of who should be involved (*ibid.*). Grimble and Wellard (1997) suggest similarities between participatory methods and stakeholder analysis, particularly in techniques used for data collection and the commonality of goals in ensuring that the interests of the disadvantaged and less powerful groups are addressed. Of the two approaches, the development agency approach places much more emphasis on participatory approaches.

In addition to the role played by participatory methods, economics has contributed to the development of stakeholder analysis for project development and environmental management. In particular, the limitations of CBA to identify the distribution of costs and benefits or to consider stakeholder concepts of value and importance led to the development of approaches to account for these aspects.

Differences between the two natural resource management stakeholder analysis approaches include the purpose, scope and emphasis placed on participatory methods and conflict

(Grimble and Wellard, 1997). A comparison of methodologies suggested by the two approaches is provided in table 3.2.

Table 3.2 Comparison of Methodologies for the Two Natural Resource Management Approaches to Stakeholder Analysis

Development Agency Approach	Grimble Approach
<ol style="list-style-type: none"> 1. Define higher objectives of project 2. Identify stakeholders and distinguish between primary, secondary and external stakeholders 3. Determine interests or stakes of stakeholders 4. Assess importance and influence of stakeholders 5. Consider whether additions to project design are required 6. Consider which stakeholder interests should be allowed for in project activities, during which stage and in what way 	<ol style="list-style-type: none"> 1. Identify main purpose of analysis 2. Identify principal stakeholders 3. Investigate stakeholder interests, characteristics and circumstances 4. Determine view of stakeholders on relevant questions 5. Identify patterns and contextual interactions between stakeholders 6. Assess options for management at all levels

Source: MacArthur (1997) and Grimble and Wellard (1997)

The development agency approach considers stakeholder analysis as a management and mediation tool explicitly concerned with the design, management and implementation of projects. Much greater emphasis is placed on participation and participatory methods and the representation of stakeholders and conflicts between them. The Grimble approach stresses stakeholder analysis as a tool for analysing situations and not solely concerned with the project cycle phase. Although concerned with conflict, this is extended to consider the tradeoffs between stakeholder objectives.

Elements of both approaches can be seen in the recent stakeholder management framework of de Lopez (2001a). Here stakeholder management is seen “as a process of understanding and predicting the behaviour and actions of stakeholders and devising strategies to ethically and effectively deal with them” (*ibid.* p. 48). Following the Grimble approach, stakeholder management does not specifically focus on participatory or consensus approaches. De Lopez (2001, p. 48) proposes four questions that need to be answered in a stakeholder management framework:

1. Who are the stakeholders of the project?

2. What is the nature of their stakes in the project?
3. What type of behaviour can be expected from stakeholders?
4. What strategies should the project adopt to achieve its goals and deal with stakeholders?

De Lopez's relatively simple framework provides a model for stakeholder analysis that is directly applicable to the management of protected areas. Stakeholder analysis provides valuable information to decision makers, however its potential outcomes would be considerably stronger if other decision aid techniques are also utilised. This is recognised by de Lopez (2001b), who included both stakeholder analysis and cost benefit analysis in the assessment of policy options for Ream National Park in Cambodia. The potential complementarity of MCA and stakeholder analysis is also suggested by Grimble and Wellard (1997).

3.5.4 Integrated Evaluation Techniques

The limitations of individual assessment techniques when used in isolation, and the recognition of the complexity of environmental problems has led to the development of more integrated techniques. A multi-disciplinary approach is advocated for developing sustainability frameworks (Park and Seaton, 1996), where links are made between scientific and socio-economic theory and the information is presented in a manner that is accessible for policy formulation and decision making processes. Lockeretz (1991, cited in Park and Seaton, 1996) describes an integrative multi-disciplinary approach as one that divides the topic into disciplinary components but gives special attention to the linkages among them and questions that overlap.

These ideas are reflected in the evolution of a relatively new discipline – integrated assessment. Integrated assessment has its origins in global climate change impact assessment (Jakeman and Letcher, 2001). Broadly, integrated assessment has two characteristics: it seeks to provide policy relevant information to some decision maker, and it brings together a broader set of areas, methods, styles of study, or degrees of certainty than would typically characterise a single-disciplinary study (CIESIN, 1995). Integrated assessment is becoming increasingly popular in natural resource management issues, particularly in integrated catchment management (Jakeman and Letcher, 2001). Models play an important role in integrated assessment; Jakeman and Letcher (2001) highlight the importance of both environmental information systems and decision support systems, where the latter provide a

way of exploring and explaining tradeoffs and a tool for adoption and adaptability by stakeholders.

MCA is a decision support system methodology which is becoming widely used in natural resource management and decision-making. MCA is both a conceptual framework that supports the decision process, and a collection of specific techniques designed to generate information to support decision-making (Qureshi and Harrison, 2001). General characteristics of MCA techniques and approaches are the consideration of a range of alternatives and the incorporation of multiple objectives and their relative importance.

Jannsen (1992) describes the overall objective of multi-objective decision analysis as improvement of the procedural rationality of a decision procedure, where procedural rationality refers to using the optimal procedure to reach the decision. Simon (1976, cited in Jannsen, 1992) defines procedural rationality as opposed to substantive rationality, which results in the selection of the best solution. This objective emphasises the role of MCA as a technique to support the decision process, rather than focused on the outcome itself. The Resource Assessment Commission (RAC) (1992) concluded that the aim of MCA is to provide a framework within which the effects of uncertainties and different values can be evaluated and explored. Jannsen (1992) further defines the functions of MCA as supporting the phases of the decision process; supporting learning by doing and information processing and supporting the integrated use of judgement, methods and data.

The potential of MCA for project appraisal and evaluation has been recognised in the literature⁵. The contribution of MCA is usually placed within the context of the perceived limitations of CBA for complex environmental problems and particularly for the analysis of sustainability. The focus is on the comparative strengths of MCA and CBA and their appropriateness in different situations, although some acknowledgement is made of the possible complementarity of the techniques (e.g. Munda *et al.*, 1998).

Nardini (1997) advocates an integrated assessment approach. The results of the EIA and CBA are integrated into MCA as the final evaluation stage. Integrated assessment of EIA, CBA and MCA is also reflected in van Pelt's (1993a) sustainability analysis framework. Numerous practical applications incorporate the results of a partial CBA into MCA,

⁵ See for example van Pelt, 1993a and 1993b; Nardini, 1997 and Munda *et al.*, 1998.

reflecting the complementarity of the approaches⁶. Bateman (1999) also discusses the potential for EIA and CBA to be complementary assessment tools. Integration of EIA, CBA and MCA is becoming a common approach to project appraisal, however the addition of stakeholder analysis is not reflected. An exception to this is Nguyen's analysis of forest management systems for the uplands of Vietnam (2001). This study incorporated a very brief stakeholder analysis into an MCA framework.

Munda *et al.* (1998) suggest the strong quantitative tradition in economics has allowed the easy integration of environmental and economic components. This may also be a reason for the lack of integration with stakeholder analysis, since this has a more qualitative basis. However the ability of MCA methods to incorporate both qualitative and quantitative data suggests that stakeholder analysis might be an appropriate inclusion in an integrated approach.

The modern development of MCA techniques dates back to Simon (1958) who developed work on satisficing, though Zionts (1992) notes that this work is not widely regarded as an MCA method. The oldest widely recorded method of solving multiple criteria problems is that of Benjamin Franklin, who termed his approach prudential or moral algebra (*ibid.*). The Franklin approach divided a problem into pros and cons and then estimated the relative weights of each reason to find where the balance of the problem lay.

A number of potential advantages of MCA over other assessment techniques are proposed in the literature. Among the most significant are flexibility in data requirements and problem structuring and its role as an aid to the learning process (RAC, 1992). MCA provides a framework within which the complexities of decision making problems can be explored (Proctor, 2001). It has the potential for differing views and values to be identified in ways that help decision makers understand the implications of decisions (RAC, 1992). This advantage is especially relevant given the trend towards consensus building and stakeholder involvement that is present in the planning field (Innes, 1996).

Criticisms of MCA relate to the lack of a consistent evaluation framework; the lack of support in the phases of problem definition and design (Jannsen, 2001); the lack of methods for incorporating uncertainty and time and susceptibility of the end result to the choice of methods and weights (van Pelt, 1993a).

⁶ See for example van Pelt, 1993a and Qureshi and Harrison, 2001.

The current range of techniques represents a variety of approaches. Techniques can be classified in several ways. An important classification is between discrete and continuous methods (van Pelt, 1993a and Janssen, 1992). Continuous methods aid analysts to design management options from a continuous decision space subject to particular targets and constraints (Venn and Harrison, 2001). Examples of continuous techniques include multi-attribute utility methods, linear programming and goal programming (van Pelt, 1993a). Discrete methods involving a finite set of alternatives are often more appropriate for project evaluation. There is general consensus regarding the selection of continuous and discrete methods given problem characteristics, but little guidance regarding selection of specific techniques (Venn and Harrison, 2001). The enormous range of techniques and the lack of guidance regarding their appropriateness can be considered a significant practical limitation of the MCA method. This is illustrated by an MCA application to choose an appropriate MCA technique for forest resources management (Teclé and Duckstein, 1992).

Janssen (1992) further classifies discrete methods according to the scale of measurement (quantitative or qualitative) the decision rule and the standardisation function. MCA techniques differ in their ability to deal with quantitative and qualitative information. Some software allow the analyst to enter qualitative data which is then converted to quantitative data, whilst others provide guidance on converting qualitative to quantitative prior to data entry (D. James, pers. comm., October 2002).

Despite the vast number of MCA techniques, practical applications utilise a relatively small range. Despite being the most theoretically simple method, weighted summation appears to be frequently used in practice (Janssen, 2001). In the literature, major advances in incorporating greater rigour (particularly in terms of utility theory) into MCA methodologies are evident, however this is not reflected in practical applications.

Applications of MCA within the field of natural resource management and decision-making include: catchment management (Qureshi and Harrison, 2001 and Robinson, 2000), physical planning (Janssen, 2001 and Monnikhof and Bots, 2000), land-use planning (van Herwijnen *et al.*, 1993; Stewart and Joubert, 1998; Ridgely and Heil, 1998), sustainable agriculture (Hermanides and Nijkamp, 1998; Prato and Hajkowicz, 2001 and Kininmonth, 2000), and coastal management (Moriki *et al.*, 1996).

3.6 CONCLUSION

Economic concepts play an important role in the management of natural resources. Particularly relevant to the provision of natural and protected areas are the concepts of property rights and public goods. This chapter has outlined the relevant economic concepts and illustrated the nature and importance of tourism in natural areas. Sustainable development has become an important policy approach and the different approaches to this concept have been explored. In light of the sustainability policy issue, tools that can be used to aid the decision making process have been discussed, including environmental impact assessment, cost benefit analysis and stakeholder analysis. The literature highlights weaknesses of these techniques when used individually. These weaknesses and the nature of environmental problems and the sustainability concept indicates that an integrated approach to assessment is required. The development of integrated approaches has been discussed, in particular MCA, which represents a useful tool for integrated assessment.

4 METHODOLOGY

4.1 INTRODUCTION

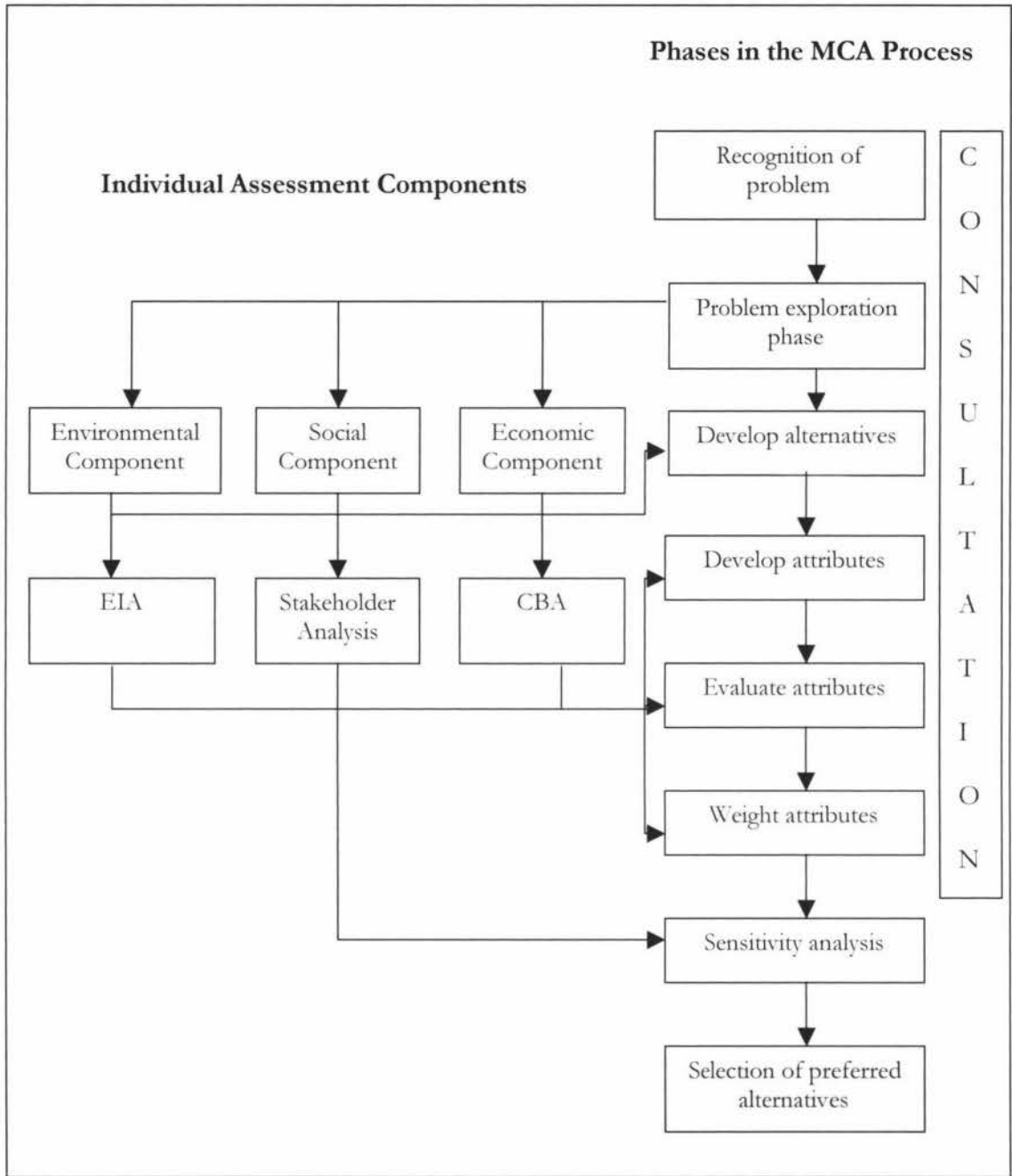
The nature of the research problem requires a broad and integrated research approach that captures the economic, biophysical, social and institutional aspects of the problem. The views and expectations of large government agencies, stakeholder groups and lower level institutions need to be incorporated into the model in order to obtain solutions that are socially and politically acceptable and feasible. This indicates an important role for stakeholder analysis. The methodology adopted for this research uses three individual assessment techniques (stakeholder analysis, EIA and CBA) to provide further information that is integrated into several stages of the MCA process. The methodology can be seen as involving three phases: designing the model, visit to sites and stakeholders and implementing the model.

4.2 PHASE I – DESIGNING THE MODEL

4.2.1 The Conceptual Framework for Integrated Evaluation

The diagram illustrated in figure 4.1 on the following page outlines the conceptual framework that underlies this research approach. The results of individual assessment techniques are integrated into the MCA process in several stages. The methodology underlying the stakeholder analysis is presented first, followed by the cost benefit analysis and impact assessment. The stages of the MCA process are then outlined, including the specific methodology adopted for each stage and the relationship between the individual components and the MCA. The model outlined in phase I of this research illustrates a decision model with an integrated assessment approach that is particularly relevant to rapid appraisal.

Figure 4.1 The Conceptual Framework for an Integrated Evaluation of Land Use and Management Alternatives for the Ningaloo Coastal Strip



4.2.2 Stakeholder Analysis

Integrated assessment frameworks developed for analysing the sustainability of projects (see e.g. Nardini, 1997 and van Pelt, 1993a) do not explicitly include stakeholder analysis as an assessment technique. This is somewhat surprising given the complementarity between stakeholder analysis and MCA, the limitations of MCA and EIA in addressing stakeholder issues and the growing trend towards stakeholder involvement in planning. This research addresses this perceived gap by explicitly including stakeholder analysis as an individual assessment technique.

This research uses a simple stakeholder analysis methodology, developed from de Lopez (2001) and Grimble and Wellard (1997). The stakeholder analysis was conducted with the aim of providing further input into the MCA process and was used in the development of alternatives, attributes and a hypothetical weight set. Since this was the end purpose of the stakeholder analysis, the objectives of the stakeholder groups were considered especially important. The stakeholder analysis involved three steps: identifying stakeholders, determining the interests of stakeholders and finally analysing the objectives of stakeholders in relation to use and management of the coastal strip.

4.2.2.1 Identification of Stakeholders

Stakeholders were identified through policy documents and from initial interviews with the primary institutional agencies. Stakeholders were classified into institutional agencies and stakeholder groups. Due to the large number of institutional agencies that have some role in the decision making process for the coastal strip, institutional agencies were further broken into primary and secondary agencies. Following Grimble and Wellard (1997) another classification of agencies and stakeholders is that of passive and active stakeholders. Active stakeholders are those who affect (determine) the decision, while passive stakeholders are those who are affected by the decision, either positively or negatively. Table 4.1 shows the classification of stakeholders for the Ningaloo coastal strip.

Table 4.1 Classification of Stakeholders for the Ningaloo Coastal Strip

Classification of Stakeholders		
	Primary (P) or Secondary (S) ¹	Active (A) or Passive (P)
Institutional Agencies		
Department of Land Administration (DOLA), Pastoral Lands Board	P	A
Department of Planning and Infrastructure (DPI)	P	A
Department of Conservation and Land Management (CALM)	P	A
Environment Australia	S	A
Western Australian Tourism Commission	S	A/P
Gascoyne Development Commission	S	A/P
Carnarvon Shire	S	A
Exmouth Shire	S	A
Stakeholder Groups		
Pastoral lease holders/Ningaloo Reef Outback Coast Association (NROCA)		A/P
Gnulli Native Title Claimants		A/P
Local community		P
Current long-term users		P
Save Ningaloo Association		A/P

¹ Primary and secondary classifications apply only to institutional agencies

4.2.2.2 Determination of Stakeholder Interests

Determining the interests of stakeholders involves gaining an understanding of the role of each stakeholder and agency. A variety of techniques and sources were used to define the interests and objectives of stakeholders. De Lopez (2001) utilized focus groups, individual interviews, observed behaviour and informal day-to-day communication as sources of information for stakeholder analysis.

This research employed the following techniques:

1. literature review of policy documents, agency websites and annual reports and other documents where applicable
2. individual interviews with primary institutional agencies

3. direct observation of stakeholder behaviour by the researcher and other practitioners in the field and
4. informal communication with stakeholder groups.

The variety of sources proved valuable in detecting differences between stakeholders stated objectives and actual behaviour. Lahdelma *et al.* (2000) recognise the importance to the planning process of identifying stakeholders' true points of view. The output of the stakeholder analysis was a written description of the interests of the institutional agencies and stakeholders and a table of stakeholder objectives. The table of stakeholder objectives provided input into the development of alternatives, attributes and preference weightings within the MCA framework. Analysis of the stakeholder objective table illustrated conflicting and congruent stakeholder objectives for the Ningaloo coastal strip. The written description of stakeholder interests is presented in the following section, while the table of stakeholder objectives is presented in chapter five, section 5.2, p. 104-105.

4.2.2.3 Description of Stakeholder Interests

4.2.2.3.1 Primary Institutional Agencies

4.2.2.3.1.1 Pastoral Lands Board – West Australian Department of Land Administration

The Department of Land Administration (DOLA) is responsible for the administration and development of Crown lands within Western Australia. Their role is to administer and develop Crown lands for the benefit of the community, ensuring proper land stewardship, management and sustainability (DOLA, 1999a). The Land Administration Act 1997 provides for the granting and administration of pastoral leases (DOLA, 1999b), and is administered by the Minister for Lands and DOLA. The Pastoral Lands Board was established under this Act (replacing the previous Pastoral Board) and is responsible for the administration of pastoral leases. Thirty-eight percent of Western Australia is pastoral leasehold land, approximately 96 million hectares held as 542 pastoral leases (DOLA, 2001). The Pastoral Lands Board's primary role is to ensure that pastoral leases are economically viable and ecologically sustainable, and managed in accordance with lease conditions and relevant legislations (DPI, 2002).

Under the Land Administration Act diversification is encouraged through the use of a permit system for non-pastoral activities, which includes pastoral-based tourism. As a matter of policy permits are not granted where the non-pastoral use is a higher and better use of the

land. In these cases the land would be excised and a new lease drawn up (DOLA, 1999b). The Land Administration Act 1997 also allows for the creation of public access routes over Crown land for access to remote tourism and recreation spots, though none have been created yet (Baulch, 2002).

The Pastoral Lands Board has indicated that managing camping on pastoral leases is not likely to be within the powers of the pastoral lessee, especially if the activity is at a commercial level (*ibid.*). The Pastoral Lands Board and DOLA are currently looking at ways to manage camping on pastoral leases (Baulch, 2002 and DPI, 2002). Any proposed excisions from pastoral leases will be examined by the Pastoral Lands Board (in conjunction with the Department of Agriculture) to determine the impact on pastoral enterprises. (MacTiernan, 2002a).

4.2.2.3.1.2 West Australian Department of Conservation and Land Management

CALM is responsible for the conservation and protection of flora and fauna throughout the state (DPI, 2002). Protected areas are vested in two statutory authorities set up under the Conservation and Land Management Act (1984): the Conservation Commission (terrestrial) or the Marine Parks and Reserves Authority (marine). Preparation of management plans and subsequent on-the-ground management is the responsibility of the department (WAPC, 2001a). CALM is also responsible for identifying areas worthy of gazettal as protected areas for conservation purposes and providing advice and support to the statutory bodies. The Conservation and Land Management Act (1984) provides for the establishment of management agreements for private or leasehold land under Section 16. CALM currently has a memorandum of understanding with pastoral leaseholders within the study area regarding management of the coastal strip.

The state waters of the Ningaloo Marine Park are vested in the Marine Parks and Reserves Authority and Cape Range National Park is vested in the Conservation Commission; both are managed by CALM. The Ningaloo Marine Park extends to 40 metres past mean high water mark, which provides some overlap with pastoralists in the management of camping. In addition CALM and the Exmouth Shire jointly manage the Jurabi and Bundegi coastal parks near Exmouth. CALM has identified areas for proposed exclusion from pastoral leases in 2015. Some of these areas have been previously proposed in publicly available documents,

while further high value areas and access corridors have also been identified (Wyre, 2002). The coastal strip has been proposed for excision in a number of public documents⁷.

4.2.2.3.1.3 West Australian Department of Planning and Infrastructure

The Department of Planning and Infrastructure (DPI) provides advice and support to the statutory Western Australian Planning Commission (WAPC). It has primary responsibility for statutory and strategic land use planning, the preparation and approval of town planning schemes and amendments (DPI, 2002). The DPI provides coastal planning advice to other government agencies and local governments and jointly prepared the draft Carnarvon Coastal Strategy (Stage One) and Exmouth-Learmonth Structure Plan with local government. Any exclusion proposed within the Carnarvon Coastal Strategy area requires consultation with the DPI. (MacTiernan, 2002a). Coastal planning in Western Australia is guided by the State Planning Strategy (WAPC, 1997), the draft Coastal Zone Management Policy (WAPC, 2001a) and the draft State Coastal Planning Policy (WAPC, 2001b). The DPI is currently in the process of developing the next stage of the Carnarvon Coastal Strategy (now referred to as the Carnarvon-Ningaloo Coast Regional Strategy).

4.2.2.3.2 Secondary Institutional Stakeholders

4.2.2.3.2.1 Environment Australia

Environment Australia has considerable interest in the outcome for this area. Ningaloo Marine Park has both a Commonwealth and State component, though it is managed as a single unit by CALM. The federal department aims to promote, support and implement conservation and ecologically sustainable use of Australia's land, water, coasts and oceans (Environment Australia, 2001) and to protect and conserve Australia's heritage. The Environment portfolio includes the Australian Heritage Commission and the Natural Heritage Trust. The Natural Heritage Trust has already provided considerable grant funding to community groups within the area, including NROCA. Given the West Australian Government's intention to seek world heritage listing for the Ningaloo Marine Park (Western Australian Labour Government, 1999 and MacTiernan, 2002c), Environment Australia's interest in this area is likely to increase.

⁷ For example, Legislative Council of Western Australia, 1995 and CALM, 1994.

4.2.2.3.2.2 *Western Australian Tourism Commission*

The Western Australian Tourism Commission (WATC) is responsible for accelerating the sustainable growth of the tourism industry for the long-term social and economic benefit of the state (WATC, 2001). Within the Commission the sustainable product unit is particularly focused on developing Western Australia as a premier nature tourism destination. The Gascoyne has been identified as a zone of opportunity for nature-based tourism development (WATC and CALM, 1997). The Tourism Commission has undertaken a preliminary feasibility study for the development of a wilderness lodge in the Ningaloo area (Adams and Associates, 1999).

4.2.2.3.2.3 *Gascoyne Development Commission*

The regional development commissions were established under the Regional Development Commission Act (1993) and are responsible for promoting regional economic growth and investment. The Gascoyne Development Commission aims to achieve an environment conducive to the balanced economic and social development of the region and be proactive in regional development planning (Gascoyne Development Commission, undated). Development priorities include developing infrastructure, adaptive communities, enriched lifestyles and livelihoods, wealth and employment and responsive governments. The region's economic development strategy (Gascoyne Development Commission, 1996) highlights the importance of the coast to economic and social development.

4.2.2.3.2.4 *Shires of Carnarvon and Exmouth*

Ningaloo station is currently part of the Shire of Exmouth, whilst all other stations within the strip are part of the Shire of Carnarvon. The shires have responsibility for local roads and local planning in the area. Both Shires were involved in the development of the draft Carnarvon Ningaloo Coastal Strategy. The Exmouth Town Planning Scheme (Gray and Lewis Planning Consultants, 1999) currently zones Ningaloo station as pastoral. This means that holiday accommodation is not permitted unless the Shire Council grants planning approval. The Carnarvon Town Planning Scheme has recently been updated (Gray and Lewis Planning Consultants, 2002) and zones the coastal strip as a coastal management zone. The draft plan indicates that use is to be in general accordance with the Carnarvon Coastal Strategy when implemented. Both Shires currently undertake road maintenance; the frequency of maintenance depends on the season and the level of use.

4.2.2.3.3 Significant Stakeholder Groups

4.2.2.3.3.1 Pastoral Lease Holders and the Ningaloo Reef Outback Coast Association

Pastoral leaseholders are currently managing camping along the coastal strip in conjunction with their pastoral activities. The leaseholders of all four pastoral stations in the study area are members of the non-profit NROCA, formed in 1998. NROCA wishes to retain management of the coastal strip and its objective is to manage its lands sustainably, ensuring a high level of equity of access and preservation of the regional culture (NROCA, 2002). The group has recently been awarded a Natural Heritage Trust grant to control recreation access to the coast, rehabilitate tracks, undertake turtle protection and dune revegetation programmes and to provide education material to visitors (*ibid.*). NROCA plans to provide composting toilets in controlled recreation areas in the near future.

NROCA has a memorandum of understanding with CALM regarding management of the coastal strip.

4.2.2.3.3.2 Gnulli Native Title Claimants

The entire study area is subject to a native title claim lodged under the Native Title Act (1993) in 1997. The claim has been lodged on behalf of the named applicants and the Ingarda-Teddei People, the Baiyung and Talangi Peoples and the Thalhari people (Michael Robinson and Associates, 2002). The claim passed registration testing in July 1999 and mediation commenced in July 2000 and is continuing. Regarding aspects of Native Title, the area is spoken for by the Yamatji Land and Sea Council. Any future developments in the coastal strip will be subject to native title considerations.

4.2.2.3.3.3 Save Ningaloo Association

The Save Ningaloo Association is a lobby group that developed in opposition to the proposed marina and resort development at Maud's Landing. The association has significant support within Western Australia and has a high public profile. The Save Ningaloo Association is a coalition of the following groups: Australian Marine Conservation Society, Wilderness Society, Conservation Council of Western Australia, Australian Wildlife Conservancy and the World Wildlife Fund. The Save Ningaloo Association supports appropriate forms of environmentally sensitive ecotourism development for the Ningaloo region.

4.2.2.3.3.4 Local Community

The local community consists of residents of Carnarvon, Coral Bay and Exmouth and those who reside within the Gascoyne region. As a broad generalisation, two main views of the local community can be distilled. One view is that the coastal strip should remain the way it is, with the current level of access, fees and facilities. Another view is that the coastal strip represents an important resource for the social and economic development of the region, and appropriate ecotourism developments would capture some of these benefits. There is an overriding recognition of the need for improved management. In a survey of resident opinions in the early nineties, Dowling (1993) found a significant level of support for tourism development in the area provided it did not occur at the expense of the environment.

4.2.2.3.3.5 Current Long-Term Users

Current long-term users frequently camp in the coastal strip for periods of three to five months over the winter. This stakeholder group values the recreational opportunity provided on the coast, particularly the lack of regulation, facilities and low fees. Generally there is a desire to retain the current management and level of facilities, although there is recognition that more management may be required. This group tends to exhibit a strong sense of social cohesion and feeling of belonging to the region (NROCA, 2002).

4.2.3 Cost Benefit Analysis

CBA is a procedure for comparing the net economic benefits of alternative projects or courses of action. The purpose of the CBA for this research was to provide information on the economic desirability of alternatives in a form that could then be incorporated into the MCA.

The CBA process is outlined below (adapted from Department of Finance, 1997).

1. Project definition
2. Identifications of costs and benefits
3. Quantification/valuation of costs and benefits
4. Calculation of Net Present Value (NPV)
5. Sensitivity test for uncertainty

The methodology followed in this CBA is outlined below for each of these stages.

4.2.3.1 Project Definition

The initial project definition phase of the CBA process requires the definition of the scope and objectives of the project and identification of constraints and alternatives. This initial phase is very similar to the initial phase of both EIA and MCA, and is dealt with in more detail in section 4.2.5.2, p. 81. Alternatives considered were all combinations of the following activities and components; pastoral operations, wilderness lodge tourism, recreation and conservation. All alternatives had some level of conservation and recreation management occurring, and none allowed for high levels of development. Differences between alternatives focused on the level of facilities and management provided and the management regime in operation. See section 4.2.5.2, p. 84-87, for a complete description of the alternatives.

It is important in CBA to identify the “without” situation, in order to accurately estimate the benefits or costs attributable to a project. The “without” situation is the situation likely to exist in the absence of any project. The current situation is unlikely to continue into the future, since it has been recognized as unsustainable. The pastoral alternatives could be considered as the status quo; since these scenarios are likely if there is no change in land tenure.

4.2.3.2 Identification of Costs and Benefits

The EIA process identified the impacts of the different alternative options. This was used to assist in identifying the costs and benefits of the alternatives. As all alternatives are combinations of different levels of activities, the costs and benefits for all activities can be presented in a single table. Dixon and Sherman (1990) suggest a typology for the classification of benefits and costs of protected areas. Benefits are classified according to five conservation objectives: maintenance of environmental resources, services and ecological processes; production of natural resources; protection of cultural and heritage sites and provision of education and research services. The Dixon and Sherman (1990) typology classified costs according to direct, indirect and opportunity costs. This typology as applied to the alternatives for the Ningaloo coastal strip is presented in table 4.2 along with the relationship to the concept of total economic value (TEV).

Table 4.2 Identification of Benefits and Costs

Benefits	TEV ¹ Category	Costs
Maintenance of environmental resources, services and ecological processes Biodiversity Protection of coral reef Ecological and biophysical processes	EV/IUV IUV IUV	Direct costs Infrastructure Operating and administration Pastoral operation costs
Production of natural resources Pastoral products (Merino sheep and goats)	DUV	Indirect costs
Provision of tourism and recreation Camping Home stay accommodation Wilderness lodge	DUV DUV DUV DUV	Opportunity costs Foregone pastoral income
Protection of cultural and heritage sites and objects Aboriginal heritage European pastoral heritage	EV/IUV EV/IUV DUV	
Provision of education and research services		

¹ TEV = total economic value; DUV = direct use value; IUV = indirect use value; OV = option value; EV = existence value

4.2.3.3 Quantification/Valuation of Costs and Benefits

The purpose of the CBA was to provide information on the economic costs and benefits in a manner that could be integrated into the MCA model. The CBA focused on the benefits from production of natural resources and provision of tourism and recreation and the direct costs of provision and management. Benefits relating to the maintenance of natural resources, services and ecological processes are addressed in separate attributes in the MCA, so no attempt was made to value these under the different alternatives. Valuation of the cultural heritage, education and research opportunities, option and existence values was not included in the CBA, however their potential significance is addressed in section 4.2.3.3.5, p. 73-75.

Costs and benefits quantified and included in the CBA were broken into the following categories of activities for estimation: pastoral, wilderness lodge tourism, and camping and management. Estimation was based on market prices and adjusted where appropriate. In

efficient markets, market prices reflect the marginal cost of producing the commodity and the willingness to pay by the marginal consumer (Department of Finance, 1997). If markets are competitive, pricing at marginal cost also implies that costs and benefits are equated with their opportunity costs. Transfer payments (taxes, insurance) were excluded from the analysis as these represent a transfer between sectors of society and not actual benefits. For the pastoral and wilderness lodge categories, data was taken from existing financial analyses and adjusted to reflect economic costs and benefits.

Krutilla (1967) suggests that natural environments will appreciate in value over time for two reasons: asymmetrical technological change and tastes. Asymmetrical technological change implies that the marginal trade-off between manufactured and natural amenities will increasingly favour the latter. Krutilla considered that tastes would progressively favour amenities of the natural environment through the learning-by-doing phenomenon. The implications of asymmetrical technological change are included in this analysis. An increase in the value of the wilderness camping experience is reflected in an increase in the price in year eleven. The prices of all other goods remain constant. This approach allows for the increasing value of environmental goods in relation to manufactured goods.

Specific assumptions that underlie the revenue and cost estimation for the various categories of activities are presented in sections 4.2.3.3.1 to 4.2.3.3.4. The actual calculations for visitation scenarios and the CBA are presented in appendix one and two.

4.2.3.3.1 Pastoral Operation

Pastoral activities occur in the two pastoral alternatives (high and low visitation). It is anticipated that pastoral activities will be at a slightly lower level than currently, as formalisation of campsites and conservation areas will require removing some land from production. It is assumed that ninety percent of the coastal strip is stocked currently, and under the two pastoral alternatives this will be reduced to seventy percent. Within the strip, areas with significant dune blowouts are fenced off and not grazed.

Currently the coastal strip mainly supports Merino sheep, and it is assumed that this will continue into the future. There is some possibility that cattle might be introduced into the coastal strip in the future, however this was not included in the analysis for simplification purposes.

The stocking rate was assumed to be 6Ha/DSE (Dry Stock Equivalent). The rangeland inventory (Payne *et al.*, 1987) recommends a stocking rate of 8Ha/DSE for the coast land system, which is the dominant land system on the coastal strip. Since only 70% of the coastal strip is stocked under these alternatives, it was assumed that those areas vulnerable to blowouts would not be grazed, and therefore a slightly higher stocking rate would be feasible.

Information on income and direct costs per DSE are sourced from a Merino enterprise budget calculated by K. White, Agriculture WA (2002). Information for the overhead and infrastructure replacement schedules was also based on this budget, however some adjustments were made to remove transfer payments from the analysis and to allow for the larger area that the coastal strip covers.

Income from feral goats was based on a stocking rate of 10 Ha/goat. Estimates of goat density reported in the National Threat Abatement Plan (Environment Australia, 1999) range from two to five goats per square kilometre, and the plan suggests that at least 20 goat-sized herbivores per square kilometre (5 Ha/goat) can be supported in rangelands with annual rainfall of 240 millimetres (*ibid.*). The turn off rate was assumed to be 30% (K.White, pers. comm., August 2002). These assumptions are consistent with the 3000 goats turned off Warroora station (107 653 Ha) in 2001 (L. Horak, pers. comm., May 2002). Price per head, labour and direct costs were based on those suggested by K. White (pers. comm., August 2002).

4.2.3.3.2 Wilderness Lodge Tourism Operation

Data for this section were based on a report produced by the WATC, 'North West Cape West Coast Ecolodge Proposal' (Adams and Associates, 1999). Data on investment costs came from the cost schedule by Construction and Property Consultants (1999) and data on operating projections came from the preliminary feasibility study by Klaus Richter and Associates (1999).

Information on investment costs was adjusted in light of comments made by Ceballos-Lascurain (1999) in the same report. He suggested that unit costs for accommodation units, ablution and service centres, central guests and administration facilities were too high and should be adjusted downwards by 30%. This analysis subsequently adjusted these costs by 20%, preferring to overestimate costs. Insurance payments were removed. Included in the operating projections was income from activities (estimated at 60% of room revenue). This was not included in the estimates by Klaus Richter and Associates but often provides a

significant proportion of income for an ecolodge (Ceballos-Lascurain, 1999). Since these estimates were in 1999 dollars, they were inflated to 2002 dollars using historical CPI inflation for 1999, 2000 and 2001. (Australian Bureau of Statistics, Undated).

4.2.3.3.3 Visitation

Visitation was calculated using two methods. The first was applied to the pastoral alternatives and was based on the current structure of visitation, and an assumed distribution of campsites per month. The second method was applied to all non-pastoral alternatives. These alternatives all involved some level of management by CALM, and the method was based on the current total level of visitation that occurs in Cape Range National Park. Visitation to the Gnoraloo 3-mile campground was calculated separately and the method was the same for all alternatives.

For the pastoral alternatives, the assumed monthly distribution of camp numbers was based on aerial surveys conducted annually by CALM, and anecdotal evidence regarding the level of camping during the off-peak summer period. Table 4.3 shows the assumed distribution for the pastoral alternatives.

Table 4.3 Assumed Monthly Distribution of Campsites

Assumed Monthly Distribution of Campsites											
Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
10	10	30	100	200	250	300	250	150	50	30	10

This distribution formed the number of campsites for year one, and future years were based on an assumed visitation growth rate. These growth rates were based on historical growth rates from CALM aerial surveys and anecdotal evidence on the growth in off-peak camping. Table 4.4 presents the visitation growth rates used in this analysis.

Table 4.4 Visitation Growth Rates for the Pastoral Alternatives

	Pastoral - Low		Pastoral - High	
	Year 1-10	Year 11-25	Year 1-10	Year 11-25
Peak ¹	0.05	0.025	0.05	0.025
Off-peak ²	0.1	0.05	0.2	0.05

¹ The peak period is assumed to be April, May, June, July and August

² The off-peak period is assumed to be January, February, March, September, October, November and December

For the pastoral alternatives it was assumed that there is a maximum capacity of 250 camping bays (A. Hogstrom, pers. comm., September 2002) along the coastal strip (this excludes the Gnoraloo 3-mile campground). Campsite formalisation would begin in year two and all 250 campsites would be formalised by year five.

Visitor nights were calculated by breaking down months into normal and school holiday periods. There are three two-week school-holiday periods in April, July and October. During this period it was assumed that three people occupy each campsite, and during non-school periods two people occupy each campsite. This assumption may understate the true level of visitation.

Visitor revenue was calculated by assuming that 60 percent of visitors pay on a weekly basis (i.e. are staying longer than a week) and 40 percent pay on a nightly basis. The fees for camping were based on the current situation that exists on Warroora (L. Horak, pers comm., May 2002). A relative increase in camping fees was assumed to occur in year eleven. This reflected an increase in demand for nature-based tourism in relation to other forms of economic activity.

Visitation for non-pastoral alternatives was based on a structure of campsites similar to that of Cape Range National Park. It was assumed that the number of visitor nights for the first year of these alternatives is 40 000. This was based on the estimated visitor nights for Cape Range National Park (A. Hogstrom, pers comm., September 2002) adjusted for the number of campsites that would be offered on the coastal strip. However this number was a bit lower than proportionate, as it is likely that many of the current visitors to the strip would not return under an alternative management system, and it may take some time to build up visitation. The visitation growth rates for all non-pastoral alternatives are presented in table 4.5.

Table 4.5 Visitation Growth Rates for All Non-Pastoral Alternatives

	Low Visitation Scenarios	High Visitation Scenarios
Year 1-10	0.05	0.1
Year 11-25	0.025	0.025

The calculation of revenue assumed that the following visitor structure exists:

- camps with two people = 80 percent of visitors

- camps with one person = 5 percent of visitors
- children = 15 percent of visitors.

The fee structure was based on the current system for Cape Range National Park. Cape Range National Park currently charges access fees through the use of park passes. A number of different types of passes exist, some are applicable to the Cape Range National Park only, while others allow for entry into all national parks in Western Australia. This made it difficult to estimate revenue from access fees. As a simplified assumption, it has been assumed that in years one to ten revenues from access fees will be \$100 000 and \$200 000 in years 11-25. This is based on the access fee revenues obtained by Cape Range National Park (G. Rykers, pers. comm., September 2002).

Visitation for the 3-mile campground on Gnaraloo station was calculated separately, as this is a formalised camping ground with ablution blocks and a shop and provides a different visitation experience. Visitation was based on the current 50 available campsites and was assumed to be the same for all alternatives. Table 4.6 presents the assumed occupancy rates for the campground that were used to estimate visitation in year one. Visitation in the following years was based on assumed growth rates as presented in table 4.7.

Table 4.6 Assumed Occupancy Rates for the Calculation of Visitor Nights in Year One, Gnaraloo 3-mile Campground

Period	Occupancy Rate
June – August	0.9
April – May and Sep – Oct	0.7
November - March	0.1

Table 4.7 Visitation Growth Rates for the Gnaraloo 3-mile Campground

	Low Visitation Scenarios	High Visitation Scenarios
Year 1-10	0.01	0.025
Year 11-25	0.00	0.00

Visitation growth rates were lower for the Gnaraloo 3-mile campground than for the wilderness camping experience; since it was assumed that there would be less demand for more developed camping. Fees were based on the current fees charged and were assumed to increase in year eleven. The costs of providing the campground facilities were estimated at fifty percent of visitor revenues, and this may underestimate the net benefits from the Gnaraloo campground.

The analysis of visitor revenues underestimates the revenues from tourism in the coastal strip. Home stay and built accommodation on the pastoral stations has not been included in the analysis for simplification purposes. The analysis also excludes the possible benefits from the proposed camping operation at Bruboodjoo point, operated by Murlanda Enterprises (NROCA, 2002). Since the estimation of visitation for the coastal strip involved a large number of assumptions, these have attempted to be conservative in order to err on the side of underestimation rather than overestimation.

4.2.3.3.4 Management and Infrastructure Costs

Campsite and fencing infrastructure costs for all alternatives were based on data provided by the CALM Exmouth office. Road maintenance costs were based on information provided by the CALM Exmouth office and the Shires of Exmouth and Carnarvon. Operating costs were based on information provide by the CALM Exmouth office and adjusted in light of estimates contained in NROCA's draft sustainability statement (NROCA, 2002). The level of facilities and roading infrastructure was assumed to be lower for the pastoral alternative.

For the pastoral alternatives it was assumed that station staff would do the majority of the ranger type work. It was assumed that these staff will work for 250 days per year on recreation management at a cost of \$100 a day. Pest control costs were based on information provided by the CALM Exmouth Office. For the pastoral alternatives the costs of goat trapping was included in the pastoral operations. For the other alternatives it was assumed that the cost of goat control is covered by the sale of trapped feral goats. For more detail regarding the estimated costs and assumptions, see appendix two, p. 176-181.

4.2.3.3.5 Costs and Benefits Not Estimated

The CBA for this research was a partial CBA and a number of benefits were not estimated. However it is considered likely that this omission does not greatly affect the relative magnitudes of CBA figures between alternatives. For many of the benefits not estimated, including provision of education and research services, cultural and heritage values and existence and option values, it is unlikely that estimates would significantly differ between alternatives. Therefore the omission is unlikely to affect the results of the MCA (which depend on the relative differences between alternatives), but results in less attractive economic returns for alternatives.

4.2.3.3.5.1 Tourism and Recreation Use Value

The current price charged on pastoral stations is relatively low, and unlikely to reflect the full use value to recreationists. The consumer surplus component of WTP is likely to be high in this situation, as evidenced by the significant distances travelled by campers to the coastal strip. Therefore the estimates of tourism revenues in the CBA will underestimate the true use value.

Initially, this research planned to estimate this value using a simplified application of the travel cost technique. Towards this purpose, a survey was designed and pilot tested during the initial site visit. Questions in the survey related to origin of visitors, length of stay, expenditure and attitude towards facilities and management options. During phase two, the visit to sites and stakeholders, the survey was dropped. For an account of the reasons for this decision see section 4.3, p. 101.

4.2.3.3.5.2 Provision of Education and Research Services

The coastal strip in conjunction with the adjacent Ningaloo Marine Park provides considerable opportunities for research and environmental education. Aspects which contribute to the research value of the area include its proximity to Cape Range, rangeland biodiversity, the relatively pristine coral reef and its marine life, turtle breeding rookeries and the Aboriginal and pastoral history of the area. No attempt has been made to quantify this aspect, though it is believed that it could be quite significant. It would be difficult to separate between the marine and terrestrial components of the value. There is the potential for a research institution in the area and this could provide a proxy estimate of the research benefits in the future.

4.2.3.3.5.3 Cultural and Heritage Values

The coastal strip has significant cultural and heritage value. Aboriginal occupation of the area dates back for thousands of years, and this has a significant value both in terms of physical sites and spiritual and oral traditions. The coastal strip also has an interesting pastoral history and this is reflected in a number of physical sites. It would be difficult to place a monetary value on these aspects, and it is difficult to estimate how they might differ between alternatives. Although this value is likely to be high, it is unlikely that it would be significantly different between alternatives.

4.2.3.3.5.4 Existence and Option Values

Public support for campaigns such as the Save Ningaloo Campaign, and the uniqueness of the area suggests the likelihood of a large existence value for the area. However it would be difficult to distinguish existence value that related specifically to the coastal strip from that of the coral reef and the area in general. The option value could also be high; public submissions to the draft Carnarvon Coastal Strategy indicated a desire to retain the wilderness values of the area so that grandchildren and future generations could experience it.

To estimate existence and option values would have required the use of the contingent valuation technique and a large survey. The practical difficulties relating to the estimation of the relevant population and accurately representing the large number of alternatives in the survey made this an impracticable option given the time and resource constraints of the researcher. Further, a total estimate for existence and option value might be obtained, but it would again be difficult to differentiate between options.

4.2.3.4 Calculation of Net Present Values

The NPV rule is the appropriate decision rule for the acceptance of projects. If mutually exclusive projects are under consideration, the project which maximizes NPV should be chosen. The formula for the NPV is presented below:

$$NPV = \sum_{t=0}^t \frac{(B_t - C_t)}{(1+r)^t}$$

Where:
B_t benefits in time period t
C_t costs in time period t
r discount rate
t = 0...t time period for CBA

Project NPVs are sensitive to the choice of discount rate and the time frame. The choice of discount rate and time frame is discussed in sections 4.2.3.4.1 and 4.2.3.4.2. For incorporation into the MCA, the NPVs were presented as equivalent annual annuities or returns (EAA). This provided more consistency with other measurements in the performance matrix, which represent static measures.

4.2.3.4.1 Discount Rate

The discount rate chosen was eight percent real, which can be interpreted as comprising a three percent margin on a real risk-free rate of five percent. The discount rate chosen is also consistent with that advocated by the Department of Finance (1997) as a benchmark rate.

Analysis of the sensitivity of the CBA results to the discount rate was also undertaken by using rates of six and ten percent.

4.2.3.4.2 Time Frame

The time frame for a project depends on the useful life of the project. The time frame chosen should encompass those years in which the bulk of benefits and costs occur.

The time frame chosen was twenty-five years, as after this period benefits and costs became trivial at the chosen discount rate. Since estimating the life of the different components proved very difficult, salvage values at the end of the period of analysis were omitted. Although this practise is not ideal, salvage values were unlikely to make a significant difference to the overall outcome due to the timeframe and discount rate.

4.2.3.5 Sensitivity Analysis

Sensitivity analysis is a method used to account for the uncertainty that prevails with forecasting into the future, and indicates the sensitivity of the NPV figure to changes in key parameters. It is important not to overload the decision maker by changing too many parameters when undertaking sensitivity analysis. The presentation of a high and low visitation scenario for each management option already incorporates some sensitivity analysis into the alternatives.

It was therefore decided to present the sensitivity analysis in the form of an optimistic and pessimistic scenario that could then be further incorporated into the MCA. Table 4.8 outlines the assumptions that were changed for the optimistic and pessimistic scenarios. Many of the variables were subject to a high degree of uncertainty and were candidates for sensitivity analysis, however since sensitivity analysis was also performed for the MCA, there was a high risk of providing too much information. All variables were changed simultaneously to reflect the pessimistic and optimistic scenarios. This is slightly unrealistic, however the two scenarios still serve to illustrate extreme positions.

Table 4.8 Variables Changed for the Sensitivity Analysis

Variable	Pessimistic scenario	Expected scenario	Optimistic scenario
Pastoral operations			
Stocking rate	8Ha/DSE	6Ha/DSE	4Ha/DSE
Percentage of overheads	30%	20%	20%
Goat turnoff rate	0.3	0.3	0.5
Wilderness lodge operations			
Occupancy rate	40%	50%	70%
Investment costs	Expected plus 10%		Expected less 10%
Recreation operating costs			
Campsite infrastructure costs	Expected plus 10%		Expected less 10%
Road maintenance costs	Expected plus 10%		Expected less 10%

4.2.4 Environmental Impact Assessment

Preliminary environmental assessment or initial environmental evaluation usually occurs in the early stages of the EIA process. The purpose of preliminary assessment is to identify whether the project requires a full EIA (Asian Development Bank and Government of India, 1988). Rapid appraisal techniques are utilised, often based on desktop studies of existing data and literature. Assessment techniques employed in preliminary assessment include ad hoc approaches, checklists, matrices, overlays, networks and simulation.

The purpose of the impact assessment for this research was to identify the major impacts of different alternatives. A rapid appraisal methodology was appropriate for a number of reasons: alternatives were not very detailed and therefore impacts were difficult to predict, time and resource constraints, availability of data, size of the area involved and the number of alternatives that needed to be considered. A full EIA was beyond the scope and purpose of this research.

Impacts of the alternative options were identified from a literature review, site visit and consultation with experts. An adapted Leopold matrix was used to assist with the preliminary assessment process.

4.2.4.1 Literature Review

A review of the relevant literature was undertaken covering generic impacts of tourism, impacts of pastoralism on the rangeland environment, and literature specific to the North West Cape region. A substantial literature exists on the generic environmental, social and economic impacts of tourism in natural areas and particularly coastal areas. This proved valuable in identifying potential impacts from tourism. Impacts of pastoralism are specific to the rangeland environment, however a recent literature has developed that provides information on the potential magnitude of these impacts. Literature specific to the region included reports, management plans and policy documents on the environment within the North West region and existing Public Environmental Reviews completed for projects along the coastal strip. The latter proved valuable in providing more specific information on the environment and potential impacts.

4.2.4.2 Site Visit and Consultation with Experts

A site visit was undertaken to the coastal strip. This involved a visit to all four stations, though the entire coastal strip was not traversed. The site visit provided observational information on the existing environment and impacts from current pastoral and camping activities. Discussions with pastoral leaseholders confirmed observations where necessary. Cape Range National Park was also included in the site visit as this provides a model for some of the CALM managed alternatives in the study.

Where little information was found on specific impacts, experts were consulted to gain clarification of the likelihood and possible magnitude of potential impacts.

4.2.4.3 Adapted Leopold Matrix

Matrices are commonly used to highlight significant impacts early in the EIA process (Jones, 1999). They generally consist of a horizontal list of proposed activities and a vertical list of environmental components. Matrices are an advance on checklists because they effectively combine two checklists into a single matrix. The Leopold matrix was an early matrix developed by Leopold and the US Geological Society in 1971 (Gilpin, 1995). The original matrix consisted of 100 columns along the horizontal axis that contained activities that might cause positive or negative impacts, and 88 rows of environmental quality variables (*ibid.*). Activities that impact on the environmental variables were assessed on scales of 1-10 for magnitude and importance, though no scale definition was provided. The original Leopold

matrix is seldom used in modern EIA, however variations of the matrix are used, particularly for rapid assessment.

This research employed the Leopold matrix because it was simple and easily understood, and reflected two dimensions of significance – magnitude and importance. It achieved the aim of identifying key impacts in a format that could be incorporated into the MCA model. Criticisms of the Leopold matrix centre on its dependence on subjective evaluation. It is argued that this subjective evaluation is converted into numbers and provides a false sense of accuracy and objectivity (Gilpin, 1995 and Jones, 1999). This is a criticism of most EIA methods, and at the preliminary assessment level, such subjective evaluation is difficult to avoid. The matrix provides a static view of impacts and cannot reflect impacts over time, secondary impacts, feedback events or irreversible impacts (Jones, 1995 and Edward-Jones *et al.*, 2000). In light of these criticisms the Rapid Impact Assessment Matrix (RIAM) methodology (Pastakia and Jensen, 1998) was considered as a methodological alternative. The RIAM framework incorporates five criteria of significance – importance, magnitude, permanence, reversibility and cumulative nature; each with defined scales (*ibid.*). Although subjective judgement is still employed to assess the criteria, the methodology is more transparent and complete. However the RIAM methodology required a greater level of assessment on the five criteria, and it was felt that given the conceptual nature of the alternatives, this would merely increase the subjectivity within the assessment. The Leopold matrix provided adequate information for input into the MCA, and it allowed assessment to be kept at an indicative level. Attempting to provide a more comprehensive assessment was not feasible given the nature of the alternatives, the level of information, and the time constraints.

The adapted Leopold matrix used for this research reflected the activities of the alternative options and the environmental components of the coastal strip. The matrix consisted of 14 activities and 40 environmental components. The activities and elements included in the matrix are presented in table 4.9.

Impacts were assessed on a scale of negative three to positive three for magnitude and on a scale of low, moderate and high for importance. Magnitude is defined as the degree, extensiveness or scale of the impact and is fact based. Importance is a value judgement and relates to how important the interaction between the project activity and environmental attribute (Edward-Jones *et al.*, 2000). Within the matrix, magnitude was given a number and

importance a colour code. A further extension was added to the matrix by including potential mitigation. If it was felt that the impact could be significantly mitigated and the likelihood of mitigation was high (particularly through environmental education) then the importance scale was given a different colour code. Although mitigation was likely for these impacts, the assessment of magnitude of the impact was for the case where mitigation did not occur. This proved to be a valuable dimension for inclusion of the impact assessment into the MCA model.

Table 4.9 Environmental Elements and Project Activities in the Adapted Leopold Matrix

Project Activities	
Stocking/destocking rangeland	Landscaping
Fox and goat control	Dune revegetation
Roads and trails	Automobile
Recreational structures	Pleasure boating
Well drilling and fluid removal	Camping
Firewood collection	Sewerage treatment and placement
Energy generation	
Environmental Elements	
Construction material	Karst system
Landform	Wilderness and open spaces
Surface	Grazing
Ocean	Fishing
Underground	Boating
Quality	Snorkelling and diving
Floods	Camping and hiking
Dune erosion	Resorts
Compaction and settling	Scenic views and vistas
Trees	Wilderness qualities
Shrubs	Open space qualities
Grass	Landscape design
Birds	Parks and reserves
Mammals above CWR ¹	Rare and unique species or ecosystems
Mammals within CWR ¹	Historical or archaeological sites and objects
Reptiles	Cultural patterns
Turtles	Health and Safety
Fish and shellfish	Employment
Cave fauna	Transportation network
Coral reef	Waste disposal

¹ CWR = Critical Weight Range for mammalian fauna, 35 to 5500 grams.

4.2.5 Multiple Criteria Analysis

4.2.5.1 The Multiple Criteria Analysis Software

This research used the MCA software TopDec developed by David James, Ecoservices Pty Ltd (1996). The software uses the weighted summation method to aggregate scores. Weighted summation uses a linear function to standardise the scores and the overall score is then the summation of individual scores multiplied by their appropriate weights (Janssen, 1992). The best alternative is found using the following equation:

$$\max_{i=1, \dots, I} \sum_{j=1}^J (w_j x_{ji})$$

Where:

I Number of alternatives

J Number of attributes

w_j Weight for the j^{th} attribute

x_{ji} Score for the j^{th} attribute and i^{th} alternative

More detail on the standardisation and weighting methods used in the software are provided in section 4.2.5.4, p. 96.

4.2.5.2 Developing the Set of Alternatives

As an initial step in all project appraisals, alternative options are designed. This is true for MCA, CBA and EIA. Theoretically no restrictions need to be imposed on the number of alternatives considered (van Pelt, 1993a); however in practice computational and time constraints limit the feasible size of alternatives. In two summaries of MCA studies (RAC, 1992 and Janssen, 2001) the majority had between three and ten alternatives. Janssen (2001) also notes that alternatives are often some combination of components or activities. A large set of alternatives can be reduced through the use of preliminary screening criteria or by selecting a representative set so that alternatives not explicitly considered can be seen as falling in between those that are (Vickers and Belton, 1990 cited in RAC, 1992). The literature places emphasis on obtaining agreement or input on the alternatives from stakeholders, otherwise the results can be rejected at the final stage (Lahdema *et al.*, 2000 and RAC, 1992).

An initial set of alternatives was specified based on policy documents and initial discussions with the primary institutional agencies. Four different alternatives were considered with land use under each alternative a combination of pastoral activities, wilderness tourism, camping and conservation activities. No intensive development options were considered as these

were considered infeasible given the current political environment, the EPA's Position Statement (1999) and indications in other planning documents. The preliminary set of alternatives focused on two management regimes – management by pastoral leaseholders (similar to the status quo) and sole management by CALM. These were management regimes suggested in the draft Carnarvon Coastal Strategy (SMEC Australia, 2001). However further discussion with stakeholders and agencies provided alternative management options, and two extra joint or co-management arrangements were included in the final set of alternatives.

Other changes in the final set of alternatives included refinement of the nature of facilities provided and the vesting mechanisms. It was also decided to include a high and low visitation scenario for each of the four management alternatives as a form of sensitivity analysis. This process of refinement of the alternatives continued throughout the research, and a final set did not develop until the final phase of implementing the model.

To some extent the nature and level of activities under each alternative is somewhat arbitrary. Every attempt was made however, to make them as realistic as possible given the management regime, discussions with stakeholders and models that currently exist in other areas. The aim was to cover a spectrum of activities such that an undescribed alternative would fall within the range, an approach suggested by Vickers and Belton (1990, cited in RAC 1992) and used by Stewart and Joubert (1998).

The alternatives are presented in tables 4.10 to 4.17, p. 84-87. The pastoral option reflects the status quo (tables 4.10 and 4.11, p. 84). The coastal strip is managed by the pastoral leaseholders and NROCA with CALM under a Memorandum of Understanding (Section 16 agreement). Currently fox baiting is carried out on some but not all of the stations and it is anticipated that this situation would continue. Under the current National Heritage Trust funding, NROCA is rationalising tracks, campsites and rubbish pits. Trapping of feral goats is undertaken as part of the pastoral activities. It is assumed that not all camping areas would be provided with facilities and some non-facility camping would still occur.

Two coastal parks near Exmouth, (Jurabi and Bundegi), are managed by the Exmouth Shire and CALM. This provides a model for a co-management alternative between the Shires and CALM (tables 4.12 and 4.13, p. 85). The two coastal parks have a greater emphasis on recreation, and this is assumed to be the case for this alternative. It is assumed that the low visitation scenario will involve the development of a single wilderness lodge facility, while

under the high visitation scenario two facilities will be developed. A slight upgrade in road access occurs, including the rationalisation of tracks. Access will still be mainly 4WD.

The third management regime considered in the alternative set is co-management between the Gnulli Native Title Claimants and CALM (tables 4.14 and 4.15, p. 86). Berkes *et al.* (1991) define co-management as the sharing of power and responsibility between government and local resource users. Involving local resource users in management and planning increase the acceptability and enforceability of management regimes (Ostrom, 1990). The West Australian government has indicated that indigenous knowledge and values will be incorporated in coastal management arrangements (WAPC, 2001a). It has been suggested that customs and practices with respect to the environment are often operational expressions of traditional knowledge on the structure and function of environmental resources (Hanna *et al.*, 1995).

The growing trend to develop co-management arrangements with indigenous people (Notzke, 1995) is reflected in this alternative. A wide range of co-management arrangements is possible, each associated with different levels of involvement of indigenous communities. No attempt is made to explicitly outline the specifics of the arrangement between Gnulli Native Title Claimants and CALM. The Gnulli co-management alternatives are similar in practical terms to the Shires co-management arrangements, however a smaller number of wilderness facilities are developed (none in the low visitation scenario and one in the high visitation scenario).

The final alternative is based on the model existing in other National Parks and Cape Range National Park in particular. This is managed solely by CALM (tables 4.16 and 4.17, p. 87). Roothing infrastructure is upgraded to allow general access by 2WD vehicles. The number of wilderness facilities developed is the same as for the Shires co-management alternative.

Table 4.10 Pastoral Alternative – Low Visitation Scenario

Pastoral - Low	
Description	Pastoral option, current visitation trends
Land Tenure	Coastal strip remains part of the pastoral lease
Land Use	Pastoral with some conservation Some intensification of tourism/recreational use
Management Arrangement	Pastoral lease holders/Ningaloo Reef Outback Coast Association with CALM under a Memorandum of Understanding (Section 16 Agreement)
Management activities	Irregular fox baiting programme Trapping of feral goats Rationalisation of tracks and campsites over four year period Caretakers to manage campsites
Facilities	Rubbish pits Provision of composting toilets at some campsites in future No upgrading of current road access
Visitor trends	Current trends continue. Average increase in demand for wilderness camping of 5-10% per year for years 1-10, and 2.5- 5% per year for years 11-25.

Table 4.11 Pastoral Alternative – High Visitation Scenario

Pastoral - High	
Description	Pastoral option, strong visitation growth
Land Tenure	Coastal strip remains part of the pastoral lease
Land Use	Pastoral with some conservation Some intensification of tourism/recreational use
Management Arrangement	Pastoral lease holders/Ningaloo Reef Outback Coastal Association with CALM under a Memorandum of Understanding (Section 16 Agreement)
Management activities	Irregular fox baiting programme Trapping of feral goats Rationalisation of tracks and campsites over four year period Caretakers to manage campsites
Facilities	Rubbish pits Provision of composting toilets at some campsites in future No upgrading of current road access
Visitor trends	Strong visitation growth. Average increase in demand for wilderness camping of 5-20 % per year for years 1-10, and 2.5-5% per year for years 11-25.

Table 4.12 Co-management Between Exmouth and Carnarvon Shires and CALM – Low Visitation Scenario.

Shires - Low	
Description	Coastal strip excised, co-management arrangement with Shires, current visitation trends
Land Tenure	Coastal strip excised and vested in Conservation Commission
Land Use	Conservation, recreation and tourism Emphasis on recreation.
Management Arrangement	Co-managed by CALM and the Exmouth and Carnarvon Shires
Management activities	Feral pest control – fox baiting and goat trapping/shooting Campsite and track rationalisation and formalisation over six year period Caretakers at individual campsites during peak season Ranger patrol activities
Facilities	Composting toilets and rubbish bins provided at campsites Slight upgrading of roads and access tracks – remain unsealed One wilderness lodge accommodation facility developed
Visitor trends	Current trends continue. Average increase in demand for wilderness camping of 5% per year for years 1-10, and 2.5% per year for years 11-25.

Table 4.13 Co-management Between Exmouth and Carnarvon Shires and CALM – High Visitation Scenario

Shires - High	
Description	Coastal strip excised, co-management with Shires, strong visitation growth
Land Tenure	Coastal strip excised and vested in Conservation Commission
Land Use	Conservation, recreation and tourism Emphasis on recreation
Management Arrangement	Co-managed by CALM and the Exmouth and Carnarvon Shires
Management activities	Feral pest control – fox baiting and goat trapping/shooting Campsite and track rationalisation and formalisation over six year period Caretakers at individual campsites during peak season Ranger patrol activities
Facilities	Composting toilets and rubbish bins provided at campsites Slight upgrading of roads and access tracks – remain unsealed Two wilderness lodge accommodation facilities developed
Visitor trends	Strong visitation growth. Average increase in demand for wilderness camping of 10% per year for years 1-10, and 2.5% per year for years 11-25.

Table 4.14 Co-management Between the Gnulli Native Title Claimants and CALM – Low Visitation Scenario

Gnulli - Low	
Description	Coastal strip excised, co-management with Gnulli Native Title Claimants, current visitation trends
Land Tenure	Coastal strip excised and vested in Conservation Commission
Land Use	Mainly conservation with recreation and tourism
Management Arrangement	Co-managed by CALM and Gnulli Native Title Claimants
Management activities	Feral pest control – fox baiting and goat trapping/shooting Campsite and track rationalisation and formalisation over six year period Caretakers at individual campsites during peak season Ranger patrol activities
Facilities	Composting toilets and rubbish bins provided at campsites Slight upgrading of roads and access tracks – remain unsealed
Visitor trends	Current trends continue. Average increase in demand for wilderness camping of 5% per year for years 1-10, and 2.5% per year for years 11-25.

Table 4.15 Co-management Between the Gnulli Native Title Claimants and CALM – High Visitation Scenario

Gnulli - High	
Description	Coastal strip excised, co-management with Gnulli Native Title Claimants, strong visitation growth
Land Tenure	Coastal strip excised and vested in Conservation Commission
Land Use	Conservation, recreation and tourism.
Management Arrangement	Co-managed by CALM and Gnulli Native Title Claimants
Management activities	Feral pest control – fox baiting and goat trapping/shooting Campsite and track rationalisation and formalisation over six year period Caretakers at individual campsites during peak season Ranger patrol activities
Facilities	Composting toilets and rubbish bins provided at campsites Slight upgrading of roads and access tracks – remain unsealed One wilderness lodge accommodation facility developed
Visitor trends	Strong visitation growth. Average increase in demand for wilderness camping of 10% per year for years 1-10, and 2.5% per year for years 11-25.

Table 4.16 CALM Alternative – Low Visitation Scenario

CALM - Low	
Description	Coastal strip excised, managed by CALM, current visitation trends
Land Tenure	Coastal strip excised and vested in the Conservation Commission
Land Use	Mainly conservation with recreation and tourism
Management Arrangement	Managed by CALM
Management activities	Feral pest control – fox baiting and goat trapping/shooting Campsite and track rationalisation and formalisation over six year period Caretakers at individual campsites during peak season Ranger patrol activities
Facilities	Composting toilets and rubbish bins provided at campsites Upgrading of roads, accessible by 2WD One wilderness lodge facility developed
Visitor trends	Current trends continue. Average increase in demand for wilderness camping of 5% per year for years 1-10, and 2.5% per year for years 11-25.

Table 4.17 CALM Alternative – Low Visitation Scenario

CALM - High	
Description	Coastal strip excised, managed by CALM, strong visitation growth
Land Tenure	Coastal strip excised and vested in the Conservation Commission
Land Use	Mainly conservation with recreation and tourism
Management Arrangement	Managed by CALM
Management activities	Feral pest control – fox baiting and goat trapping/shooting Campsite and track rationalisation and formalisation over six year period Caretakers at individual campsites during peak season Ranger patrol activities
Facilities	Composting toilets and rubbish bins provided at campsites Upgrading of roads, accessible by 2WD Two wilderness lodge facilities developed
Visitor trends	Strong visitation growth. Average increase in demand for wilderness camping of 10% per year for years 1-10, and 2.5% per year for years 11-25.

4.2.5.3 Developing the Set of Attributes

The development of criteria or attributes is a crucial stage in the MCA process. Two approaches can be used – a top-down or bottom-up approach (Lahdelma *et al.*, 2000 and Edward-Jones *et al.*, 2000). A top-down approach starts with an overall objective which is decomposed into sub-objectives and further down until the impact level is reached (Keeney and Raiffa, 1993). A bottom-up approach starts at the impact level and builds these into attributes. In advocating this approach Roy (1985, cited in Lahdelma *et al.*, 2000) considers that points of view will emerge after a thorough analysis of the consequences, taking into account the cultural background of the stakeholders involved. Both approaches are used in the literature (see e.g. Gallego *et al.*, 1998; Proctor, 2001 and Monki *et al.*, 1996). The two approaches are not mutually exclusive and some applications appear to use both (e.g. Qureshi and Harrison, 2001).

This research utilises aspects of both approaches to develop criteria. Objectives of different stakeholder groups were analysed in the stakeholder analysis (see section 4.2.2.2, p. 59), however a specific objective tree was not developed. Impacts were identified through the EIA and CBA and the key impacts were integrated into attributes. The three separate analysis techniques were integral to the development of the attributes.

A preliminary set of attributes was developed and sent to stakeholder groups and agencies for their comments and input. The response rate was very high from all groups, indicating a willingness to participate in the development process and a desire to have their view incorporated into the attributes. Janssen (2001) notes that in many MCA applications, the attributes become a list of the attributes that all stakeholder groups want considered. To avoid this problem, stakeholder comments and input were then analysed and a new set of attributes developed in light of these comments, rather than merely adding each suggestion to the attribute set. Further refinement of the attributes occurred in an attempt to make them operational. Similar to the process of specifying alternatives, an operational attribute set did not emerge until late in the MCA process, a finding also mentioned by Monnikhof and Bots (2000).

Keeney and Raiffa (1993) suggest the following desirable properties for a set of attributes:

Complete There should be no further criteria which can be used to judge between two alternatives

- Operational* Attributes must be meaningful to the decision maker and measurable in some way.
- Decomposable* Two factors should not be in opposition in a single criterion. For example if tree planting is beneficial in some areas but not in others, tree planting cannot be used as an attribute.
- Non-redundant* Any aspect of the problem should enter the criteria only once to avoid the consequences of double counting. Keeney and Raiffa (1993) indicate two common ways that non-redundancies enter the set of attributes; through the inclusion of attributes related to both means and ends objectives or when some attributes represent inputs into a system and others represent outputs.
- Minimal* Subject to the previous four criteria, the set of attributes should be as small as possible. No smaller set of attributes should be available that satisfy the above criteria.

Keeney and Raiffa's (1993) desirable properties were adhered to in the process of specifying attributes. For the purposes of this study, thirteen attributes were chosen against which the alternative management options were measured and compared. The final attribute set is presented in table 4.18.

Table 4.18 Attributes for the Ningaloo Study

Module	Attribute	Description
Environmental	Coral reef	Impact of increased visitation on the coral reef
	Dune erosion	Impact of destocking and revegetation and fencing programmes on dune erosion
	Native vegetation – shrubs, grasses	Impact of stocking/destocking on native vegetation
	Native fauna – turtles	Impact of increased visitation on turtles
	Native fauna – mammals within CWR, reptiles and birds	Impact of stocking/destocking on native fauna
	Feral animals	Impact of feral pest control programmes on fox and goat populations
Economic	Total costs and benefits of project	The expected annual economic returns
	Regional tourism expenditure	Tourism expenditure in the region
Social	Range of recreational opportunities	Range of recreational opportunities provided
	Level of involvement of Aboriginal community	Likelihood of involvement of Aboriginal community
Institutional	Capacity to achieve positive environmental outcomes for terrestrial ecosystem	The institutional capacity to achieve a positive environmental outcome. Based on expertise, funding and management structures.
	Capacity to achieve positive environmental outcomes for marine ecosystem	The institutional capacity to achieve a positive environmental outcome. Based on expertise, contribution of funding to the Marine Park and management structures.
	Level of involvement of affected parties	Likelihood of the involvement of local affected parties

The following sections discuss the individual attributes, justification for their inclusion and underlying assumptions.

4.2.5.3.1 *Environmental Attributes*

Environmental attributes were developed from the EIA and adapted Leopold matrices. Physical and biological elements were considered, and these related to the first 21 rows of the adapted Leopold matrix. Elements were considered for inclusion as attributes in the MCA where impacts were rated as being of moderate or high importance. Impacts of low importance were not included. Where mitigation was likely, the impact was not included in the MCA, regardless of the importance rating of the impact. There were two exceptions to this and these related to the elements of turtles and the coral reef. These were still included

as attributes despite the likelihood of impacts being mitigated, due to the very high importance of these elements for the region.

Originally a criterion for flora and fauna in general was specified, however this was not operational in practice and more specific attributes were required. Fauna and flora groups were combined into a single criterion where impacts were of the same magnitude. Scores for environmental attributes were based on the magnitude scores from the adapted Leopold matrix. For more detail on the scores for the environmental attributes see chapter five, section 5.5.1, p. 123.

4.2.5.3.2 Economic Costs and Benefits

This attribute reflects the economic aspect of sustainability and was a direct incorporation of the results of the CBA. The scores for this criterion were expressed as equivalent annual annuities, since the other criteria reflect static measurements. As discussed in section 2.3.3.4 the CBA did not include estimation of non-market benefits, and is therefore, an underestimation of the true economic worth of the alternatives. The incorporation of CBA results into MCA is recommended by the literature (see van Pelt *et al.*, 1990 and van Pelt, 1993a and 1993b). If all economic benefits and costs cannot be monetised, a partial CBA can be undertaken and the results incorporated into the MCA, however a partial CBA should carry less weight in the MCA than a full one (van Pelt, 1993a).

4.2.5.3.3 Tourist Expenditure

Tourism is an expanding industry within the Gascoyne region and is the second largest industry in the region (Gascoyne Development Commission, 2001). The draft Coastal Zone Management Policy (WAPC, 2001a) indicates the importance of coastal areas to the regional economic base. For these reasons, tourism expenditure was included as a separate attribute. Tourism expenditure was based on the visitation scenarios assumed for the CBA (see section 4.2.3.3.3, p. 70). Further assumptions related to the breakdown of visitors from within and outside Western Australia. Tourist expenditure was only included in the analysis for visitors from outside Western Australia. If Western Australian visitors do not come to the coastal strip they are likely to go elsewhere in the state and spend similar money. Therefore from a state perspective no loss or gain exists from West Australian expenditure in the region and this instead represents a transfer from one region to another. In contrast, expenditure by visitors from outside Western Australia represents a real gain to the state.

The proportion of non-Western Australian visitors was based on surveys of visitors in the Exmouth region and Cape Range National Park (Wood and Hopkins, 2001; Wood and Dowling, 2002 and Cary *et al.*, 2000). Tourism expenditure was based on the same surveys and additional estimates by the WATC (WATC, 2000). The assumptions regarding origin of visitors and their expenditure are presented in table 4.19.

The breakdown of visitor origin differs between pastoral and non-pastoral alternatives. This is based on the assumption that the current pastoral camping regime has a higher level of visitation by Western Australians, compared to CALM managed lands such as Cape Range National Park. Expenditure per person per day is the same for all alternatives. It is possible that those that camp for longer periods on the pastoral stations actually spend less, however there was no available data to support this. Tourism expenditure includes expenditure on food, petrol and activities, but not accommodation.

Table 4.19 Assumptions Regarding Regional Tourist Expenditure

	% of Non-WA visitors		Expenditure Per Person Per Day
	Years 1-10	Years 11-25	
Pastoral Alternatives	0.40	0.45	\$70
Non-pastoral Alternatives	0.54	0.60	\$70

4.2.5.3.4 Range of Recreational Opportunities

This attribute reflects the opportunity for the coastal strip to provide for multiple recreation uses. This is an objective of both CALM and the DPI, and was stressed in the draft Carnarvon Coastal Strategy (2001). Planning policy for the region restricts the range of feasible activities and accommodation, so high impact activities and accommodation were not considered. The attribute is an index of activities and accommodation that are currently, or could be, present on the coastal strip under the given alternatives. The index is made up of nine activities and nine forms of accommodation as shown in table 4.20.

The range of accommodation reflects the spectrum of possible alternatives from non-facility wilderness camping through to caravan park type camping grounds. Included as a type of accommodation is “no time restrictions on camping”, since this is a significant factor that

influences the current visitation to the area. Many retirees ‘grey nomads’ come for three or more months during the winter period.

The index is scored with a one if the activity or accommodation type is present, or zero otherwise. These are then summed to provide a total for activities and accommodation respectively, which are then summed to provide a total score.

Table 4.20 Activities and Accommodation Types Included in the Index of Recreational Opportunity

Activities	
Snorkelling and swimming	Windsurfing
Scuba diving	Surfing
Walking	Wildlife viewing
Fishing – boat	Organised tours
Fishing - shore	
Accommodation	
No time restrictions on camping	Campsites with foot access only
Campsites with facilities	Caravan Park
Campsites without facilities	Station accommodation
Campsites with 4WD access only	Wilderness lodge
Campsites with general 2WD access	

4.2.5.3.5 *Involvement of the Aboriginal Community in Planning and Management of the Ningaloo Coastal Strip*

This attribute reflects the social importance of local Aboriginal peoples involvement in decision making and planning relating to natural resource management. The draft Coastal Zone Management Policy (WAPC, 2001) indicates that traditional knowledge and values will be incorporated in coastal management arrangements.

This attribute was assessed using a Likert scale as presented in table 4.21. Zero represents no involvement, two represents a nominal level of involvement and four represents a comprehensive level of involvement, where involvement refers to all facets of planning and day-to-day management of the coastal strip. Scores were based on the likelihood of involvement given the management regime, and were the researcher’s assessment based on discussions with stakeholders and other models currently in place.

Table 4.21 Likert Scale for Involvement of Aboriginal Community in Planning and Management of the Ningaloo Coastal Strip

0	1	2	3	4
No involvement		Nominal level of involvement		Comprehensive level of involvement

4.2.5.3.6 Institutional Capacity to Achieve Positive Environmental Outcomes in the Medium-Long Term, for Terrestrial and Marine Ecosystems

These two attributes recognise that institutional constraints may prevent the successful implementation of alternatives, and that some alternatives may be less sustainable because of these institutional constraints. For the terrestrial ecosystem, institutional capacity was based on three factors; the range of expertise within the managing organizations, access to sustainable funding and sustainable management structures within and between organizations. Range of expertise covers four types of expertise: pastoral, conservation, recreation and traditional knowledge. For the marine ecosystem institutional capacity was similarly based on three factors: range of expertise, funding contribution to the Ningaloo Marine Park, and sustainable management structures. Range of expertise for the marine ecosystem covers three types: conservation, recreation and traditional knowledge. The marine ecosystem was included because of the linkages between the coast and the Marine Park and the importance of managing these as an interrelated system. Funding contribution to the Marine Park was included after it was identified as a key issue to the sustainability of both the Marine Park and the coastal strip (J. Carey, pers. comm., July 2002).

The contribution of the three factors to overall institutional capacity for the terrestrial and marine ecosystems is presented in table 4.22. Each expertise type was scored out of two; with zero indicating that the expertise is not present within the managing organization. Access to sustainable funding and sustainable management structures were scored out of two and scaled up to ensure all factors were of equal importance in the final score. For both the terrestrial and marine ecosystems, scores were based on the literature and discussions with stakeholder groups and experts in the field.

Table 4.22 Factors in the Index of Institutional Capacity for Positive Environmental Outcomes for the Terrestrial and Marine Ecosystems

Terrestrial Ecosystem		Marine Ecosystem	
	Max score		Max score
Range of expertise		Range of expertise	
Pastoral expertise	2	Conservation expertise	2
Conservation expertise	2	Recreation expertise	2
Recreation expertise	2	Traditional knowledge	2
Traditional knowledge	2	Sub-total	6
Sub-total	8	Contribution of funding to Marine Park	6
Access to sustainable funding	8	Sustainable management structures	6
Sustainable management structures	8		
Total	24	Total	18

4.2.5.3.7 Involvement of Stakeholder Groups in Planning and Management of the Ningaloo Coastal Strip

This attribute was assessed using the Likert scale presented in table 4.23. This is the same scale as for the involvement of Aboriginal community attribute, however the purpose of this criterion is to reflect the institutional benefits of involving affected parties in planning and management. (see Hanna *et al.*, 1995). The current government’s attitude is towards a much greater level of involvement of stakeholder groups in planning and this is also a trend that is occurring worldwide (Innes, 1996). Scores were based on the likelihood of involvement given the management regime, and were the researcher’s assessment based on discussions with stakeholders and existing models in other places.

Table 4.23 Likert Scale for Involvement of Stakeholder Groups in Planning and Management of the Ningaloo Coastal Strip

0	1	2	3	4
No involvement		Nominal level of involvement		Comprehensive level of involvement

4.2.5.4 Standardisation and weighting

4.2.5.4.1 Standardisation

A number of procedures for standardisation exist (see Janssen, 1992 or Bouyssou *et al.*, 2000). The standardisation procedure used by the TopDec software is transformation by the following linear function:

$$x_{ij}' = x_{ij} \frac{x_{ij}}{\max_i |x_{ij}|}$$

Where:

x_{ij}'	Standardised score for the i^{th} alternative and j^{th} attribute
x_{ij}	Raw score for the i^{th} alternative and j^{th} attribute
I	Number of alternatives
J	Number of attributes

This procedure scales the scores according to the relative distances between the origin and the maximum score (Janssen, 1992). Bouyssou *et al.*, (2000) suggest that such a standardisation method should be used when the value zero places a special role in the measurement scale. The implication of a linear transformation function is that equal differences in values on a criterion result in equal differences in the overall evaluation function (x_{ij}'), regardless of the position of the interval of values (*ibid.*). For many of the attributes in this research, zero has special significance, particularly for the environmental attributes (where zero indicates no impact). A limitation of the TopDec software is that it uses only a single standardisation method, so the sensitivity of rankings to the standardisation method cannot be checked. The final ranking of alternatives may be dependent on the standardisation method, as illustrated by Bouyssou *et al.*, (2000). However the procedure appears appropriate for the scoring systems used in this research.

4.2.5.4.2 Weighting

Weights represent the tradeoffs between attributes and the scope for substitution between attributes, however Janssen (1992) notes that in practical applications weights are generally used as a representation of the relative importance of the attribute.

Weights can be linear or non-linear. Linear weights are independent of the value of the attribute scores; this implies that no limits are imposed on the possibility of substitution between attributes. Non-linear weights allow for a variety of functions between weights and attribute scores and can allow for limitations on the possibility of substitution between attributes (Janssen, 1992).

The TopDec software employs two methods of linear weighting. The first procedure (termed the rating method by the software) allows the allocation of a number between one

and ten, where ten represents maximum importance and one represents minimal importance. Two attributes can be given the same weight using this procedure. The software then calculates a weight set based on:

$$w_j = \frac{r_j}{\sum_{j=1}^J r_j}$$

Where:

- w_j relative weight for the j^{th} attribute
- r_j rating for the j^{th} attribute
- J Number of attributes

The second procedure requires a complete ranking of the attributes in order of importance (the software labels this the priority order method). Attributes cannot be given equal importance to the decision. The software then converts this ranking into a weight set using the expected value method (Rietvald, 1983 in Janssen, 1992). The expected value method requires a complete ranking and imposes the conditions that the quantitative weights are non-negative and equal to one. Given a ranking, the weight set is calculated by assuming that each possible weight set within the set of feasible weights has equal probability. The weight vector is the expected value of the feasible set. This gives rise to a convex relationship between ordinal and quantitative weights such that the difference between two subsequent weights is larger for more important criteria (see table 4.25, p. 99 for an example of a weight set using the priority order method).

Using the expected value approach, the first two weights are worth 42% of the total, whilst the last five weights are worth only 10% of the total. This implies that only the first few attributes contribute significantly to the final ranking. Zhu *et al.* (2001) also note that ranking does not provide decision makers with an opportunity to weigh the relative importance of attributes. For this research, this was considered inappropriate, so the weighting used the rating method. However the sensitivity of the final rankings to the use of priority order method was explored in the sensitivity analysis (see section 4.2.5.5, p. 98).

A number of approaches exist for determining the weights to be used in the analysis. Van Pelt (1993a) suggests three: direct questioning of policy makers and other parties involved, estimating weights based on actual behaviour (revealed preferences), and estimated hypothetical weights chosen by the analyst to be representative of a specific agent or general perspective. Practical applications of MCA appear to use the first and third approaches, few based weights on revealed preferences. Direct questioning of policy makers and stakeholder groups was frequently done through the use of a questionnaire (e.g. Quereshi and Harrison, 2001 and Prato and Hajcowicz, 2001), and one study suggests the use of a citizens' jury to

estimate weights (Proctor, 2001). Many studies provided a hypothetical weight set, with variation in weights to represent different perspectives. In particular, in studies where sustainable development was an overriding aim, weight vectors were varied to place emphasis on economic, social and environmental perspectives (see e.g. Tiwari *et al.*, 1999 and van Herwijnen *et al.*, 1993).

This research used researcher-constructed weights, based the stakeholder analysis. The weight vector chosen was based on the results of the stakeholder analysis, which exhibited an overriding concern for the environment. All environmental attributes were given a rating of 10, whilst all other attributes were given a rating of 5 (see table 4.24). This weight set is also consistent with the sustainable development policy approach adopted in the National Strategy for Ecologically Sustainable Development (1992).

4.2.5.5 Sensitivity Analysis

The sensitivity of the final ranking to the weight set, weighting method and scores was explored, as recommended by the literature (e.g. van Pelt, 1993a and van Herwijnen *et al.*, 1993). Three other weight sets were used. The first was a weight set where all weights were equal. This is commonly used in MCA (see e.g. van Herwijnen *et al.*, 1993). An equal weight set is consistent with the policy approach adopted in the draft Western Australian State Sustainability Strategy (2002). The second and third weight sets reflected alternative social and economic perspectives to sustainability. Table 4.24 presents the weight sets used in the analysis.

The ranking of alternatives can be sensitive to the weighting method used. This was explored by using the priority order method in the TopDec software. As it was not possible to have equal weightings using this method, an environmental and economic weight set was used, as shown in table 4.25. This method meant that the last few attributes had minimal relative weights.

Table 4.24 Sensitivity to Weights: Weight Sets Used in the Multiple Criteria Analysis

Attribute	Environmental		Equal		Economic		Social	
	Rating	Relative Weight	Rating	Relative Weight	Rating	Relative Weight	Rating	Relative Weight
Coral reef	10	10.53	10	7.69	8	8.6	8	8.6
Dune erosion	10	10.53	10	7.69	8	8.6	8	8.6
Native vegetation	10	10.53	10	7.69	8	8.6	8	8.6
Turtles	10	10.53	10	7.69	8	8.6	8	8.6
Other native fauna	10	10.53	10	7.69	8	8.6	8	8.6
Feral pests	10	10.53	10	7.69	8	8.6	8	8.6
Costs and benefits of project	5	5.26	10	7.69	10	10.75	5	5.38
Tourist expenditure	5	5.26	10	7.69	10	10.75	5	5.38
Range of recreational opportunity	5	5.26	10	7.69	5	5.38	10	10.75
Involvement of Aboriginal Community	5	5.26	10	7.69	5	5.38	10	10.75
Terrestrial capacity	5	5.26	10	7.69	5	5.38	5	5.38
Marine capacity	5	5.26	10	7.69	5	5.38	5	5.38
Involvement of local parties	5	5.26	10	7.69	5	5.38	5	5.38

Table 4.25 Sensitivity to Weighting Method: Weight Sets Using the Priority Order Method

Attribute	Environmental		Economic	
	Ranking	Relative Weight	Ranking	Relative Weight
Coral reef	1	24.46	3	12.92
Dune erosion	2	16.77	4	10.36
Native vegetation	3	12.92	5	8.44
Turtles	4	10.36	6	6.9
Other fauna	5	8.44	7	5.62
Feral animals	6	6.9	8	4.52
Costs and benefits of project	13	0.59	1	24.46
Tourist expenditure	12	1.23	2	16.77
Range of recreational opportunity	8	4.52	10	2.7
Involvement of Aboriginal community	7	5.62	9	3.56
Terrestrial capacity	11	1.93	13	0.59
Marine capacity	10	2.7	12	1.23
Involvement of local parties	9	3.56	11	1.93

The last component of the sensitivity analysis involved exploring the sensitivity of the final rankings to the attribute scores. This was achieved by assuming an optimistic and pessimistic scenario. These scenarios assumed different outcomes for environmental and economic attributes, while social and institutional scores remained the same. Environmental scores were varied for attributes where uncertainty surrounded the scores. The alternative scores represented a poorer or better outcome for that attribute depending on the scenario. The score for the total costs and benefits attribute was based on the sensitivity analysis conducted for the CBA. The score for the tourist expenditure attribute was also varied, based on a higher and lower level of expenditure per person (\$50 per person for pessimistic scenario, \$80 per person for optimistic scenario).

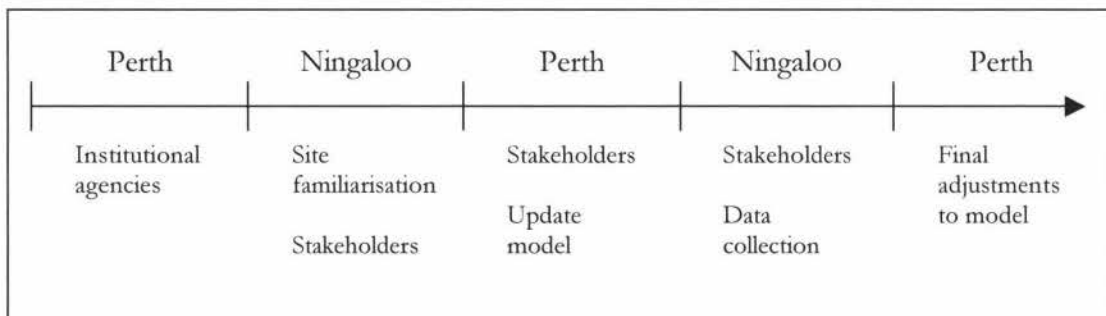
The analysis for the pessimistic and optimistic scenarios used the rating method and an equal weight set.

4.3 PHASE II – VISIT TO SITES AND STAKEHOLDERS

Once the initial desk-top model was designed, the information was then verified by site visits and meetings with stakeholders. The methodology adopted necessitated an extensive period of field research and consultation in Western Australia. This consisted of interviews and meetings with institutional agencies, stakeholders and experts, and visits to the coastal strip and surrounding areas. Since stakeholders, institutional agencies and experts were spread over a vast geographical distance, visits to stakeholders required traveling between Perth, Carnarvon, Exmouth and the pastoral stations several times.

This field research took place over a period of three months from May to July 2002. Figure 4.2 outlines the sequence of events during the visits to sites and stakeholders.

Figure 4.2 Timeline of Visits to Sites and Stakeholders



During the initial period in Perth, interviews were conducted with the primary institutional agencies to discuss the alternatives and the research approach. This provided a significant amount of further information on key issues and other stakeholder groups. The initial site visit to the Ningaloo region involved discussions with stakeholder groups in Carnarvon and Exmouth. A week was spent on the pastoral stations and some time was also spent in Cape Range National Park. Following the initial site visit, discussions with further stakeholder groups in Perth were held and the preliminary criteria were sent by email to institutional agencies and stakeholder groups for comment and input. During this period extensions were also made to the alternatives being considered.

After the initial site visit it was decided not to proceed further with the survey of campers on the coastal strip. It was planned that this survey would be undertaken during the second site visit. The survey was discontinued for the following reasons:

1. It proved very difficult to estimate use value for the different options, since the survey population was only current users. It is likely that many of this group would be replaced by other visitors should the management regime change. The survey would reflect this as lower use value for the non-pastoral options, which would be inaccurate, since replacement groups could potentially have lower, equal or higher valuations.
2. The size and isolation of the survey area proved to be significant constraints given the resources and time of the researcher.
3. Two other surveys were being undertaken in the same region during a similar period, and the pilot survey showed a reluctance to participate in the survey. Previous surveys had led to a distrust of surveys in general.
4. The owners of the stations were involved in actively canvassing support to retain the status quo, and it was felt that this might bias results.

Another issue that emerged during this period involved the issue of wilderness and its incorporation as an attribute into the MCA. It was initially intended to include this aspect as an attribute, however it proved too difficult to operationalise. The difficulties with the concept arise from its subjective nature; wilderness means different things to different people. Two general approaches to estimating landscape values could be used: an inventory

approach based on characteristics of the environment (Hall, 1992) or an estimate of the public's preferences and willingness to pay (Santos, 1998). An inventory approach is more simple, but less accurate, and still requires some idea of public preferences regarding what should be included. An estimation of stakeholder preferences would have required a large survey of the local community, campers, international visitors and other interested groups. This was outside the scope of this research. A wilderness attribute was not included in this research, however some aspects of the wilderness camping experience are included in the range of recreational opportunities attribute.

A final site visit was made which involved further informal discussions with stakeholders and the collection of further data. On return to Perth, the model was finalised before the implementation stage. The iterative nature of the MCA process meant that the model was not completely finalised until near the end of the research period. At this stage the researcher had returned to New Zealand and a significant amount of further consultation and clarification was undertaken by email.

4.4 PHASE III – IMPLEMENTING THE MODEL

The final phase of the methodology involved implementing the model. This involved the development of spreadsheets for the CBA, completing the adapted Leopold matrices for alternatives and inputting the data into the TopDec software.

4.5 CONCLUSION

This chapter outlines the integrated assessment methodology adopted in this research. Three phases of the methodology are outlined: designing the model, visit to sites and stakeholders and implementing the model. Phase one outlines the model adopted in this research. Three individual assessment techniques are used to provide input into the following stages of the MCA process: developing alternatives and attributes, scoring attributes and weighting. This section outlines the alternatives and attributes used in this research and the assumptions that underlie them. Phase two describes the visit to sites and stakeholders that was undertaken over a three-month period during the winter of 2002. Significant changes that were made to the model following these visits are outlined. The final phase in the methodology involved implementing the model.

5 ANALYSIS AND RESULTS

5.1 INTRODUCTION

The results of the assessment of land use and management alternatives using the integrated assessment framework developed in chapter four are presented in this chapter. The structure of this chapter follows the development of the model presented in chapter four. In section 5.2 the results of the analysis of stakeholder objectives are presented. This is followed by a summary of the results of the CBA in section 5.3. More detailed calculations for the CBA are provided in appendices one and two. Finally the results of the EIA are presented in section 5.4. The Leopold matrices are provided for each alternative and the key impacts are discussed.

Section 5.5 provides a link between the results of the individual assessment techniques and the integrated evaluation. More detail and analysis is provided on the scoring of the attributes and this includes how the results from the CBA and EIA are included in the scores for attributes in the MCA..

The results of the integrated evaluation are presented in section 5.6. Firstly the scores for the attributes are provided in a performance matrix. This matrix shows the raw data for input into the TopDec software. The results of the MCA using the TopDec software rating method and equal and environmental weight sets are presented in sections 5.6.2 and 5.6.3. Section 5.6.4 provides the results of the MCA sensitivity analyses and include sensitivity to weighting method, weight sets and scores.

Section 5.7 provides a summary of the rankings of the alternatives for all of the MCA evaluations.

5.2 STAKEHOLDER ANALYSIS

Table 5.1 Stakeholder Objectives for the Ningaloo Coastal Region

Analysis of Stakeholders in Ningaloo Coastal Region			
Actor/Stakeholder	Key Objectives		
	Economic	Social	Environmental
Primary Institutional Agencies			
Department of Conservation and Land Management		<ul style="list-style-type: none"> ▪ Provide variety of opportunities and facilities for appropriate public recreation ▪ Minimise conflict between users ▪ Protect cultural resources 	<ul style="list-style-type: none"> ▪ Protect and conserve indigenous plants and animals and their habitats ▪ Control feral animals and noxious weeds ▪ Representative system of reserves
Department of Land Administration Pastoral Lands Board	Maintain economic viability of pastoral lease		Manage pastoral leases in an ecologically sustainable manner
Ministry of Planning and Infrastructure	<ul style="list-style-type: none"> ▪ Conservative and sustainable resource use ▪ Provision for balanced multiple use of coastal zone resources ▪ Economic resource base for regional areas ▪ Provide wide range of tourism experiences and recreational facilities 	<ul style="list-style-type: none"> ▪ Equitable access to coastal resources ▪ Low impact recreational and tourism use and enjoyment of the coast ▪ Retention of wide options for future generations ▪ Minimisation of resource use conflicts 	<ul style="list-style-type: none"> ▪ Protection and conservation of areas of environmental and cultural significance ▪ Avoidance or mitigation of adverse impacts from human activities ▪ Retain wilderness values ▪ Maintenance of physical and biological processes
Secondary Institutional Agencies			
Western Australian Tourism Commission	Develop coastal strip as a wilderness area for nature-based tourism	<ul style="list-style-type: none"> ▪ Involve and benefit local communities ▪ Encourage Aboriginal participation in nature-based tourism 	Protect states natural assets and return benefits back to the environment

Gascoyne Development Commission	<ul style="list-style-type: none"> Develop regional infrastructure, wealth and employment 	<ul style="list-style-type: none"> Develop adaptive communities Enrich regional lifestyles and livelihoods 	<ul style="list-style-type: none"> Environmentally sustainable development Support development but not at expense of environment
Shire of Carnarvon	Allow some low-key tourism development	Provide access to coastal resource for public	
Shire of Exmouth	Allow some low-key tourism development	Provide access to coastal resource for public	
Stakeholders			
Pastoral lease holders	Maximise pastoral income		Maintain rangeland resource
Ningaloo Reef Outback Coast Association	Charge recreational fees to cover management costs	<ul style="list-style-type: none"> Provide alternative model for management Provide wide range of recreational options Equity of access Conserve cultural and recreation heritage 	<ul style="list-style-type: none"> Long term conservation of environmental heritage Manage modified environment
Gnulli Native Title Claimants	Economic benefits to accrue to Aboriginal people	Aboriginal input into management and control of area	Protection and long term conservation of land and sea
Save Ningaloo Association	Appropriate ecotourism development for area	Maintain resource for future generations	Maintain wilderness and ecological values
Current long-term users	Maintain low-cost camping opportunities	Maintain current “wilderness” camping opportunities for future generations	Protect the coastal resource
Exmouth and Carnarvon Locals	‘retain status quo’	Maintain current level of fees	Maintain current “wilderness” camping opportunities and level of access
	‘welcome change’	Coastal strip to provide economic benefits to region through low-level tourism development	
			Protect the coastal resource

Table 5.1 presents the economic, social and environmental objectives of stakeholders and institutional agencies in relation to management and use of the Ningaloo coastal strip. The table shows considerable compatibility between environmental objectives for all stakeholders and institutional agencies.

Objectives appear to conflict over the issue of wilderness and the appropriate level of development. NROCA, current long-term users and some of the local community desire to retain the current wilderness aspects of the current access and camping structure. In contrast to this institutional agencies appear to favour some form of wilderness lodge tourism to generate greater economic benefits for the region.

The social objectives in table 5.1 also indicate a desire amongst both stakeholders and institutional agencies to consider intergenerational equity. Economic objectives relate to obtaining benefits from appropriate ecotourism development (mainly institutional agencies) and retaining an appropriate fee structure (stakeholder groups). The economic objectives stress that ecotourism development should be appropriate and at a low level. This suggests that the environment is an overriding concern for most stakeholders.

5.3 COST BENEFIT ANALYSIS

5.3.1 Net Present Values

Considerable recent discussion has focused on the economic sustainability of pastoral operations in the rangelands (e.g. Productivity Commission, 2002). Given the assumptions used in this research, pastoral operations appear to provide net benefits on the coastal strip, though they are small in comparison to the potential benefits provided by wilderness lodge tourism.

Table 5.2 Net Present Values and Expected Annual Returns for Alternatives (Eight Percent Discount Rate)

	Net Present Values				Expected Annual Return
	Pastoral	Wilderness Lodge	Camping and Management	Total	
Pastoral					
Low	360300		-1584326	-1224026	-114665
High	360300		-773443	-413143	-38703
Shires and CALM					
Low		4222188	-2901069	1321119	123761
High		8444375	-1297406	7146969	669519
Gnulli and CALM					
Low			-2901069	-2901069	-271769
High		4222188	-1297406	2924782	273990
CALM					
Low		4222188	-5505626	-1283439	-120231
High		8444375	-3901963	4542412	425528

Table 5.2 shows that revenues from camping activities do not fully subsidise the costs of management. However from year eleven onwards visitor revenues exceed management costs and there is an annual net benefit from camping and management operations (see appendix one, table 9.11, p. 184). Management costs are highest for the CALM sole management alternative. The total NPVs suggest that the high visitation scenarios for the co-management arrangements and sole management by CALM are the most economically desirable. The only low visitation scenario with a positive NPV is the Shires co-management arrangement. The expected annual returns show the expected annual benefit or cost at an eight percent discount rate. For detailed calculations see appendix two, p. 176.

5.3.2 Sensitivity Analysis

Sensitivity analysis was undertaken by changing parameters to reflect an optimistic and pessimistic scenario (see section 4.2.3.5, p. 76) and by changing the discount rate separately.

5.3.2.1 Optimistic Scenario

Table 5.3 Net Present Values and Expected Annual Returns for Alternatives Under an Optimistic Scenario (Eight Percent Discount Rate)

	Net Present Values				Expected Annual Return
	Pastoral	Wilderness Lodge	Camping and Management	Total	
Pastoral					
Low	709966		-1353625	-643659	-60297
High	709966		-542742	167224	15665
Shires and CALM					
Low		15044566	-2658900	12385666	1160274
High		30089132	-1055237	29033895	2719860
Gnulli and CALM					
Low			-2658900	-2658900	-249083
High		15044566	-1055237	13989329	1310503
CALM					
Low		15044566	-5263457	9781109	916282
High		30089132	-3659794	26429338	2475868

Table 5.3 presents the results for the optimistic scenario. The NPVs for two alternatives changed sign under the optimistic scenario; these were the pastoral high visitation scenario and the CALM sole management high visitation scenario. These two alternatives are economically desirable under the optimistic scenario, but not in the expected scenario (base model). The low visitation scenarios for the Pastoral and Gnulli and CALM co-management options remain economically undesirable. The net benefits from wilderness lodge tourism are significantly higher in the optimistic scenario, and these benefits contribute the major part of the differences between the NPVs for the expected (base model) and optimistic scenarios.

5.3.2.2 Pessimistic Scenario

Table 5.4 shows the results for the pessimistic scenario. Under this assumption the NPVs for all alternatives are negative. The net benefits from pastoral activities remain positive, but net benefits from wilderness lodge tourism are now negative. Under the pessimistic scenario, both pastoral options have the least negative NPVs.

Table 5.4 Net Present Values and Expected Annual Returns for Alternatives Under a Pessimistic Scenario (Eight Percent Discount Rate)

	Net Present Values				Expected Annual Return
	Pastoral	Wilderness Lodge	Camping and Management	Total	
Pastoral					
Low	210323		-1815027	-1604704	-150327
High	210323		-1004144	-793821	-74364
Shires and CALM					
Low		-1527232	-3143238	-4670470	-437524
High		-3054465	-1539575	-4594040	-430364
Gnulli and CALM					
Low			-3143238	-3143238	-294455
High		-1527232	-1539575	-3066807	-287295
CALM					
Low		-1527232	-5747795	-7275028	-681516
High		-3054465	-4144132	-7198597	-674356

5.3.2.3 Discount Rate

Table 5.5 presents the total NPVs at discount rates of six, eight and ten percent. For most of the alternatives the NPVs are higher (or less negative) at the six percent discount rate and lower at the ten percent discount rate as would be expected. There are two exceptions to this, the pastoral low visitation alternative and the Gnulli and CALM co-management low visitation alternative. The pastoral alternative has a less negative NPV at both the six and ten percent discount rates in comparison to eight percent. This is attributable to the profile of costs and benefits for the pastoral and camping operations. The Gnulli and CALM co-management alternative is more negative at a discount rate of six percent, and less negative at the ten percent rate. This is unusual but is again attributable to the profile of costs and benefits for camping operations. The costs of camping operations dominate the cost/benefit profile and these are more negative at lower discount rates.

Table 5.5 Total Net Present Values for Alternatives at Six, Eight and Ten Percent Discount Rates

	NPV 6 % discount rate	NPV 8 % discount rate	NPV 10 % discount rate
Pastoral			
Low	-1219767	-1224026	-1197881
High	-160676	-413143	-567380
Shires and CALM			
Low	3535381	1321119	-251951
High	12159538	7146969	3533849
Gnulli and CALM			
Low	-2972658	-2901069	-2802619
High	5651499	2924782	983181
CALM			
Low	834067	-1283439	-2765324
High	9458224	4542412	1020475

At a six percent discount rate the CALM sole management low visitation alternative has a positive NPV, in contrast to the negative NPV at eight and ten percent rates. The NPV for the Shires and CALM co-management low visitation alternative also changes sign at the ten percent discount rate, becoming negative. For both these alternatives the change in the NPV figure ranges from 1.5 – 2 million under the discount rates, and this is large enough to change the sign.

These results indicate sensitivity to the choice of discount rate. In particular the profile of costs and benefits for the camping operation has an unusual effect on the direction of change for the NPVs for the different discount rates.

5.4 ENVIRONMENTAL IMPACT ASSESSMENT

The results for the environmental impact assessment are presented in adapted Leopold matrices in section 5.4.4, p. 115-122. Key impacts presented in the Leopold matrices are discussed in sections 5.4.1 to 5.4. Table 5.6 provides a guide to the relevant tables for the Leopold matrices for each management alternative. Impacts that are the same for all alternatives are discussed in section 5.4.1 under the pastoral alternatives, and those that are the same for all alternatives other than pastoral are discussed in section 5.4.2 under the co-management alternatives.

Table 5.6 Guide to the Leopold Matrices Presented in the Text for Each Management Alternative.

Management Alternative	Visitation Scenario	Table in Text	Page Number
Pastoral	Low	5.7	115
	High	5.8	116
Shires and CALM Co-management	Low	5.9	117
	High	5.10	118
Gnulli and CALM Co-management	Low	5.11	119
	High	5.12	120
CALM sole management	Low	5.13	121
	High	5.14	122

5.4.1 Pastoral Alternatives

The adapted Leopold matrices for the pastoral alternatives are presented in tables 5.7 and 5.8. The construction of formal campsites and increase in camping numbers are both likely to have a negative impact on the wilderness qualities of the area (cells d30 and l30). The research has assessed the magnitude of this impact as low but of high importance, however wilderness is a subjective concept and thus difficult to assess. For the high visitation scenario, the impact of increased camping will be greater (cell l30, table 5.8). These two factors will also negatively impact on the cultural patterns of the current long-term camping community (cells d36 and l36), who value the unregulated camping opportunity.

The formalisation of campsites and subsequent landscaping could affect areas of aboriginal heritage (row 35), particularly if these sites are not formally registered. However this impact is likely to be mitigated by legislation requiring protection and full investigation of possible impacts on aboriginal heritage sites.

Dune revegetation activities will have a positive impact on dune erosion. Such activities would involve the fencing of fragile areas and possible reseeded. This impact is the same for all alternatives (cell i8, tables 5.7 to 5.14).

Increased snorkelling and scuba diving (associated with increased camping) and pleasure boating will impact on the coral reef (row 20, tables 5.7 to 5.14). Impacts include damage from boat anchors, trampling and breakage of coral by snorkellers. Studies by Hawkins and Roberts (1993, cited in Newsome *et al.*, 2001) and Allison (1996, cited in Newsome *et al.*, 2001) both showed positive correlation between snorkelling activity and coral breakage. This impact is assessed as being low negative but of high importance. Impacts could potentially be mitigated through visitor education. The impact of increased snorkelling and pleasure boating on the coral reef is the same across all alternatives.

There is the potential for human effluent to impact on underground and ocean water (column m, rows 4 – 6). However this is considered unlikely given the aridity of the area and low runoff, and the strict requirements in relevant planning documents. This potential threat is considered to be of equal magnitude and importance across all alternatives.

Continued grazing of the coastal strip will result in a low negative impact of moderate importance on native trees, shrubs, mammals below critical weight range and reptiles. Landsberg *et al.* (1997) present a review of relevant literature on the impacts of grazing on these components. The destocking of fragile dune areas will result in a medium positive impact on dune erosion for the pastoral alternatives (cell a8).

Continued goat control will have a small positive impact on dune erosion and vegetation. Although a fox control programme may not be carried out across the whole coastal strip, fox control will have a low positive impact on small mammals, reptiles and turtles. This positive impact is considered of high importance since these fauna groups contain a number of threatened species.

Currently firewood is collected on the coastal strip, though some stations require wood to come from further inland. It is difficult to control this practice and it is anticipated that it may continue for some time under the pastoral alternatives. Removal of dead vegetation is likely to have a negative impact on trees and shrubs, as live material can be mistaken for dead wood, particularly during a drought. This practice will also have a negative impact on birds, reptiles and small mammals (Newsome *et al.*, 2001). However this impact is recognised by

pastoral leaseholders and likely to be mitigated through visitor education and regulation (L. Horak, pers. comm., May, 2002).

Increased camping and visitation may have a negative impact on turtle breeding activity; this is considered of high importance given the value of the area as a turtle rookery. Impacts on turtles could include obstacles on the beach (e.g. wheel ruts, sand castles), light disturbance, touching, digging and moving around nests and even trampling of hatchlings. These impacts can lead to a reduction in successful nesting activity (Jacobsen and Lopez, 1994 cited in Newsome *et al.*, 2001). A higher level of visitation and camping is likely to have a greater negative impact. Mitigation of these impacts is likely through visitor education and regulation and control. This impact is the same for all alternatives, but differs between low and high visitation scenarios (cell I17).

5.4.2 Co-management Options

The adapted Leopold matrices for the Shires and CALM co-management alternative are presented in tables 5.9 and 5.10 and for the Gnulli Native Title Claimants and CALM co-management arrangement in tables 5.11 and 5.12.

Under all non-pastoral options, the rangeland will be destocked. This will have a medium positive impact on dune erosion, which is the same as for the pastoral alternatives, since dune areas would have already been destocked in the pastoral alternatives. It is also likely that destocking will have a small positive impact on vegetation, birds, small mammals and reptiles. There is little literature on the impacts of destocking on native vegetation, however a visual inspection of Cape Range appears to indicate a positive impact on these elements.

It is assumed that all non-pastoral options will have a more regular and thorough fox-baiting programme, and this is reflected in the positive moderate impact on small mammals and turtles (cells b15 and b17). In addition to the impacts from campsite construction and increases in camping, the slight upgrading of roads for the two co-management options will have a small negative impact on the wilderness qualities of the area.

The construction of wilderness lodges will have a medium negative impact on the wilderness qualities of the area and the cultural patterns of long-term campers (cells d30 and d36, tables 5.9, 5.10, 5.12). These lodges will provide a positive impact on employment and this could

be large for alternatives with two facilities (Shires and CALM co-management and CALM sole management, high visitation scenarios).

Associated with wilderness lodges will be the provision of water, presumed to come from groundwater supplies (column e). This could potentially impact on the underground water supply and depending on how closely the facility is to the Cape Range, on the Karst system and associated cave fauna. Although this is an important aspect, it is considered that any project that had a significant negative impact on groundwater resources would not pass EPA approval.

The assessments of environmental impact for the two co-management arrangements are very similar. The main difference arises from a lack of wilderness facilities in the low visitation scenario of the Gnulli and CALM co-management alternative. It is also assumed that the input of the Gnulli people will minimise risk to areas of aboriginal heritage significance (tables 5.11 and 5.12, row 35).

5.4.3 CALM Options

The adapted Leopold matrices for the CALM sole management alternatives are presented in tables 5.13 and 5.14. The significant differences in the impact profile of the CALM sole management alternatives relate to the hardening of road infrastructure. The hardening of roads to a level that will allow 2WD access will have a medium negative impact on the wilderness qualities of the area (cell c30), and this is considered to be of high importance. Hardening will also have a positive impact on the transportation system (cell c39).

5.4.4 The Adapted Leopold Matrices

Table 5.7 Impacts Associated With the Pastoral Management Alternative, Low Visitation Rate (Pastoral – Low)

NATURAL & HUMAN ENVIRONMENTAL ELEMENTS			PROJECT IMPACTS														
			a	b	c	d	e	f	g	h	i	j	k	l	m		
			Stocking/destocking of rangeland	Fox and Goat control	Roads and trails	Recreational structures	Well drilling and fluid removal	Firewood collection	Energy generation	Landscaping	Dune revegetation	Automobile	Pleasure boating	Camping	Sewerage treatment/placement		
A. Physical and chemical characteristics	1. Earth	1 Construction material															
		2 Landform				-1					-1						
	2. Water	3 Surface															
		4 Ocean															-1
		5 Underground															-1
	3. Processes	6 Quality															-1
		7 Floods															
		8 Dune erosion		2	1							2					
		9 Compaction and settling		-1									-1			-1	
B. Biological conditions	1. Flora	10 Trees		1				-1									
		11 Shrubs		-1	1			-1			1						-1
		12 Grass		-1	1							1	-1				-1
	2. Fauna	13 Birds		-1	1				-1								
		14 Mammals above CWR ¹		-2	1							1					
		15 Mammals within CWR ¹		-1	1					-1		1					
		16 Reptiles		-1	1					-1		1					
		17 Turtles			1							1				-1	
	3. Ecosystems	18 Fish and shellfish															-1
		19 Cave fauna															
		20 Coral reef														-1	-1
21 Karst system																	
C. Cultural factors	1. Landuse	22 Wilderness and open spaces				-1					-1						
		23 Grazing		1	1		-1							-1			
	2. Recreation	24 Fishing															-1
		25 Boating															-1
		26 Snorkelling & diving														-1	
	3. Aesthetics and human interest	27 Camping and hiking					1					1	1				-1
		28 Resorts															
		29 Scenic views and vistas						-1				-1	2				
		30 Wilderness qualities						-1				-1		-1			-1
		31 Open space qualities															
	4. Cultural status	32 Landscape design						1				1					
		33 Parks and reserves											1				-1
		34 Rare and unique species or ecosystems															-1
		35 Historical or archaeological sites and objects							-1				-1				
		36 Cultural patterns															-1
37 Health and Safety																-1	
38 Employment																	
39 Transportation network																-1	
5. Man-made facilities and utilities	40 Waste disposal														-1	1	

LEGEND		
MAGNITUDE	IMPORTANCE	POTENTIAL MITIGATION OF IMPACT
-3 Indicates a high negative impact	Low Importance	Low Importance
-2 Indicates a medium negative impact	Moderate Importance	Moderate Importance
-1 Indicates a low negative impact	High Importance	High Importance
3 Indicates a high positive impact		
2 Indicates a medium positive impact		

¹ CWR = Critical Weight Range, 35 - 5500 grams.

Table 5.8 Impacts Associated with the Pastoral Management Alternative, High Visitation Rate (Pastoral – High)

NATURAL & HUMAN ENVIRONMENTAL ELEMENTS		PROJECT IMPACTS		a	b	c	d	e	f	g	h	i	j	k	l	m		
				Stocking/destocking of rangeland	Fox and Goat control	Roads and trails	Recreational structures	Well drilling and fluid removal	Firewood collection	Energy generation	Landscaping	Dune revegetation	Automobile	Pleasure boating	Camping	Sewerage treatment/placement		
A. Physical and chemical characteristics	1. Earth	1 Construction material																
		2 Landform																
	2. Water	3 Surface																
		4 Ocean																
		5 Underground																
		6 Quality																
	3. Processes	7 Floods																
		8 Dune erosion																
		9 Compaction and settling																
	1. Flora	10 Trees																
	11 Shrubs																	
	12 Grass																	
	13 Birds																	
B. Biological conditions	2. Fauna	14 Mammals above CWR ¹																
		15 Mammals within CWR ¹																
		16 Reptiles																
		17 Turtles																
		18 Fish and shellfish																
		19 Cave fauna																
	3. Ecosystems	20 Coral reef																
		21 Karst system																
	1. Landuse	22 Wilderness and open spaces																
	2. Recreation	23 Grazing																
	24 Fishing																	
	25 Boating																	
	26 Snorkelling & diving																	
	27 Camping and hiking																	
	28 Resorts																	
C. Cultural factors	3. Aesthetics and human interest	29 Scenic views and vistas																
		30 Wilderness qualities																
		31 Open space qualities																
		32 Landscape design																
		33 Parks and reserves																
		34 Rare and unique species or ecosystems																
		35 Historical or archaeological sites and objects																
	4. Cultural status	36 Cultural patterns																
		37 Health and Safety																
		38 Employment																
5. Man-made facilities and utilities	39 Transportation network																	
	40 Waste disposal																	

LEGEND		
MAGNITUDE	IMPORTANCE	POTENTIAL MITIGATION OF IMPACT
- 3 Indicates a high negative impact	Low Importance	Low Importance
- 2 Indicates a medium negative impact	Moderate Importance	Moderate Importance
- 1 Indicates a low negative impact	High Importance	High Importance
3 Indicates a high positive impact		
2 Indicates a medium positive impact		
1 Indicates a low positive impact		

¹ CWR = Critical Weight Range, 35 – 5500 grams

Table 5.9 Impacts Associated with the Co-management Alternative between the Shires and CALM, Low Visitation Rate (Shires – Low)

NATURAL & HUMAN ENVIRONMENTAL ELEMENTS		PROJECT IMPACTS													
		a	b	c	d	e	f	g	h	i	j	k	l	m	
		Stocking/destocking of rangeland	Fox and Goat control	Roads and trails	Recreational structures	Well drilling and fluid removal	Firewood collection	Energy generation	Landscaping	Dune revegetation	Automobile	Pleasure boating	Camping	Sewerage treatment/placement	
A. Physical and chemical characteristics	1. Earth	1 Construction material			-1	-1				-1					
		2 Landform				-1				-1					
	2. Water	3 Surface													
		4 Ocean													-1
		5 Underground							-1						-1
	3. Processes	6 Quality													-1
		7 Floods													
		8 Dune erosion		2	1						2				
		9 Compaction and settling	1									-1		-1	
B. Biological conditions	1. Flora	10 Trees		1		-1									
		11 Shrubs	1	1	-1	-1				1				-1	
		12 Grass	1	1	-1	-1				1				-1	
	2. Fauna	13 Birds	1	1											
		14 Mammals above CWR ¹	1	1						1					
		15 Mammals within CWR ¹	1	2						1					
		16 Reptiles	1	1						1					
		17 Turtles		2						1				1	
		18 Fish and shellfish													-1
		19 Cave fauna						-1							
3. Ecosystems	20 Coral reef											-1	-1		
	21 Karst system						-1								
C. Cultural factors	1. Landuse	22 Wilderness and open spaces				-1			-1						
		23 Grazing													
		24 Fishing													-1
	2. Recreation	25 Boating													-1
		26 Snorkelling & diving												-1	
	3. Aesthetics and human interest	27 Camping and hiking			1	1				1	1				-1
		28 Resorts			1	1	1			1	2				-1
		29 Scenic views and vistas					-1				-1	2			
		30 Wilderness qualities			-1	-2					-1		-1		-1
		31 Open space qualities													
		32 Landscape design					1			1					
		33 Parks and reserves		1	1	1					1				-1
	4. Cultural status	34 Rare and unique species or ecosystems													-1
		35 Historical or archaeological sites and objects					-1			-1					
		36 Cultural patterns	-1				-2								-1
		37 Health and Safety													-1
38 Employment						2									
5. Man-made facilities and utilities		39 Transportation network			1	1							-1		
		40 Waste disposal													-1

LEGEND		
MAGNITUDE	IMPORTANCE	POTENTIAL MITIGATION OF IMPACT
- 3 Indicates a high negative impact	Low Importance	Low Importance
- 2 Indicates a medium negative impact	Moderate Importance	Moderate Importance
- 1 Indicates a low negative impact	High Importance	High Importance
3 Indicates a high positive impact		
2 Indicates a medium positive impact		
1 Indicates a low positive impact		

¹ CWR = Critical Weight Range, 35 – 5500 grams

Table 5.10 Impacts Associated with the Co-management Alternative between the Shires and CALM, High Visitation Rate (Shires – High)

NATURAL & HUMAN ENVIRONMENTAL ELEMENTS		PROJECT IMPACTS		a	b	c	d	e	f	g	h	i	j	k	l	m
				Stocking/destocking of rangeland	Fox and Goat control	Roads and trails	Recreational structures	Well drilling and fluid removal	Firewood collection	Energy generation	Landscaping	Dune revegetation	Automobile	Pleasure boating	Camping	Sewerage treatment/placement
A. Physical and chemical characteristics	1. Earth	1 Construction material				-1	-1				-1					
		2 Landform					-1				-1					
	2. Water	3 Surface														
		4 Ocean														
		5 Underground						-2								-1
		6 Quality														-1
		7 Floods														-1
	3. Processes	8 Dune erosion		2	1							2				
		9 Compaction and settling		1										-1	-1	
B. Biological conditions	1. Flora	10 Trees		1	1		-1									
		11 Shrubs		1	1	-1	-1				1				-1	
		12 Grass		1	1	-1	-1				1				-1	
	2. Fauna	13 Birds		1	1											
		14 Mammals above CWR ¹		1	1						1					
		15 Mammals within CWR ¹		1	2						1					
		16 Reptiles		1	1						1					
		17 Turtles			2							1				-2
		18 Fish and shellfish														-1
	3. Ecosystems	19 Cave fauna						-1							-1	-1
		20 Coral reef													-1	-1
C. Cultural factors	1. Landuse	21 Karst system					-1									
		22 Wilderness and open spaces					-1				-1					
	2. Recreation	23 Grazing														
		24 Fishing														-1
		25 Boating														-1
		26 Snorkelling & diving													-1	
		27 Camping and hiking				1	1				1	1				-2
		28 Resorts				1	1				1	2				
	3. Aesthetics and human interest	29 Scenic views and vistas					-1				-1	2				-2
		30 Wilderness qualities					-1	-2			-1	-1				-2
		31 Open space qualities														
		32 Landscape design									1					
		33 Parks and reserves				1	1	1					1			-1
		34 Rare and unique species or ecosystems														-1
	4. Cultural status	35 Historical or archaeological sites and objects						-1				-1				
		36 Cultural patterns						-2								-2
		37 Health and Safety														-1
	38 Employment															
5. Man-made facilities and utilities	39 Transportation network														-1	
	40 Waste disposal														-2	1

LEGEND		
MAGNITUDE	-3	Indicates a high negative impact
	-2	Indicates a medium negative impact
	-1	Indicates a low negative impact
	3	Indicates a high positive impact
	2	Indicates a medium positive impact
1	Indicates a low positive impact	
IMPORTANCE	Low Importance	
	Moderate Importance	
	High Importance	
POTENTIAL MITIGATION OF IMPACT	Low Importance	
	Moderate Importance	
	High Importance	

¹ CWR = Critical Weight Range, 35 – 5500 grams

Table 5.11 Impacts Associated with the Co-management Alternative between the Gnulli Native Title Claimants and CALM, Low Visitation Rate (Gnulli – Low)

NATURAL & HUMAN ENVIRONMENTAL ELEMENTS		PROJECT IMPACTS													
		a	b	c	d	e	f	g	h	i	j	k	l	m	
		Stocking/deslocking of rangeland	Fox and Goat control	Roads and trails	Recreational structures	Well drilling and fluid removal	Firewood collection	Energy generation	Landscaping	Dune revegetation	Automobile	Pleasure boating	Camping	Sewerage treatment/placement	
A. Physical and chemical characteristics	1. Earth	1 Construction material													
		2 Landform													
	2. Water	3 Surface													
		4 Ocean													
		5 Underground													-1
	3. Processes	6 Quality													-1
		7 Floods													-1
		8 Dune erosion													-1
		9 Compaction and settling													-1
B. Biological conditions	1. Flora	10 Trees													
		11 Shrubs													
		12 Grass													
	2. Fauna	13 Birds													
		14 Mammals above CWR ¹													
		15 Mammals within CWR ¹													
		16 Reptiles													
		17 Turtles													-1
		18 Fish and shellfish													-1
		19 Cave fauna													
3. Ecosystems	20 Coral reef													-1	
C. Cultural factors	1. Landuse	21 Karst system													
		22 Wilderness and open spaces													
	2. Recreation	23 Grazing													
		24 Fishing													-1
		25 Boating													-1
		26 Snorkelling & diving													-1
	3. Aesthetics and human interest	27 Camping and hiking													-1
		28 Resorts													-1
		29 Scenic views and vistas													-1
		30 Wilderness qualities													-1
		31 Open space qualities													-1
		32 Landscape design													-1
		33 Parks and reserves													-1
		34 Rare and unique species or ecosystems													-1
	4. Cultural status	35 Historical or archaeological sites and objects													-1
		36 Cultural patterns													-1
37 Health and Safety														-1	
5. Man-made facilities and utilities	38 Employment													-1	
	39 Transportation network													-1	
	40 Waste disposal													-1	

LEGEND		
MAGNITUDE	IMPORTANCE	POTENTIAL MITIGATION OF IMPACT
-3 Indicates a high negative impact	Low Importance	Low Importance
-2 Indicates a medium negative impact	Moderate Importance	Moderate Importance
-1 Indicates a low negative impact	High Importance	High Importance
3 Indicates a high positive impact		
2 Indicates a medium positive impact		
1 Indicates a low positive impact		

¹ CWR = Critical Weight Range, 35 – 5500 grams

Table 5.12 Impacts Associated with the Co-management Alternative between the Gnulli Native Title Claimants and CALM, High Visitation Rate (Gnulli – High)

NATURAL & HUMAN ENVIRONMENTAL ELEMENTS		PROJECT IMPACTS													
		a	b	c	d	e	f	g	h	i	j	k	l	m	
		Stocking/destocking of rangeland	Fox and Goat control	Roads and trails	Recreational structures	Well drilling and fluid removal	Firewood collection	Energy generation	Landscaping	Dune revegetation	Automobile	Pleasure boating	Camping	Sewerage treatment/placement	
A. Physical and chemical characteristics	1. Earth	1 Construction material													
		2 Landform													
	2. Water	3 Surface													
		4 Ocean													
		5 Underground													
	3. Processes	6 Quality													
		7 Floods													
		8 Dune erosion													
		9 Compaction and settling													
B. Biological conditions	1. Flora	10 Trees													
		11 Shrubs													
		12 Grass													
	2. Fauna	13 Birds													
		14 Mammals above CWR ¹													
		15 Mammals within CWR ¹													
		16 Reptiles													
		17 Turtles													
		18 Fish and shellfish													
	3. Ecosystems	19 Cave fauna													
		20 Coral reef													
		21 Karst system													
	C. Cultural factors	1. Landuse	22 Wilderness and open spaces												
			23 Grazing												
			24 Fishing												
		2. Recreation	25 Boating												
			26 Snorkelling & diving												
			27 Camping and hiking												
3. Aesthetics and human interest		28 Resorts													
		29 Scenic views and vistas													
		30 Wilderness qualities													
		31 Open space qualities													
		32 Landscape design													
		33 Parks and reserves													
		34 Rare and unique species or ecosystems													
4. Cultural status		35 Historical or archaeological sites and objects													
		36 Cultural patterns													
5. Man-made facilities and utilities	37 Health and Safety														
	38 Employment														
	39 Transportation network														
	40 Waste disposal														

LEGEND		
MAGNITUDE	-3	Indicates a high negative impact
	-2	Indicates a medium negative impact
	-1	Indicates a low negative impact
POTENTIAL MITIGATION OF IMPACT	Low Importance	
	Moderate Importance	
	High Importance	
MAGNITUDE	3	Indicates a high positive impact
	2	Indicates a medium positive impact
	1	Indicates a low positive impact

¹ CWR = Critical Weight Range, 35 – 5500 grams

Table 5.13 Impacts Associated with the CALM Sole Management Alternative, Low Visitation Rate (CALM – Low)

NATURAL & HUMAN ENVIRONMENTAL ELEMENTS		PROJECT IMPACTS	a	b	c	d	e	f	g	h	i	j	k	l	m		
			Stocking/destocking of rangeland	Fox and Goat control	Roads and trails	Recreational structures	Well drilling and fluid removal	Firewood collection	Energy generation	Landscaping	Dune revegetation	Automobile	Pleasure boating	Camping	Sewerage treatment/placement		
A. Physical and chemical characteristics	1. Earth	1 Construction material			-1	-1				-1							
		2 Landform															
	2. Water	3 Surface															
		4 Ocean														-1	
		5 Underground														-1	
	3. Processes	6 Quality														-1	
		7 Floods															
		8 Erosion			2	1						2					
		9 Compaction and settling		1									-1		-1		
B. Biological conditions	1. Flora	10 Trees			1												
		11 Shrubs		1	1				1	1					-1		
		12 Grass		1	1						1				-1		
	2. Fauna	13 Birds		1	1												
		14 Mammals above CWR ¹		1	1							1					
		15 Mammals within CWR ¹		1	2							1					
		16 Reptiles		1	1							1					
		17 Turtles			2							1			-1		
		18 Fish and shellfish														-1	
		19 Cave fauna															
	3. Ecosystems	20 Coral reef												-1	-1		
		21 Karst system															
	C. Cultural factors	1. Landuse	22 Wilderness and open spaces				-1				-1						
			23 Grazing				-1										
		2. Recreation	24 Fishing														-1
			25 Boating														-1
			26 Snorkelling & diving														-1
			27 Camping and hiking			1	1					1	1				-1
		3. Aesthetics and human interest	28 Resorts			1						2					-1
29 Scenic views and vistas						-1					-1	2				-1	
30 Wilderness qualities					-1	-1					-1		-1			-1	
31 Open space qualities																	
32 Landscape design						1					1						
33 Parks and reserves				1	1							1				-1	
34 Rare and unique species or ecosystems																-1	
4. Cultural status		35 Historical or archaeological sites and objects														-1	
		36 Cultural patterns		-1												-1	
		37 Health and Safety														-1	
5. Man-made facilities and utilities	38 Employment				1												
	39 Transportation network			1										-1			
	40 Waste disposal				1									-1	1		

LEGEND		
MAGNITUDE	IMPORTANCE	POTENTIAL MITIGATION OF IMPACT
- 3 Indicates a high negative impact	Low Importance	Low Importance
- 2 Indicates a medium negative impact	Moderate Importance	Moderate Importance
- 1 Indicates a low negative impact	High Importance	High Importance
3 Indicates a high positive impact		
2 Indicates a medium positive impact		
1 Indicates a low positive impact		

¹ CWR = Critical Weight Range, 35 – 5500 grams

Table 5.14 Impacts Associated with the CALM Sole Management Alternative, High Visitation Rate (CALM – High)

NATURAL & HUMAN ENVIRONMENTAL ELEMENTS		PROJECT IMPACTS	a	b	c	d	e	f	g	h	i	j	k	l	m	
			Stocking/destocking of rangeland	Fox and goat control	Roads and trails	Recreational structures	Well drilling and fluid removal	Firewood collection	Energy generation	Landscaping	Dune revegetation	Automobile	Pleasure boating	Camping	Sewerage treatment/placement	
A. Physical and chemical characteristics	1. Earth	1 Construction material			-2	-1					-1					
		2 Landform				-1				-1						
	2. Water	3 Surface														
		4 Ocean														-1
		5 Underground					-2									-1
	6 Quality														-1	
	3. Processes	7 Floods														
B. Biological conditions	1. Flora	8 Dune erosion	1	1							2					
		9 Compaction and settling	1									-1		-1		
		10 Trees		1		-1				1	1					-1
	2. Fauna	11 Shrubs	1	1	-1	-1				1	1					-1
		12 Grass	1	1	-1	-1					1					-1
		13 Birds	1	1												
	3. Ecosystems	14 Mammals above CWR ¹	1	1												
		15 Mammals within CWR ¹	1	2							1					
		16 Reptiles	1	1							1					
		17 Turtles		2							1					-2
		18 Fish and shellfish														-1
		19 Cave fauna					-1									
		20 Coral reef													-1	-1
C. Cultural factors	1. Landuse	21 Karst system					-1									
		22 Wilderness and open spaces				-1				-1						
	2. Recreation	23 Grazing														
		24 Fishing														-1
		25 Boating			1											-1
		26 Snorkelling & diving														-1
	3. Aesthetics and human interest	27 Camping and hiking			1	1					1	1				-2
		28 Resorts			1	1				1	2					
		29 Scenic views and vistas					-1				-1	2				
		30 Wilderness qualities					-2	-1				-1				-2
		31 Open space qualities														
		32 Landscape design					1				1					
	4. Cultural status	33 Parks and reserves		1	1	1						1				-1
		34 Rare and unique species or ecosystems														-1
		35 Historical or archaeological sites and objects					-1				-1					
		36 Cultural patterns	-1				-2									-2
37 Health and Safety															-1	
5. Man-made facilities and utilities	38 Employment					3										
	39 Transportation network			2	-1								-1			
	40 Waste disposal					1									-2 1	

LEGEND		
MAGNITUDE	IMPORTANCE	POTENTIAL MITIGATION OF IMPACT
- 3 Indicates a high negative impact	Low Importance	Low importance
- 2 Indicates a medium negative impact	Moderate Importance	Moderate importance
- 1 Indicates a low negative impact	High Importance	High importance
3 Indicates a high positive impact		
2 Indicates a medium positive impact		
1 Indicates a low positive impact		

¹ CWR = Critical Weight Range, 35 – 5500 grams

5.5 ANALYSIS OF SCORES IN THE PERFORMANCE MATRIX

This section provides information on the scoring of the attributes for the performance matrix presented in section 5.6.1, p. 131. This includes how the results of the individual assessment techniques (EIA and CBA) were incorporated into scores for the environmental and economic attributes. For social and institutional attributes, the details of the actual scores and assumptions are provided.

5.5.1 Environmental Attributes

Scores for the environmental attributes were developed from the EIA and adapted Leopold matrices. Physical and biological elements were considered, and these related to the first 21 rows of the adapted Leopold matrix. Elements were considered for inclusion as attributes in the MCA where impacts were rated as being of moderate or high importance. Impacts of low importance were not included. Where mitigation was likely, the impact was not included in the MCA, regardless of the importance rating of the impact. There were two exceptions to this and these related to the attributes of turtles and the coral reef. These were still included despite the likelihood of impacts being mitigated, due to the very high importance of these elements for the region.

Feral animals were included as an attribute and this attribute refers to fox and goat numbers and the impact on these of pest control programmes. The impacts of foxes and goats on flora, fauna and dune erosion (column b in the Leopold matrix) were therefore not included in the other attributes, since this would entail double counting. For pastoral alternatives, the impact on feral animals of pest control was considered to be low and positive, while for non-pastoral alternatives it was slightly higher to reflect the increased fox control programme.

The attribute for the coral reef refers to the impact of increases in camping and pleasure boating. Although this impact is likely to be mitigated it was still included due to the very high importance of the coral reef (cells k20 and l20 in the adapted Leopold matrix). The dune erosion attribute assesses the impact of destocking dune areas and revegetation programmes (cells a8 and i8), which were both considered to be a medium positive impact across all alternatives. Native vegetation assesses the impact on shrubs and grasses of destocking the rangeland (cells a11 and a12). Although other activities impact on these elements, they are of low importance and therefore were not included. Since the impact of

destocking was assessed as the same for these two elements they were aggregated into a single attribute.

Two fauna groups were included as attributes. The first related to the impacts of increased camping on turtles (cell l17). Although this impact is likely to be mitigated, it was included because of the importance of the area as a turtle rookery and the endangered status of sea turtles. Foxes have a large impact on turtles, however this impact was already included in the feral animals attribute so was not included here. Mammals within the critical weight range, reptiles and birds were aggregated for the other fauna attribute. This attribute measures the impact of destocking on these elements (cells a13, a15, a16). Again foxes have an impact on these faunal groups, but this was already accounted for in the feral animals attribute. The impacts on mammals above the critical weight range (such as kangaroos) were considered to be of low importance so they were not included.

5.5.2 Economic Attributes

The total costs and benefits attribute was scored using the results of the CBA (see section 5.3.1, table 5.2) in the form of expected annual returns. The calculations and figures for the tourism expenditure are presented in appendix one, p. 172. The scores for the tourism expenditure attribute are also in annual form.

5.5.3 Social Attributes

5.5.3.1 Range of Recreational Opportunities

This attribute was assessed using an index of recreational opportunity, which included a range of activities and types of accommodation as detailed in chapter four (see section 4.2.5.3.4, p.92). The recreational index in table 5.15 presents the scores for each alternative based on the presence of the activities and accommodation. All activities are present for all of the alternatives. The accommodation type “no time restrictions on camping” is present only for the two pastoral alternatives. Under the non-pastoral options there would be restrictions on the length of stay and these would follow the current restrictions on CALM managed land. Campsites with 2WD access are only present under the CALM sole management alternatives. Wilderness lodge accommodation is not present for the two pastoral alternatives and the Gnulli and CALM co-management alternative with low visitation.

The index was scored with a one if the activity or accommodation type was present, or zero otherwise. These were summed to provide a total for activities and accommodation respectively, which were then summed to provide a total score (out of a maximum of 18). These total scores were then scaled to fit the range of zero to three, which is the measurement scale used in the performance matrix. There is very little differentiation between the total scores, and none when these scores are scaled.

Table 5.15 Scores for the Index of Recreational Opportunity

		Alternatives							
		Pastoral		Shires		Gnulli		CALM	
		L ²	H ²	L	H	L	H	L	H
Activities	Snorkelling and Swimming								
	Scuba								
	Walking								
	Fishing – boat								
	Fishing – shore								
	Windsurfing								
	Surfing								
	Wildlife viewing								
	Organised tours								
	Total for activities	9	9	9	9	9	9	9	9
Accommodation	No time restrictions on camping								
	Campsites with facilities								
	Campsites without facilities								
	Campsites with 4WD access only								
	Campsites with general 2WD access								
	Camping with foot access only								
	Caravan Park								
	Station accommodation								
	Wilderness Lodge Accommodation								
	Total for accommodation	7	7	7	7	6	7	8	8
	Total (accommodation and activities)	16	16	16	16	15	16	17	17
	Scaled Score¹	3	3	3	3	3	3	3	3
Legend									
Activity/accommodation present = 1					Activity/accommodation not present = 0				

¹ Scaled score: 0 = 0-4, 1 = 5-9, 2 = 10-14, 3 = 15-1

² L = Low visitation; H = High visitation

5.5.3.2 Involvement of the Aboriginal Community in Planning and Management of the Ningaloo Coastal Strip

This attribute was assessed using a Likert scale as detailed in chapter four (see section 4.2.5.3.5, p. 94). Table 5.16 presents the scores for the management alternatives. The Shires and CALM co-management and CALM sole management alternatives were assessed as

having a nominal level of involvement of the Aboriginal community, and this is likely to be in the form of consultation. Since the pastoral option involves the Aboriginal community at Cardabia in the planning and management of the coastal strip, this alternative was assessed as having a higher level of involvement. The co-management alternative between the Gnulli Native Title Claimants and CALM was assessed as comprehensively involving the Aboriginal community as this would involve the Gnulli people in the planning and management of the coastal strip.

Table 5.16 Scores for the Involvement of the Aboriginal Community in Planning and Management of the Ningaloo Coastal Strip

Pastoral		Shires and CALM		Gnulli and CALM		CALM	
Low	High	Low	High	Low	High	Low	High
3	3	2	2	4	4	2	2

5.5.4 Institutional Attributes

5.5.4.1 Capacity to Achieve Positive Environmental Outcomes in the Medium-Long Term, for the Terrestrial Ecosystem

Table 5.17 Scores for the Capacity to Achieve Positive Environmental Outcomes in the Medium-Long Term, for the Terrestrial Ecosystem

	Max Score	Scores for Alternatives			
		Pastoral H ² and L ²	Shires H and L	Gnulli H and L	CALM H and L
Range of expertise					
Pastoral expertise	2	2	0	0	0
Conservation expertise	2	1	1	1	2
Recreation expertise	2	1	2	1	2
Traditional knowledge	2	1	0	2	0
Sub-total	8	5	3	4	4
Access to sustainable funding	8	4	8	8	8
Sustainable management structures	8	8	4	4	8
Total	24	17	15	16	20
Scaled score¹	3	2	2	2	3

¹ Scaled scores: 0 = 0–5, 1 = 6–11, 2 = 12–17, 3 = 18–24

² H = High visitation; L = Low visitation

The pastoral management alternative was considered to be the only alternative with the presence of pastoral expertise. The CALM sole management alternative was considered to have a high level of conservation expertise, while all other alternatives have a lower level of conservation expertise. All alternatives have some level of recreation expertise, however this was considered to be higher for the Shires and CALM co-management alternative and the CALM sole management alternative, since these organisations are directly involved in managing the provision of recreation facilities in nearby areas. The pastoral management and Gnulli and CALM co-management alternatives were considered to have some level of traditional knowledge expertise. For the pastoral alternative this occurs through the owners of Cardabia station, however this was considered slightly lower than for the Gnulli co-management option, which would likely involve more of the Aboriginal community.

Access to sustainable funding was considered to be high for all alternatives that involve CALM (this assumes that sufficient funds would be directed to the area). The pastoral alternatives were presumed to have less access to sustainable funding and likely to be reliant on state and national government grants.

The pastoral and CALM alternatives were considered to have sustainable management structures. For the pastoral alternative, NROCA appears to have a high level of commitment amongst members. Both co-management alternatives were considered to have less sustainable structures, the Shires alternative due to the difficulties involved with working with the two Shires and the Gnulli alternative since this group currently appears to lack a suitable management framework (though this may occur in the future with the settlement of native title claims).

5.5.4.2 Capacity to Achieve Positive Environmental Outcomes in the Medium-Long Term, for the Marine Ecosystem

The pastoral alternative was considered to lack the presence of marine conservation expertise, whilst those alternatives that involve CALM have a higher level. CALM has a high level of marine recreation management expertise as it currently manages the Ningaloo Marine Park. Other alternatives were assessed as having a lower level of recreation expertise. The pastoral alternative has some expertise in marine recreation management through the leaseholders experience in managing the behaviour of campers. The level of traditional knowledge expertise for each alternative is the same as for the terrestrial ecosystem.

Table 5.18 Scores for the Capacity to Achieve Positive Environmental Outcomes in the Medium-Long Term, for the Marine Ecosystem

	Scores for Alternatives				
	Max Score	Pastoral H ² and L ²	Shires H and L	Gnulli H and L	CALM H and L
Range of expertise					
Conservation expertise	2	0	1	1	2
Recreation expertise	2	1	1	1	2
Traditional knowledge	2	1	0	2	0
Sub-total	6	2	2	4	4
Contribution of funding to Marine Park	6	0	3	3	6
Sustainable management structures for marine management	6	0	3	3	6
Total	18	2	8	10	16
Scaled score¹	3	0	1	2	3

¹ Scaled scores: 0 = 0–3, 1 = 4–8, 2 = 9–13, 3 = 14–18

² H = High visitation; L = Low visitation

It was considered that under the CALM management option a significant portion of funds would be directed to the management of the Marine Park, and this would occur at a lower level for alternatives that involve co-management with CALM. It was assessed as unlikely that the pastoral alternative would contribute funds to the management of the Marine Park.

The pastoral alternative was assessed as lacking the presence of a sustainable structure for marine management. The other alternatives were considered to have sustainable structures for marine management, with the sole CALM management alternative having the most sustainable structures since it currently manages Cape Range National Park in conjunction with the Marine Park.

5.5.4.3 Involvement of Stakeholder Groups in Planning and Management of the Ningaloo Coastal Strip

This attribute was assessed using a Likert scale as detailed in chapter four (see section 4.2.5.3.7, p. 95). Table 5.19 shows the scores for the management alternatives. The pastoral alternative was assessed as having a high level of involvement of stakeholders in planning and management. This arrangement would involve the pastoral leaseholders, long-term campers, and some of the Aboriginal community. Both co-management alternatives were considered to have a nominal level of involvement of stakeholder groups. The Shires alternative would

allow some involvement of the local community and the Gnulli alternative would involve the Aboriginal community. The CALM sole management alternative was assessed as having a low level of stakeholder involvement in planning and management; such involvement would likely be in the form of consultation.

Table 5.19 Scores for the Involvement of Stakeholder groups in Planning and Management of the Ningaloo Coastal Strip

Pastoral		Shires and CALM		Gnulli and CALM		CALM	
Low	High	Low	High	Low	High	Low	High
3	3	2	2	2	2	1	1

5.6 INTEGRATED ASSESSMENT

In this section the results of the MCA are presented. Firstly, the scores (as detailed in the previous section) for the attributes are presented in a performance matrix. These provide the raw data for the MCA model. The results of the MCA using the TopDec software and an environmental and then equal weight set are presented. Following this, the results of the sensitivity analysis are presented, which include the sensitivity to the weighting method, weight set and scores.

5.6.1 Performance Matrix

The scores for the MCA attributes are presented in the performance matrix in table 5.20, p. 131. These scores are for the base model and reflect an expected scenario. The scores for environmental attributes are similar for most alternatives, particularly for dune erosion and impact on the coral reef. For dune erosion, this reflects the assumption that dune revegetation programmes and destocking of fragile dune areas will be undertaken for all alternatives. The impact on the coral reef is slightly negative, and reflects the impact of increased visitation (snorkelling and boating).

The impact of visitation on turtles differs according to the visitation scenario; high visitation scenarios have a greater negative impact. Overall the environmental the scores for the environmental attributes are lower for the pastoral alternatives. This is mainly attributable to the continued stocking of the rangeland and the less regular fox control programme.

The attribute that reflects the results of the CBA shows that some alternatives have negative annual returns. These include both pastoral options and the low visitation scenarios for Gnulli co-management and CALM sole management alternatives. The Shires option is the only alternative that has a positive return for both visitation scenarios; this reflects the economic orientation of this alternative.

The scores for the range of recreational opportunities attribute are the same for all alternatives. Although there were small differences in the range of accommodation present, these are not reflected in the scaled score. The pastoral alternative performs relatively well against the attributes of involvement of Aboriginal community and local affected parties, as does the Gnulli co-management option. There is considerable variation in the scores for the marine institutional capacity attribute. These range from zero for pastoral alternatives to three for the CALM sole management option.

Table 5.20

Performance Matrix for the Ningaloo Coastal Region

EFFECTS OF LAND USE AND MANAGEMENT SCENARIOS ON NINGALOO COASTAL REGION											
Module	Assessment Tool	Attribute	Measurement Scale	Scores for Alternative Options							
				Pastoral		Shires and CALM		Gnulli and CALM		CALM	
				Low	High	Low	High	Low	High	Low	High
Environment	EIA	Coral Reef	-3 to 0	-1	-1	-1	-1	-1	-1	-1	-1
		Dune erosion	-3 to 3	2	2	2	2	2	2	2	2
		Native vegetation –shrubs and grasses	-3 to 3	-1	-1	1	1	1	1	1	1
		Native fauna - turtles	-3 to 3	-1	-2	-1	-2	-1	-2	-1	-2
		Native fauna – mammals within CWR, reptiles and birds	-3 to 3	-1	-1	1	1	1	1	1	1
		Feral animals	-3 to 3	1	1	2	2	2	2	2	2
Economic	CBA	Total costs and benefits of project	\$ (annually)	- 114 665	- 38 703	123 761	669 519	-271 769	273 990	-120 231	425 528
		Tourist expenditure in regional economy	\$ (annually)	2 958 938	3 350 078	3 056 213	3 989 617	3 056 213	3 989 617	3 056 213	3 989 617
Social	Recreational index	Range of recreational opportunities	0 to 3	3	3	3	3	3	3	3	3
	Likert scale	Level of involvement of Aboriginal community	0 to 4	3	3	2	2	4	4	2	2
Institutional	Institutional index	Capacity to achieve positive environmental outcome for terrestrial ecosystem	0 to 3	2	2	2	2	2	2	3	3
	Institutional index	Capacity to achieve positive environmental outcome for marine ecosystem	0 to 3	0	0	1	1	2	2	3	3
	Likert scale	Level of involvement of local affected parties	0 to 4	3	3	2	2	2	2	1	1

5.6.2 MCA Results – Environmental Weighting

The analysis of stakeholder objectives (see section 5.2, p. 104) shows considerable consistency amongst environmental objectives, and illustrates the importance of environmental objectives for nearly all stakeholder groups. This is reflected in the environmental weight set, where environmental attributes are given higher weights and all other attributes are given lesser, equal weights, as shown in table 5.21. Figure 5.1 illustrates the final ranking of alternatives using an environmental weight set and the rating method. The most preferred option is co-management between Gnulli Native Title Claimants and CALM, low visitation scenario. The next preferred management option is sole management by CALM. Low visitation scenarios are ranked higher than high visitation scenarios because the former perform better on the higher weighted environmental attributes. The pastoral options are ranked the lowest of the management alternatives. As figure 5.1 shows, there is minimal difference between the co-management option and sole management by CALM.

Figure 5.1 Ranking of Alternatives using the TopDec Software Rating Method and an Environmental Weighting (L = Low Visitation, H = High Visitation)

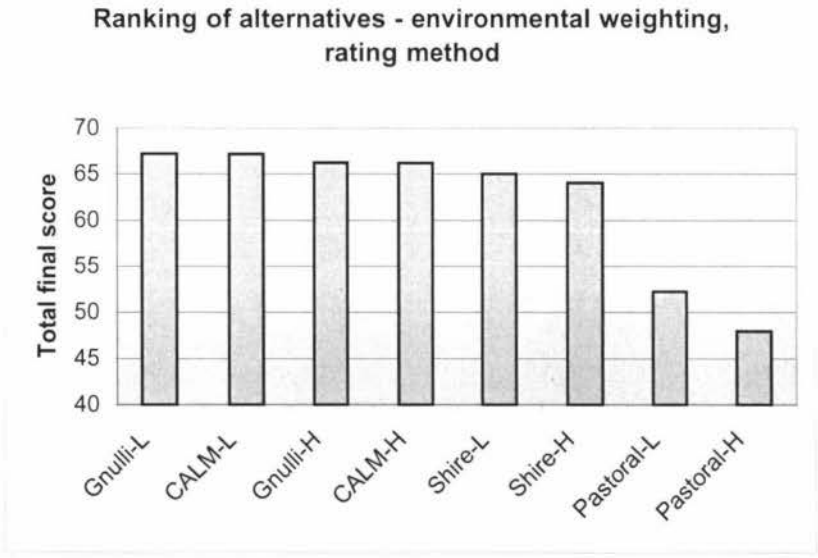


Table 5.21 Ranking of Alternatives using the TopDec Software Rating Method and an Environmental Weighting

Attribute	Relative Weight	Weighted Final Scores for Alternatives using TopDec Software							
		Pastoral		Shires and CALM		Gnulli and CALM		CALM	
		Low	High	Low	High	Low	High	Low	High
Coral reef	10.53	-10.53	-10.53	-10.53	-10.53	-10.53	-10.53	-10.53	-10.53
Dune erosion	10.53	10.53	10.53	10.53	10.53	10.53	10.53	10.53	10.53
Native vegetation	10.53	5.26	5.26	10.53	10.53	10.53	10.53	10.53	10.53
Turtles	10.53	10.53	5.26	10.53	5.26	10.53	5.26	10.53	5.26
Other fauna	10.53	5.26	5.26	10.53	10.53	10.53	10.53	10.53	10.53
Feral animals	10.53	8.42	8.42	10.53	10.53	10.53	10.53	10.53	10.53
Costs and benefits of project	5.26	0.88	1.3	2.21	5.26	0	3.05	0.85	3.9
Tourist expenditure	5.26	3.9	4.42	4.03	5.26	4.03	5.26	4.03	5.26
Range of recreational opportunity	5.26	5.26	5.26	5.26	5.26	5.26	5.26	5.26	5.26
Involvement of Aboriginal community	5.26	3.95	3.95	2.63	2.63	5.26	5.26	2.63	2.63
Terrestrial capacity	5.26	3.51	3.51	3.51	3.51	3.51	3.51	5.26	5.26
Marine capacity	5.26	0	0	1.75	1.75	3.51	3.51	5.26	5.26
Involvement of local parties	5.26	5.26	5.26	3.51	3.51	3.51	3.51	1.75	1.75
Total final score		52.24	47.92	65.02	64.04	67.19	66.21	67.16	66.18

5.6.3 MCA Results – Equal Weighting

Using an equal weight set, the most preferred option is co-management between the Gnulli Native Title Claimants and CALM with a high visitation scenario, as illustrated in figure 5.2. However as the total final scores in table 5.22 show, there is very little difference between this co-management option and the sole CALM management alternative with high visitation. The next preferred options involve the same management regimes but with low visitation scenarios. Again there is minimal difference between the two management alternatives. Given an equal weight set, high visitation scenarios are generally preferred to low visitation scenarios as they have significantly higher weighted scores for the economic criteria, as shown in table 5.22. The two pastoral options are the least preferred.

Figure 5.2 Ranking of Alternatives using the TopDec Software Rating Method and Equal Weighting (L= Low Visitation, H = High Visitation)

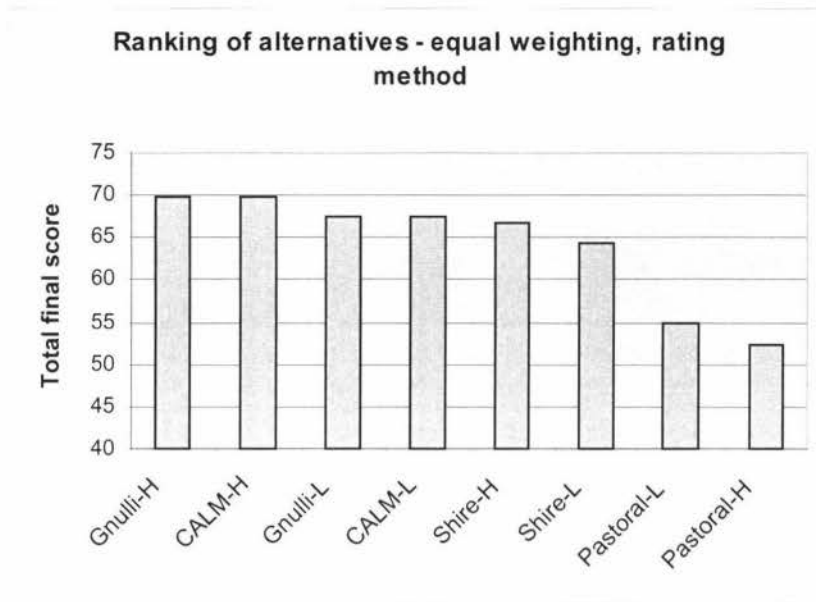


Table 5.22 Ranking of Alternatives using the TopDec Software Rating Method and Equal Weighting

Attribute	Relative Weight	Weighted Final Scores for Alternatives using TopDec Software							
		Pastoral		Shires and CALM		Gnulli and CALM		CALM	
		Low	High	Low	High	Low	High	Low	High
Coral reef	7.69	-7.69	-7.69	-7.69	-7.69	-7.69	-7.69	-7.69	-7.69
Dune erosion	7.69	7.69	7.69	7.69	7.69	7.69	7.69	7.69	7.69
Native vegetation	7.69	3.85	3.85	7.69	7.69	7.69	7.69	7.69	7.69
Turtles	7.69	7.69	3.85	7.69	3.85	7.69	3.85	7.69	3.85
Other fauna	7.69	3.85	3.85	7.69	7.69	7.69	7.69	7.69	7.69
Feral animals	7.69	6.15	6.15	7.69	7.69	7.69	7.69	7.69	7.69
Costs and benefits of project	7.69	1.28	1.9	3.23	7.69	0	4.46	1.24	5.7
Tourist expenditure	7.69	5.71	6.46	5.89	7.69	5.89	7.69	5.89	7.69
Range of recreational opportunity	7.69	7.69	7.69	7.69	7.69	7.69	7.69	7.69	7.69
Involvement of Aboriginal community	7.69	5.77	5.77	3.85	3.85	7.69	7.69	3.85	3.85
Terrestrial capacity	7.69	5.13	5.13	5.13	5.13	5.13	5.13	7.69	7.69
Marine capacity	7.69	0	0	2.56	2.56	5.13	5.13	7.69	7.69
Involvement of local parties	7.69	7.69	7.69	5.13	5.13	5.13	5.13	2.56	2.56
Total final score		54.81	52.34	64.25	66.67	67.43	69.84	67.39	69.8

5.6.4 Sensitivity Analysis

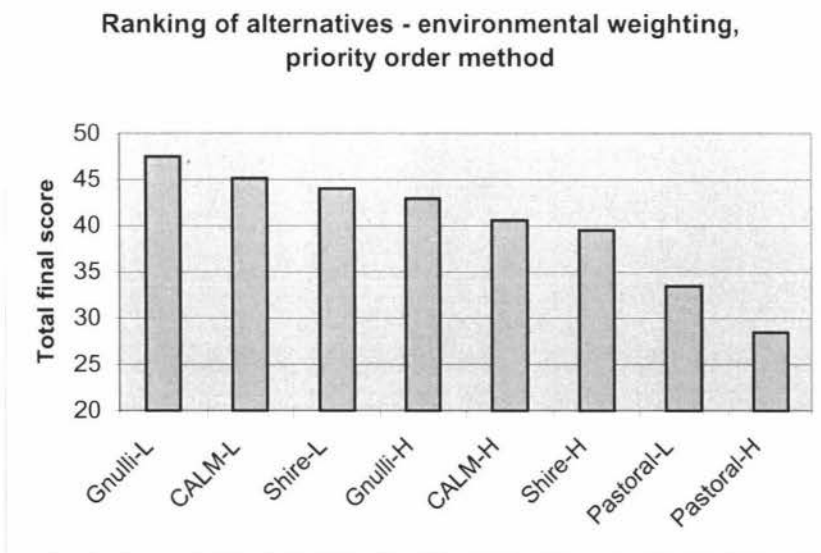
The results of the sensitivity analysis are presented below in three sub-sections: weighting method, weight set and scores.

5.6.4.1 Sensitivity to the Weighting Method

The results for the two weights sets using the TopDec software priority order weighting method are illustrated in figures 5.3 and 5.4. The ranking for the environmental and economic weight sets and the corresponding relative weights calculated by the TopDec software are shown in table 4.25, p. 99.

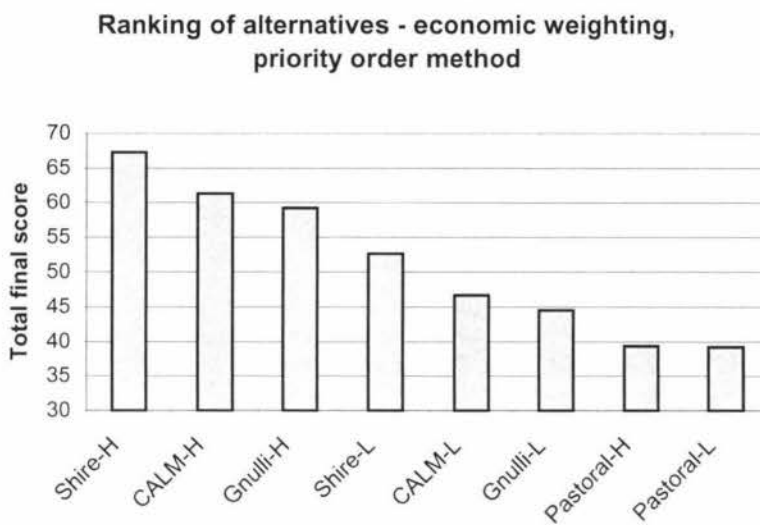
Using an environmental weight set, the highest ranked alternative is co-management by the Gnulli Native Title Claimants and CALM with a low visitation scenario, as illustrated in figure 5.3. The next ranked alternative is sole management by CALM; these results are similar to the ranking using the environmental weight set and the rating method. In contrast to the result using the rating method, the third ranked option is co-management between the Shires and CALM (low visitation scenario), which is ranked fifth using the rating method. Again similar to the rating method, low visitation scenarios are preferred to high visitation scenarios and the pastoral management options are ranked last.

Figure 5.3 Ranking of Alternatives using the TopDec Software Priority Order Method and Weight Set One (L = Low Visitation, H = High Visitation)



The final ranking using an economic weight set is shown in figure 5.4. The highest ranked alternative is co-management between the Shires and CALM with a high visitation scenario, followed by sole management by CALM. Similar to the rating method with equal weights, high visitation scenarios are preferred to low visitation scenarios and the pastoral options are ranked last. The high ranking of the Shires co-management option can be explained by its high score for the total economic costs and benefits attribute, which has a weighting of 24.5 percent.

Figure 5.4 Ranking of Alternatives using the TopDec Software Priority Order Method and Weight Set Two (L = Low Visitation, H = High Visitation)



The priority order method produces a similar ranking to the rating method using an environmental weight set, but there is a more marked difference between the two methods using an economic weight set. Although this indicates some sensitivity of rankings to the weighting method, it is not considered a significant limitation, as the economic weight set does not adequately model a likely set of preferences. The economic weight set implies that economic attributes have a combined relative weight of 40 percent, which is not reflected in stakeholder objectives. The environmental weight set could be considered to more adequately reflect preferences and this produced a similar ranking to the rating method. The final scores using the priority order method are more differentiated than those using the rating method. This is a consequence of the relative weights used for each method.

5.6.4.2 Sensitivity to the Weight Set

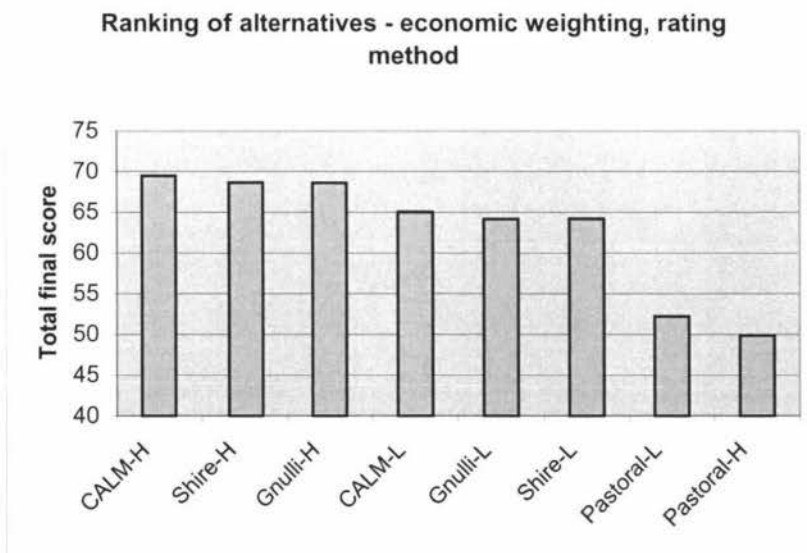
The sensitivity of the ranking of alternatives to the weight set is also investigated using the rating method and weight sets that reflect alternative economic and social perspectives. The weight sets reflect the following preferences:

Economic weight set: economic > environmental > social = institutional

Social weight set: social > environmental > economic = institutional

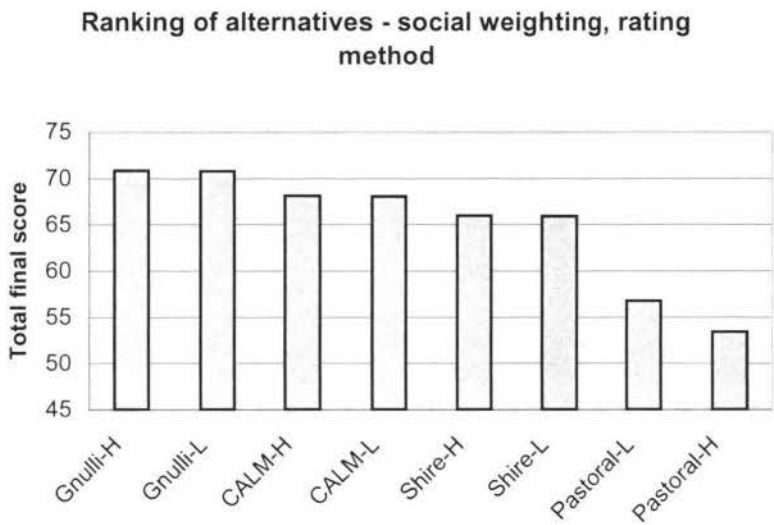
The actual weight sets used are provided in table 4.24, p. 99. The ranking of alternatives using the economic weight set is illustrated in figure 5.5. Sole management by CALM (high visitation scenario) is the most preferred alternative, followed by the high scenarios for the two co-management options, which show minimal difference between them. As expected, high visitation scenarios are preferred to low visitation scenarios and again the pastoral options rank the lowest. Similar to the economic weight set using the priority order method, the co-management option between the Shires and CALM (high visitation scenario) is ranked second. However, the low visitation scenario is ranked sixth, compared to third using the priority order method. For the sole management by CALM and the two co-management options, differentiation mainly occurs between high and low visitation scenarios, and for each scenario the three alternatives have similar scores.

Figure 5.5 Ranking of Alternatives using the TopDec Software Rating Method and an Economic Weight Set (L = Low Visitation, H = High Visitation)



The ranking of alternatives using a social weight set and the rating method is presented in figure 5.6. Co-management between Gnulli Native Title Claimants and CALM is the preferred alternative, followed by sole management by CALM. In contrast to the results using the equal, environmental and economic weight sets, there is little discernible difference between high and low visitation scenarios for each alternative, with the exception of the pastoral alternatives. Each management alternative is preferred to the next regardless of the visitation scenario.

Figure 5.6 Ranking of Alternatives using the TopDec Software Rating Method and a Social Weight Set (L = Low Visitation, H = High Visitation)



The social and economic weight sets represent alternative preferences which may be present amongst decision makers and/or society. The results of the sensitivity analysis show some minor changes in the ranking in comparison to the equal or environmental weighting. However management options that ranked highly in the latter weight sets (Gnulli co-management and sole management by CALM) still feature highly in the rankings produced with economic and social weight sets.

5.6.4.3 Sensitivity to Scores – Optimistic and Pessimistic Scenarios

Scores for the optimistic and pessimistic scenarios reflect sensitivity analyses conducted for the CBA, changed tourism expenditure assumptions and varied scores for environmental attributes. The performance matrix for the optimistic scenario is presented in table 5.23, p. 140.

The scores for the coral reef and turtles attributes show that despite increased visitation, there will be no deterioration in the condition of the coral reef and a smaller relative negative impact on turtles (relative to the expected scenario, see table 5.20, p.131). This might reflect increased visitor education and management presence and control. The optimistic scenario assumes that the pest control programme would be more successful across all alternatives.

For the attributes of native fauna (mammals within critical weight range, reptiles and birds) and native vegetation, the scores for the pastoral options have improved relative to the expected scenario, while the other options remain the same. This reflects a smaller impact from stocking on the rangeland flora and fauna and perhaps greater management for environmental purposes by pastoralists.

Under the optimistic scenario, all CBA results are higher or less negative, while the pastoral (high visitation) and CALM (low visitation) alternatives have switched from a negative to a positive annual expected return. These results are further discussed in section 5.3.2.1, p. 108. Tourist expenditure is relatively higher for all alternatives, and scores for social and institutional attributes remain the same across all alternatives.

Table 5.24 presents the performance matrix for the pessimistic scenario. The scores for environmental attributes reflect a poorer overall environmental outcome. The impact on the coral reef is assumed to be greater for high visitation scenarios. All alternatives have a smaller positive impact for the attributes of dune erosion and pest control relative to the expected scenario. In particular, the poorer outcome for dune erosion could reflect the difficulties of dune revegetation in arid climates. For pastoral alternatives, continued stocking of the rangeland will result in a deterioration of native vegetation, whilst for non-pastoral alternatives destocking will have no positive impact on vegetation. Under the pessimistic scenario, it is assumed that destocking the rangeland will have no impact on terrestrial native fauna, so all alternatives have a slight negative impact.

Under the pessimistic scenario, all annual returns are negative, however the pastoral options are least negative. For more explanation of the results of the CBA sensitivity analysis see section 5.3.2.2, p. 109. Tourist expenditure is relatively lower for all alternatives, whilst scores for social and institutional attributes remain the same as for the expected scenario.

Table 5.23 Performance Matrix for the Ningaloo Coastal Region, Optimistic Scenario

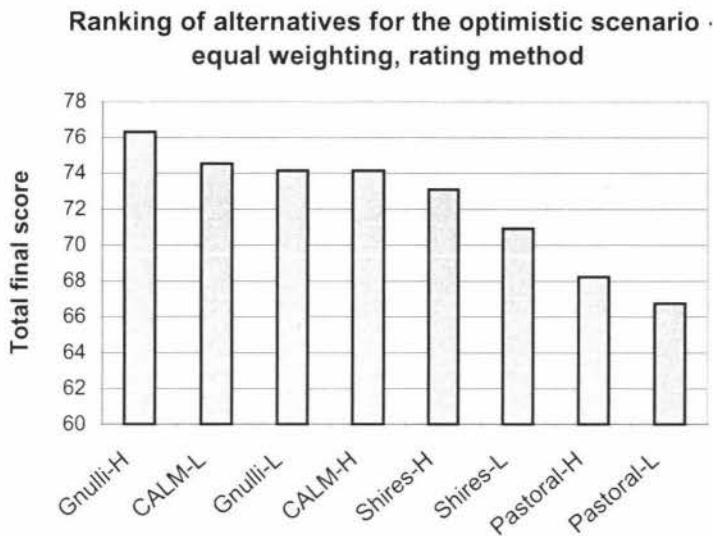
EFFECTS OF LAND USE AND MANAGEMENT SCENARIOS ON NINGALOO COASTAL REGION											
Module	Assessment Tool	Attribute	Measurement Scale	Scores for Alternative Options							
				Pastoral		Shires and CALM		Gnulli and CALM		CALM	
				Low	High	Low	High	Low	High	Low	High
Environment	EIA	Coral Reef	-3 to 0	0	0	0	0	0	0	0	0
		Dune erosion	-3 to 3	2	2	2	2	2	2	2	2
		Native vegetation –shrubs and grasses	-3 to 3	0	0	1	1	1	1	1	1
		Native fauna - turtles	-3 to 3	0	-1	0	-1	0	-1	0	-1
		Native fauna – mammals within CWR, reptiles and birds	-3 to 3	1	1	1	1	1	1	1	1
		Feral animals	-3 to 3	2	2	3	3	3	3	3	3
Economic	CBA	Total costs and benefits of project	\$ (annually)	- 60 297	15 665	1 160 274	2 719 860	--249 083	1 310 503	916 282	2 475 868
		Tourist expenditure in regional economy	\$ (annually)	3 381 644	3 828 661	3 492 815	4 559 562	3 492 815	4 559 562	3 492 815	4 559 562
Social	Recreational index	Range of recreational opportunities	0 to 3	3	3	3	3	3	3	3	3
	Likert scale	Level of involvement of Aboriginal community	0 to 4	3	3	2	2	4	4	2	2
Institutional	Institutional index	Capacity to achieve positive environmental outcome for terrestrial ecosystem	0 to 3	2	2	2	2	2	2	3	3
	Institutional index	Capacity to achieve positive environmental outcome for marine ecosystem	0 to 3	0	0	1	1	2	2	3	3
	Likert scale	Level of involvement of local affected parties	0 to 4	3	3	2	2	2	2	1	1

Table 5.24 Performance Matrix for the Ningaloo Coastal Region, Pessimistic Scenario

EFFECTS OF LAND USE AND MANAGEMENT SCENARIOS ON NINGALOO COASTAL REGION											
Module	Assessment Tool	Attribute	Measurement Scale	Scores for Alternative Options							
				Pastoral		Shires and CALM		Gnulli and CALM		CALM	
				Low	High	Low	High	Low	High	Low	High
Environment	EIA	Coral Reef	-3 to 0	-1	-2	-1	-2	-1	-2	-1	-2
		Dune erosion	-3 to 3	1	1	1	1	1	1	1	1
		Native vegetation – shrubs and grasses	-3 to 3	-1	-2	-1	-2	-1	-2	-1	-2
		Native fauna - turtles	-3 to 3	-2	-2	-2	-2	-2	-2	-2	-2
		Native fauna – mammals within CWR, reptiles and birds	-3 to 3	-1	-1	-1	-1	-1	-1	-1	-1
		Feral animals	-3 to 3	0	0	0	0	0	0	0	0
Economic	CBA	Total costs and benefits of project	\$ (annually)	-150 327	-74 364	-437 524	-430 364	-294 455	-287 295	-681 516	-674 356
		Tourist expenditure in regional economy	\$ (annually)	2 113 527	2 393 913	2 183 009	2 849 726	2 183 009	2 849 726	2 183 009	2 849 726
Social	Recreational index	Range of recreational opportunities	0 to 3	3	3	3	3	3	3	3	3
	Likert scale	Level of involvement of Aboriginal community	0 to 4	3	3	2	2	4	4	2	2
Institutional	Institutional index	Capacity to achieve positive environmental outcome for terrestrial ecosystem	0 to 3	2	2	2	2	2	2	3	3
	Institutional index	Capacity to achieve positive environmental outcome for marine ecosystem	0 to 3	0	0	1	1	2	2	3	3
	Likert scale	Level of involvement of local affected parties	0 to 4	3	3	2	2	2	2	1	1

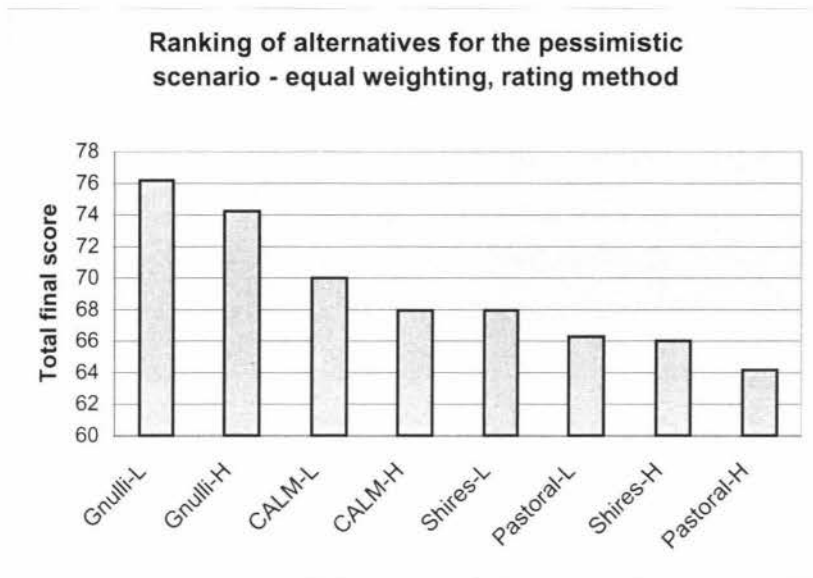
The ranking of alternatives for the optimistic scenario using an equal weight set and the rating method is illustrated in figure 5.7. The highest ranked option is co-management with the Gnulli Native Title Claimants (high visitation scenario), followed by the sole CALM management option (low visitation scenario). The least preferred options are the pastoral alternatives.

Figure 5.7 Ranking of Alternatives for the Optimistic Scenario, using the TopDec Software Rating Method and Equal Weighting (L = Low Visitation, H = High Visitation)



The ranking of alternatives for the pessimistic scenario with an equal weight set and using the rating method are presented in figure 5.8. The most preferred option is co-management by Gnulli Native Title Claimants (both high and low scenarios) followed by CALM sole management. There is a discernible difference in the final scores for the low and high visitation scenarios for the Gnulli co-management option and the CALM alternative. The pastoral alternative (low visitation) is preferred to co-management by the Shires and CALM, high visitation scenario but not the low visitation scenario.

Figure 5.8 Ranking of Alternatives for the Pessimistic Scenario, using the TopDec Software Rating Method and Equal Weighting (L = Low Visitation, H = High Visitation)



For both optimistic and pessimistic scenarios, co-management by the Gnulli is the highest ranked alternative (high visitation for the optimistic scenario, and low visitation for the pessimistic scenario). The next preferred option for both scenarios is sole management by CALM (low visitation scenario).

5.7 CONCLUSION

This chapter presents the overall results of MCA, and also the individual results for the EIA, CBA and stakeholder analysis. Table 5.19 provides a summary of the rankings of alternatives from all MCA evaluations.

Table 5.25 Summary of Rankings of Alternatives for all MCA Evaluations

	Pastoral		Shires and CALM		Gnulli and CALM		CALM	
	Low	High	Low	High	Low	High	Low	High
Rating method								
Environmental	7	8	5	6	1	3	2	4
Equal	7	8	6	5	3	1	4	2
Economic	7	8	6	2	5	3	4	1
Social	7	8	6	5	2	1	4	3
Priority order method								
Environmental	7	8	3	6	1	4	2	5
Economic	8	7	4	1	6	3	5	2
Scores (rating method, equal weights)								
Optimistic scenario	7	8	5	6	3	1	2	4
Pessimistic scenario	6	8	5	7	1	2	3	4

6 DISCUSSION

6.1 INTRODUCTION

In this chapter, the results of this research are discussed in relation to other research where relevant. The analytical framework developed is discussed, including its relationship to other integrated assessment frameworks and the advantages and disadvantages of the methodology adopted. Finally the results suggest some interesting policy implications for the planning direction of the coastal strip.

6.2 RESULTS OF THE INTEGRATED EVALUATION

The results of this research indicate that the co-management arrangement between Gnulli Native Title Claimants and CALM is the highest ranked management alternative with both an environmental and equal weight set. The preferred scenario depends on the weight set used, where all attributes are considered of equal importance the high visitation scenario is preferred and where environmental attributes are considered to be of greater importance the low visitation scenario is preferred. Sole management by CALM is the second ranked alternative for both the equal and environmental weighting. The preferred scenarios for the sole management CALM alternative are the same as for the Gnulli co-management alternative. Very little difference exists between the total final scores for the two management regimes and this suggests that either management regime could be implemented.

The environmental weight set is consistent with the National Strategy for Ecological Sustainability (Ecologically Sustainable Development Steering Committee, 1992), while the equal weight set is more in line with the Western Australian draft State Sustainability Strategy (Government of Western Australia, 2002).

The Gnulli co-management and CALM sole management alternatives also perform well in the sensitivity analysis. In total, four different weight sets were used with the rating method and two with the priority order method. Two alternative scenarios with different scores were also investigated. Of all evaluations, the co-management option between the Gnulli and CALM is ranked in the top three for seven out of eight evaluations for the high visitation scenario, and six out of eight for the low visitation scenario. The sole CALM management

option ranked in the top three for four out of eight evaluations for both visitation scenarios. The Shires co-management option ranked in the top three for two of eight evaluations (high visitation scenario) and once out of eight evaluations for the low visitation scenario. Neither pastoral option ranked in the top three alternatives.

In every evaluation, at least one of the Gnulli co-management scenarios ranked in the top three alternatives, while for four evaluations both scenarios rank in the top three alternatives. A CALM sole management scenario ranked in the top three alternatives for every evaluation, but no evaluations featured both scenarios in the top three alternatives. Although no one alternative is consistently preferred for all evaluations, the results of the sensitivity analysis indicate that the Gnulli co-management and CALM sole management alternatives generally perform well across the range of evaluations.

The implications of alternative weightings of the system components of sustainability is explored by using weight sets with environmental, economic and social weight perspectives. The results show considerable compatibility between social and environmental perspectives; the top three alternatives are the same for both weight sets, though their order differs. Both Gnulli co-management alternatives feature in the top three alternatives, with the low visitation scenario being ranked first in the environmental weighting and second in the social. The CALM sole management, low visitation scenario is ranked second and third in the environmental and social weighted evaluations respectively.

Given the inherent tensions between economic and environmental objectives, it was expected that there would be less compatibility between the rankings produced by environmental and economic oriented weight sets. In particular, those alternatives that were more economically oriented were expected to feature in the top three ranked alternatives with an economic weight set. The Shires co-management option (high visitation scenario) is the most economically oriented of all alternatives, as it has a high level of visitation, lower level of management activities and the maximum number of wilderness lodges. The results confirm this expectation. The Shires co-management high visitation scenario ranked second, following the CALM sole management high visitation scenario. The only alternative to feature in the top three ranked alternatives for both environmental and economic oriented evaluations is the Gnulli high visitation scenario, suggesting that this may provide a compromise solution between the two system components.

Similar results were found by van Herwijnen *et al.* (1993) in a MCA study of sustainable development planning for a Greek island. The study compared results from an ecological oriented weight set to a socio-economic oriented weight set. As in this research, the highest ranked alternative for the environmental evaluation did not feature in the top three ranked alternatives of the socio-economic evaluation. However in that study, both of the second and third ranked alternatives featured in both evaluations, which suggests more compatibility between the economic and environmental objectives than is found in this research.

The sensitivity of rankings to attribute scores is explored using an optimistic and pessimistic scenario. The rankings, given a pessimistic scenario, are of particular interest, since a pessimistic scenario allows the meaningful application of the precautionary principle. Combining poorer outcomes for both environmental and economic attributes provides a worst-case scenario, since it is likely that poor environmental outcomes would be associated with higher economic outcomes and vice versa, for at least the short-run. Co-management between the Gnulli and CALM is the highest ranked option, with the low visitation scenario ranked first and the high visitation scenario second. The third ranked alternative is sole management by CALM (low visitation scenario). These alternatives also feature in the top three alternatives of the expected scenario when an equal weighting is used. This suggests that either of these management regimes will be appropriate even if environmental and economic outcomes are worse than predicted in the expected scenario.

Van Herwijnen *et al.* (1993) found considerable sensitivity of rankings to variations in attribute scores, however they were still able to suggest a compromise solution that generally performed well. The greater sensitivity of the rankings might be a result of the more in-depth sensitivity analysis using a Monte Carlo approach, whereas this research used a more simple methodology based on extreme scenarios.

Components and activities that varied between the high and low visitation scenarios centred on the level of visitation and the number of wilderness lodge facilities developed. The management/planning authority has control over the development of facilities, but not over the level of visitation, though it may be influenced by controls on numbers and marketing activities. Low visitation scenarios are generally preferred when an environmentally oriented weight set is used, or alternatively if a more pessimistic outcome is expected. High visitation scenarios are generally preferred when an equal or economic oriented weight set is used.

The MCA results show very little overall differentiation between the total final scores of alternatives. In some evaluations, alternatives have final scores that hardly differ in practical terms. Overall, final scores differ little because individual attribute scores were often very similar across alternatives, particularly for the environmental attributes, which are generally weighted highly. This lack of differentiation is a function of the formulation of the alternatives. Alternatives were generally poorly defined at a practical level, since planning was only at the conceptual stage. Therefore the details of alternatives were based on assumptions, and it was difficult to differentiate the level of facilities and management activities based on a proposed regime. Studies with greater differentiation between alternatives (in particular those that considered vastly different options such as development and conservation) obtained much greater differentiation in the final scores (e.g. Moriki *et al.*, 1996 and Robinson, 2000).

6.3 RESULTS OF THE INDIVIDUAL ASSESSMENT

6.3.1 Environmental Impact Assessment

The lack of differentiation in the environmental scores of attributes is reflected in the adapted Leopold matrices for the environmental impact assessment. There are very few high scores (either positive or negative) across all alternatives. There are no large negative impacts and only one element (employment) has a large positive impact. Particularly noticeable is the similarity of the Leopold matrices for all non-pastoral alternatives. All these alternatives involved excision of the coastal strip and vesting in the Conservation Commission of Western Australia, and subsequent sole or part management by CALM. It was therefore assumed that these alternatives would be subject to similar regulations, camping facilities, visitor numbers and management activities. This assumption resulted in very similar impact profiles for these alternatives.

Alternatives with significant negative impacts are unlikely to be implemented, given relevant planning policy for the area. In particular the position statement by the EPA (1999) signifies the limitations on development and the likelihood of EPA involvement in any development proposal for the area. Therefore alternatives considered were only those with relatively low environmental impact, and this is reflected in the low scores within the Leopold matrices.

6.3.2 Cost Benefit Analysis

The results of the CBA are sensitive to the assumptions, and the extreme optimistic and pessimistic scenarios considered in the sensitivity analysis result in marked changes in the economic desirability of some alternatives. However it is important to note that this is also a function of the scenarios, since they involve simultaneous changes in a number of variables. Although this assumption could be considered unlikely, it represents two extreme scenarios.

The CBA is only partial, and does not include all use values and non-use values. Pearce and Barbier (2000) report on thirteen studies that involved estimates of use and non-use values. These studies suggest that when estimated separately (and where non-use values were relevant), non-use values dominated the outcome of CBA studies and accounted for between 50 and 98 percent of total economic value. A recent study of non-use values held by Europeans for protection of the Amazonian rainforest (Horton *et al.*, 2002) indicated significant willingness to pay for conservation. Although not directly relevant, this research provides some evidence that areas of global conservation significance have non-use value internationally.

The uniqueness and pristine condition of the Ningaloo Reef and its potential for World Heritage listing (Western Australian Labour Government, 2001) suggests that the international community might hold significant non-use values for the reef and adjacent coastline. Inclusion of these values would likely result in positive NPVs for all alternatives. Although inclusion of non-use values would change the absolute magnitude of the NPVs, it is less likely that this would result in significant changes in the relative magnitudes for alternatives. Since it is the relative magnitudes that matter for the MCA, this exclusion is unlikely to affect the results.

6.3.3 Stakeholder Analysis

The results of the stakeholder analysis indicate that there is a high level of compatibility amongst the environmental objectives of stakeholder groups. Almost all groups desire to protect and preserve the environment, and there is an overriding desire to retain wilderness values, though there is considerable conflict surrounding what wilderness values are. Economic objectives centre on obtaining economic benefits from appropriate ecotourism development and retaining an appropriate fee structure. Differences involve social objectives; particularly those groups that desire to retain the current uses of the coastal strip.

6.4 THE RESEARCH METHODOLOGY

6.4.1 Integrated Assessment Framework

The integrated methodology used in this research reflects a systems approach to sustainable development, where economic, environmental and social systems are considered in conjunction with institutional aspects. Such an approach is ideally suited to environmental problems that are characterised by a large number of stakeholders and institutional agencies, competing and conflicting objectives, interdependent social, economic and environmental components, relative uncertainty over impacts, a lack of hard environmental data, and a number of potential solutions.

The role of MCA in integrated assessment is widely acknowledged (Ledoux *et al.*, 2002; van Pelt, 1993a and Nardini, 1997). A major strength of MCA is its ability to explore tradeoffs between objectives and system components and the implications of alternative preference structures. This makes it an ideal tool for exploring complex environmental problems. Nardini (1997) and van Pelt (1993a) advocate the incorporation of individual assessment techniques, such as CBA and EIA, into MCA.

Although similar to other integrated assessment frameworks proposed by Nardini (1997) and van Pelt (1993a) and those developed within the field of integrated assessment, the analytical framework developed in this research differs in two key aspects. Firstly, it is more applicable to situations where decision making is constrained by a short time frame and resource constraints. This means that the development of more detailed models, which characterise research from the field of integrated assessment⁸, is not practicable. Impact assessment is constrained to rapid appraisal methodologies, and CBA tends to be partial rather than a full environmental CBA. Rapid integrated assessment provides decision makers with timely information, and serves to highlight areas that may deserve further attention. In this manner, the advantages are similar to those gained from preliminary impact assessment, however the rapid integrated assessment framework goes further because it allows the integration of different sustainability aspects.

Secondly, in direct contrast to Nardini (1997) and van Pelt (1993a), this research explicitly includes stakeholder analysis as an individual evaluation technique alongside CBA and EIA. Some form of analysis of stakeholder objectives is common in most MCA studies as this

⁸ See for example. CIESIN, 1995; Ledoux *et al.*, 2002 and Jakeman and Letcher, 2001

provides information on possible attributes and preferences. The focus is usually on participation rather than analysis, and few studies tend to use techniques developed in the field of stakeholder analysis. An exception to this is Bien's (2001) research into forest management systems in Vietnam, which utilised a simple stakeholder analysis to investigate the relationship between stakeholders and management regimes.

The framework used in this research includes stakeholder analysis as a separate technique from the MCA, with less focus on participation. The process of stakeholder analysis used in this research is based on previous stakeholder analysis frameworks, and thus benefits from developments in this field. Explicit inclusion of stakeholder analysis provides the necessary information for MCA, but also allows further exploration of stakeholder issues that provides valuable information for decision makers.

The integrated assessment framework developed in this research provides the greatest benefits when conducted early in the planning process. This allows the planning process to be focussed on the more relevant and important aspects of the problem, and for further research to be conducted in specific areas. As evident in this research, this is likely to mean that alternatives are at a stage where they are poorly specified.

6.4.2 Development of Attributes

The development of attributes or criteria is a crucial phase in MCA. This research developed attributes from the individual assessment techniques. Stakeholders were consulted and their recommendations included where appropriate. Although this approach has greater stakeholder involvement than those where attributes are developed solely from the literature (e.g. Tiwari *et al.*, 1999), a stronger set of attributes and greater level of consensus could have been developed through the use of community workshops (see Robinson, 2000 and Stewart and Joubert, 1998). Unfortunately such an approach was not possible given the short time frame, and geographical distance between stakeholders.

The adequateness of the attribute set in relation to the desirable properties specified by Keeney and Raiffa (1993) is discussed below (see chapter four, section 4.2.5.3, p. 88 for details of the desirable properties). The properties are:

Complete As identified in the stakeholder analysis, the concept of wilderness is a crucial issue for this coastline. It was initially intended to include a

measure of wilderness in the set of attributes. However the development of an operational wilderness attribute proved impossible in the time frame necessary (for more details see chapter four, section 4.3.3, p. 101). It was therefore excluded from the set, although some aspects of wilderness were included in the attribute of recreational opportunities. The attribute set was as complete as possible given the constraints involved.

Operational All attributes were operational, excluding the wilderness attribute which was subsequently dropped for this reason. Attributes could all be measured in quantitative terms, though many were assessed using scales and indices.

Decomposable No factors were in opposition in a single criterion

Non-redundant No aspect entered the attribute set more than once. Particular attention was paid to avoid any overlap between tourism expenditure and the costs and benefits of the project. Had a wilderness attribute been included, this may have resulted in some double counting with the range of recreational opportunities attribute.

Minimal The set of attributes was as small as possible.

It can be concluded that the attribute set is methodologically sound, recognising the constraints involved in the research.

6.4.3 Impact Assessment

The rapid appraisal nature of impact assessment meant that more detailed and realistic models of environmental and economic impacts could not be utilised. In particular the Leopold matrix did not allow for the treatment of irreversibility or the profile of the impact over time. Although the impact assessment produced results that were adequate for the nature of this assessment, more sophisticated rapid appraisal methodologies are available and may have provided better impact assessment.

6.5 POLICY IMPLICATIONS

The results of this research suggest a number of policy implications. These are addressed below and specific recommendations are developed in the following chapter.

Those alternatives that ranked highly in the evaluations involved excision of the coastal strip and subsequent vesting in the Conservation Commission of Western Australia. Under the pastoral options, the coastal strip remained in pastoral lease. This is a weaker vesting for conservation purposes than full vestment in the Conservation Commission, though it is possible for covenants to be placed on pastoral leasehold land to ensure conservation.

The stakeholder analysis suggests that stakeholders desire an environmentally oriented strategic direction. This is also consistent with the National Strategy for Ecologically Sustainable Development (Council of Australian Governments, 1992). In light of this, the research suggests that co-management between Gnulli Native Title Claimants and CALM is the best management arrangement for the area.

Adoption of an environmentally based strategic direction for the area would suggest that low-visitation scenarios are preferred. This is particularly the case if a precautionary policy is adopted and there is some probability of a worse than expected environmental and economic outcome. A low-visitation scenario would imply that at most one wilderness lodge is developed in the area, and that a conservative approach to carrying capacity is adopted.

Alternatively, if a more economically oriented strategic direction for the coast is adopted then high visitation scenarios would likely be preferred. This suggests that two wilderness lodge facilities might be developed and that visitor growth (particularly in the traditional off-season) might be encouraged through marketing programmes.

The results of this research suggest two further feasible alternatives that could have been included and deserve further investigation. The first would involve excision of the pastoral strip, but co-management between the current pastoral leaseholders (who would hold adjoining leases) and CALM. Such an arrangement would provide continuity in the management of the area. The second alternative would involve joint management by a number of stakeholder groups, and the possibility of this should be more fully explored, especially given the congruency between stakeholder objectives. If such a management

institution could be devised, the Ningaloo coastal strip has the potential to provide a model for community management in a developed country.

The stakeholder analysis also showed that stakeholders value the traditional wilderness aspects of the area (particularly the current long-term users, NROCA and some community members). There is an inherent tension between retaining these aspects and developing the necessary infrastructure to cope with increasing visitation. One possibility to partially resolve these tensions would be in relation to camping regulations. Currently regulations for CALM managed land allow a maximum stay of 28 days and this is considered inappropriate by current long-term users. A departure from this regulation could be considered for the coastal strip. Although this would not completely resolve this issue, it might go some way towards finding middle ground. Further research into the concepts of wilderness held by stakeholder groups would be invaluable in determining planning policy for the area.

6.6 CONCLUSION

The results of this research suggest that co-management between the Gnulli Native Title Claimants and CALM is an appropriate management regime for the Ningaloo coastal strip, and that development should be kept to a low level. The research develops a decision model for integrated assessment that differs from existing frameworks due to its rapid nature and the explicit inclusion of stakeholder analysis. Limitations of this framework can be considered as a direct result of the rapid appraisal nature of the research.

7 CONCLUSION AND RECOMMENDATIONS

7.1 INTRODUCTION

The Ningaloo Coastal Strip is a fragile coastal environment subject to increasing human pressures. This research developed a decision model for sustainable management of natural resources that incorporates economic, social and environmental factors in an integrated assessment framework. In the framework, three individual assessment techniques are integrated into a MCA framework. The research examines eight management alternatives and the results suggest that an appropriate management regime would involve co-management between local indigenous groups and CALM. Specific recommendations centre on an environmental policy approach that limits development and involves stakeholder groups in management and planning.

7.2 CONCLUSION

The planning and management of the Ningaloo coastal strip is complicated by the interdependencies between the coastal strip and the Ningaloo Marine Park. In addition, there exist a large number of stakeholders and the general public exhibits considerable interest in the issue. Any attempt to assess alternative management and development regimes requires an integrated evaluation framework that can assess the components of sustainability and address the variety of stakeholder interests.

The aim of this research was to develop a decision model for sustainable management that integrated economic, social and environmental factors; and that could provide decision makers with timely information on alternative land use and management regimes for the Ningaloo coastal strip. Specific objectives involved the identification and estimation of social, economic and environmental impacts, the analysis of stakeholder objectives and the incorporation of these aspects into an MCA framework.

This research developed an integrated assessment decision model that is particularly suited to problems that require rapid appraisal. Three individual assessment techniques were integrated into a broader multiple criteria evaluation framework: EIA, CBA and stakeholder analysis. Impacts were identified and estimated through the techniques of EIA and CBA. Stakeholder objectives were identified and analysed using stakeholder analysis techniques.

The research assessed eight alternatives that covered the range of possible options from retaining the status quo (management by pastoral lease holders and the NROCA organisation) through to excision of the coastal strip and sole management by CALM. Two co-management arrangements were considered: between the Gnulli Native Title Claimants and CALM and between the two Shires and CALM. Each alternative management arrangement had a high and low visitation scenario that reflected different possible visitation levels and in some cases a different level of wilderness lodge facilities. The alternatives considered covered a spectrum of possible facilities and infrastructure, from limited camping facilities and minimal road development through to the full provision of campsites with facilities and roading adequate for 2WD access.

Alternatives were assessed against a set of thirteen attributes. These attributes covered four modules that reflected a systems perspective of sustainability; environmental, economic, social and institutional. Attributes were developed from the individual assessment techniques and stakeholder consultation. Scores for the environmental attributes were derived from the adapted Leopold matrices used in the EIA, whilst scores for the economic attributes were derived from the CBA. Scores for social and institutional attributes were developed through the use of indices and scales.

Standardisation of scores and the weighting of criteria were performed using the MCA software TopDec (Ecoservices Pty Ltd, 1996). This software uses the weighted summation technique to aggregate weighted scores. This is the simplest MCA technique, but has advantages in being transparent and easy to understand. The TopDec software uses two weighting methods to convert preference information into relative weights. This research used the simpler of these two methods, termed the rating method. This method allowed attributes to be given equal weighting, which was considered necessary to adequately reflect preferences for this issue. The sensitivity of the results to the weighting method was checked using the second method (priority order), which is based on the expected value method. The sensitivity of results to the weight set used and the scores of alternatives was also explored.

The weight set used in this research reflected the strong emphasis on environmental objectives that came out of the stakeholder analysis. The weight set placed a high weighting on environmental attributes and economic, social and institutional attributes were given a lesser, equal weighting. Sensitivity of the results to the weight set was explored by using equal weights and weight sets that reflected alternative social and economic perspectives.

The environmental weight set was also consistent with the national sustainability policy, whilst an equal weight set reflected the policy approach to sustainability proposed by the state government.

Overall, the co-management alternative between the Gnulli Native Title Claimants and CALM ranked the highest (low visitation scenario) followed by sole management by CALM (low visitation scenario). This result was fairly stable, with the Gnulli co-management and CALM sole management alternatives consistently performing highly in the rankings for all evaluations in the sensitivity analysis.

In general, low visitation scenarios were preferred if the weight set was environmentally orientated, or if a precautionary policy was adopted given the possibility of a pessimistic scenario outcome. High visitation scenarios were preferred if the weight set was equal or economic orientated.

The results of the research suggest a potential direction for the development of planning policy for the Ningaloo coastal strip towards a community based management arrangement involving the traditional Aboriginal inhabitants and a low level of development. Specific policy recommendations are presented in section 7.3.

Limitations of the methodology arise from the rapid appraisal nature of the integrated assessment framework. These include a lack of stakeholder participation in some areas of the MCA and a relatively limited impact assessment methodology. These limitations suggest areas for further research and refinements to the integrated assessment framework.

Further research is required on techniques to involve stakeholders in a workshop-based environment, where the nature of the research is constrained by time and a wide geographical spread of stakeholders. Such techniques were beyond the scope of this research, however their inclusion would greatly strengthen the acceptability and policy relevance of the MCA results. Further refinements of the assessment framework could relate to the impact assessment methodology, in particular a more modern assessment technique than the Leopold matrix could be utilised. EIA techniques that include the dimensions of time, and cumulative and irreversible impacts would strengthen the impact assessment stage. Formal feedback loops between the stages of the MCA could be developed, to ensure that new attributes and alternatives that develop at later stages of the process can be formally included.

Despite these limitations, the research provides useful results that suggest a possible direction for the future of the Ningaloo coastal strip. Subsequent policy development during November 2002, has seen the decision to exclude the 2 kilometre coastal strip from pastoral leases in 2015. This confirms the findings of this research. A two-year period now exists to negotiate the details of excision and the nature of management arrangements. This research is ideally suited to inform this negotiation and to serve as a basis for further research during this period.

7.3 POLICY RECOMMENDATIONS

1. Policy and planning for the coastal strip should, given the high congruency between the environmental objectives of stakeholders, exhibit an overriding concern for the environment.
2. A management option for the coastal strip involving co-management between the Gnulli Native Title Claimants and CALM should be given the highest consideration.
3. Development of the Ningaloo coastal strip should be restricted. Development should be limited to a single wilderness lodge facility and constraints should be placed on visitor numbers where necessary.
4. Further research and consultation should be carried out to investigate alternatives that involve co-management with a wider range of stakeholders, including NROCA.
5. Further research should explore the nature and importance of the wilderness concept for stakeholders.

8 REFERENCES

- Arrow, K.J., Cline, W.R., Maler, K.G., Munasinghe, M., Squitieri, R. and Stiglitz, J.E. (1996). Intertemporal equity, discounting and economic efficiency. In J.P. Bruce, H. Lee and E.F. Haites (Eds.), *Climate change 1995: economic and social dimensions of climate change*. Cambridge: Cambridge University Press.
- Asian Development Bank and Government of India. (1988). *Training workshop on environmental impact assessment and evaluation, 18-24 January, Lucknow, India: Proceedings and training manual*. India: Government of India.
- Australian Bureau of Statistics. (2002). *Yearbook Australia 2002*. Canberra: Australian Bureau of Statistics.
- Australian Bureau of Statistics. (Undated). *AusStats: Selected tables from Consumer Price Index, Australia*. (Online). <http://www.abs.gov.au/ausstats/abs@.nsf/w2.2.F?OpenView>.
- Australian Commonwealth Department of Tourism. (1994). *National ecotourism strategy*. Canberra: Australian Government Publishing Service.
- Australian Heritage Commission. (1997). *Registration of the natural estate database: Place report – Ningaloo Marine Park and proposed additions*. Author.
- Australian State of the Environment Committee. (2001). *Australia state of the environment, 2001*. Independent report to the Commonwealth Minister for the Environment and Heritage. Collingwood, Victoria: CSIRO Publishing.
- Barbier, E. (1987). The concept of sustainable economic development. *Environmental Conservation*, 14, p. 101-110.
- Barnett, H.J. and Morse, C. (1963). *Scarcity and growth: The economics of natural resource availability*. Baltimore: John Hopkins Press.
- Bateman, I.J. (1999). Environmental impact assessment, cost-benefit analysis and the valuation of environmental impacts. In J. Petts (Ed.), *Handbook of environmental impact assessment, volume one*, (p. 93-120). Oxford: Blackwell Science Ltd.
- Batie, S.S. (1989). Sustainable development: Challenges to the profession of agricultural economics. *American Journal of Agricultural Economics*, 71(5), 1083-1101.
- Baulch, R. (2002). Public access to pastoral leases. In *Proceedings of the Gascoyne Muster pastoral industry forum, 4-5 May 2002, Carnarvon*. Perth: Pastoral Lands Board.
- Beaumont, P.M. and Walker, R.T. (1996). Land degradation and property rights. *Ecological Economics*, 18, 55-66.
- Berkes, F. (1996). Social systems, ecological systems, and property rights. In S.S. Hanna, C. Folke and K. Maler (Eds.), *Rights to nature: Ecological, economic, cultural, and political principles for institutions for the environment*, (p. 87-107). Washington, DC: Island Press.

- Berkes, F., George, P. and Preston, R.J. (1991). Comanagement – the evolution in theory and practice of the joint administration of living resources. *Alternatives-Perspectives on Society, Technology and Environment*, 18(2).
- Bien, N.N. (2001). *Forest management systems in the uplands of Vietnam: Social, economic and environmental perspectives*. EEPSEA Research Report 2001-RR4. Singapore: Economy and Environment Program for Southeast Asia (EEPSEA).
- Biodiversity Group Environment Australia (1999a). *Threat abatement plan for competition and land degradation by feral goats*. (Online).
<http://www.ea.gov.au/biodiversity/threatened/tap/goats/index.html>.
- Biodiversity Group Environment Australia (1999b). *Threat abatement plan for predation by the European red fox*. (Online).
<http://www.ea.gov.au/biodiversity/threatened/tap/foxes/index.html>.
- Blamey, R.K. (1997). Ecotourism: The search for an operational definition. *Journal of Sustainable Tourism*, 5(2), 109-130.
- Blamey, R.K. and Hatch, D. (1998). *Profiles and motivations of nature-based tourists visiting Australia*. BTR Occasional Paper No. 25. Canberra: Bureau of Tourism Research (BTR).
- Boo, E. (1990). *Ecotourism: The potentials and pitfalls, volume one*. Washington DC: The WorldWide Fund for Nature.
- Boulding, K. (1966). The economics of the coming spaceship Earth. In H. Jarrett (Ed.), *Environmental quality in a growing economy: Essays from the sixth resources for the future forum*. Baltimore: John Hopkins Press.
- Bouyssou, D., Marchant, T., Piriot, M., Perny, P., Tsoukias, A. and Vincke, P. (2000). *Evaluation and decision models: A critical perspective*. Massachusetts and Dordrecht: Kluwer Academic Publishers.
- Bromley, D.W. (1991). *Environment and economy: property rights and public policy*. Massachusetts and Oxford: Basil Blackwell, Inc.
- Buckley, R. and Pannell, J. (1990). Environmental impacts of tourism and recreation in national parks and conservation reserves. *The Journal of Tourism Studies*, 1(1), 24-32.
- Cambell, C.L. and Heck, W.W. (1997). An ecological perspective on sustainable development. In F.D. Muschett (Ed.), *Principles of sustainable development*. Florida: St Lucie Press.
- Cary, J.L., Grubba, T., Hogstrom, A., Milton, K. and Williams, C. (2000). *Human usage in Ningaloo Marine Park: A collaborative project between CALM Marine Conservation Branch, CALM Karratha Regional Office and CALM Exmouth District Office*. Fremantle, Perth: CALM Marine Conservation Branch.
- Ceballos-Lascurain, H. (1999). North West Cape ecolodge project. In Adams and Associates Pty Ltd., *North West Cape eco lodge development proposal*. Perth: Western Australian Tourism Commission.

- Cleveland, C.J. and Ruth, M. (1997). When, where, and by how much do biophysical limits constrain the economic process? A survey of Nicholas Georgescu-Roegen's contribution to ecological economics. *Ecological Economics*, 22, 203-223.
- Cole, M.A. (1999). Limits to growth, sustainable development and environmental Kuznets curves: An examination of the environmental impact of economic development. *Sustainable Development*, 7, 87-97.
- Consortium for International Earth Science Information Network (CIESIN). (1995). *Thematic guide to integrated assessment modelling of climate change*. (Online). Michigan: Author. <http://sedac.ciesin.org/mva/iamecc/rg/IGIIP.html>.
- Construction and Property Consultants Pty Ltd. (1999). North West Cape, west coast ecolodge, indicative cost plan. In Adams and Associates Pty Ltd., *North West Cape eco lodge development proposal*. Perth: Western Australian Tourism Commission.
- D.A. Lord and Associates Pty Ltd. (2000). *Carnarvon coastal strategy: Environmental setting and coastal geomorphology*. Report prepared for SMEC Australia.
- DAL Science and Engineering Pty Ltd. (2002). *Technical appendix 1: Coral Bay boating facility, coastal geomorphology and processes*. (Online). http://www.dplwa.gov.au/inline/whats_new/coral_bay.html
- Daly, H.E. (1977). *Steady-state economics*. San Francisco: W.H. Freeman.
- Davis, D., Banks, S., Birtles, A., Valentine, P. and Cuthill, M. (1997). Whale Sharks in Ningaloo Marine Park: Managing tourism in Australian marine protected areas. *Tourism Management*, 18(5), 259-271.
- De Lopez, T.T. (2001a). Stakeholder management for conservation projects: A case study of Ream National Park, Cambodia. *Environmental Management*, 28(1), 47-60.
- De Lopez, T.T. (2001b). *Policy options for Cambodia's Ream National Park: A stakeholder and economic analysis*. EEPSA Research Report 2001-RR5. Singapore: Economy and Environment Program for Southeast Asia (EEPSA).
- Demsetz, H. (1967). Toward a theory of property rights. *American Economic Review*, 57, 347-359.
- Department of Conservation and Land Management (CALM). (1987). *Cape Range National Park management plan 1987-1997*. Perth: Author.
- Department of Conservation and Land Management (CALM). (1989). *Ningaloo Marine Park management plan 1989-1999*. Perth: Author.
- Department of Conservation and Land Management (CALM). (1994). *A representative marine reserve system for Western Australia*. Report of the Marine Parks and Reserves Selection Working Group. Perth: Author.
- Department of Environmental Protection and Ministry for Planning. (1999). *Environmental and planning guidelines for tourism development on the North West Cape*. Report prepared for the Gascoyne Coast Planning Coordinating Committee of the Western Australian Planning Commission. Perth: Western Australian Planning Commission.

- Department of Finance. (1997). *Handbook of cost-benefit analysis*. Canberra: Australian Government Publishing Service.
- Department of Land Administration (DOLA). (1999a). *Management of the crown estate*. (Online). [http://www.dola.wa.gov.au/home.nsf/\(FrameNames\)/Publications](http://www.dola.wa.gov.au/home.nsf/(FrameNames)/Publications).
- Department of Land Administration (DOLA). (1999b). *Pastoral leases*. (Online). [http://www.dola.wa.gov.au/home.nsf/\(FrameNames\)/Publications](http://www.dola.wa.gov.au/home.nsf/(FrameNames)/Publications).
- Department of Land Administration (DOLA). (1999c). *Department of Land Administration annual report 2001*. Perth: Author. [http://www.dola.wa.gov.au/home.nsf/\(FrameNames\)/Publications](http://www.dola.wa.gov.au/home.nsf/(FrameNames)/Publications).
- Department of Planning and Infrastructure (DPIO). (2002). *Report of the ministerial taskforce: Review of the structural arrangements for coastal planning and management in Western Australia*. Perth: Author.
- Dixon, J. and Sherman, P. (1990). *Economics of protected areas: A new look at benefits and costs*. London: Earthscan Ltd.
- Dorfman, R. (1993). Some concepts from welfare economics. In R. Dorfman and N. Dorfman (Eds.), *Economics of the environment: Selected readings*, (p. 79-96). (3rd ed.). New York: W.W. Norton and Co.
- Dowling, R.K. (1993). Tourist and resident perceptions of the environment-tourism relationship in the Gascoyne region, Western Australia. *Geojournal*, 29(3), 243-252.
- Dowling, R.K. (1997). Plans for the development of regional ecotourism: Theory and practice. In C.M. Hall, J. Jenkins and G. Kearsley (Eds.), *Tourism planning and policy in Australia and New Zealand: Cases, issues and practice*. Sydney: Irwin.
- Ecologically Sustainable Development Steering Committee. (1992). *National strategy for ecologically sustainable development*. (Online). http://www.ca.gov.au/esd/national/nased/strategy_intro.html.
- Ecoservices Pty Ltd. (1996). TopDec. (Computer Software). New South Wales: Author.
- Edward-Jones, G., Davies, B. and Hussain, S. (2000). *Ecological economics: An introduction*. Oxford: Blackwell Science Ltd.
- Ekins, P. (2000). *Economic growth and environmental sustainability: The prospects for green growth*. London: Routledge.
- Environment Australia (2001). *Environment Australia annual report 2000-01*. Canberra: Author. http://www.ca.gov.au/about/annual_report/00-01/index.html.
- Environmental Protection Agency (EPA). (1999). *Environmental protection of Cape Range province: Position statement number one*. Perth: Author.
- Forrest, K. (1996). *The challenge and the chance: The colonisation and settlement of North West Australia 1861-1914*. Western Australia: Hesperian Press.
- France, L. (Ed.). (1997). *The Earthscan reader in sustainable tourism*. London: Earthscan Publications Ltd.

- Freeman, E.R. (1984). *Strategic management: A stakeholder approach*. Boston: Pitman.
- Friend, A. (1992). Economics, ecology and sustainable development: Are they compatible? *Environmental Values*, 1(2), 157-170.
- Gallego, E., Rios-Insua, S., Mateos, A. and Rios-Insua, D. (1998). Contaminated aquatic ecosystems: A case study. In F.J. Giron and M.L. Martinez (Eds.), *Applied decision analysis*, (p. 19-31). Massachusetts and Dordrecht: Kluwer Academic Publishers.
- Gascoyne Development Commission. (1996). *Gascoyne region economic development strategy*. Carnarvon: Author.
- Gascoyne Development Commission. (1997). *Gascoyne geographic perspective: An overview of the geography of Western Australia's Gascoyne region*. Carnarvon: Author.
- Gascoyne Development Commission. (2001). *Gascoyne economic perspective: An update on the economy of Western Australia's Gascone region*. Carnarvon: Author.
- Gascoyne Development Commission. (Undated). *About the Gascoyne Development Commission*. (Online). http://www.gdc.wa.gov.au/about_the_gdc.html.
- Gilpin, A. (1995). *Environmental impact assessment (EIA): Cutting edge for the twenty-first century*. Cambridge: Cambridge University Press.
- Goble-Garatt and Associates. (2002). *Technical appendix 4: Coral Bay boating facility, terrestrial vegetation and fauna study*. (Online). http://www.dpi.wa.gov.au/inline/whats_new/coral_bay.html.
- Government of Western Australia. (2002). *Focus on the future: The Western Australian state sustainability strategy, consultation draft*. Perth: Department of the Premier and Cabinet.
- Gray and Lewis Planning Consultants. (1999). *Shire of Exmouth town planning scheme no. 3*. Exmouth: Shire of Exmouth.
- Gray and Lewis Planning Consultants. (2001). *Draft Shire of Carnarvon town planning scheme no. 12*. Carnarvon: Shire of Carnarvon.
- Grimble, R. and Wellard, K. (1997). Stakeholder methodologies in natural resource management: A review of principles, contexts, experiences and opportunities. *Agricultural Systems*, 55(2), 173-193.
- Hall, C.M. (1992). *Wasteland to world heritage: Preserving Australia's wilderness*. Carlton, Victoria: Melbourne University Press.
- Hall, C.M. (1994). *Introduction to tourism in Australia: Impacts, planning and development*. (2nd ed.). Melbourne: Longman Cheshire.
- Hall, C.M. and Page, S.J. (2001). *The geography of tourism and recreation: Environment, place and space*. (2nd ed.). New York: Routledge.
- Hanley, N. and Spash, C. (1993). *Cost-benefit analysis and the environment*. Cheltenham: Edward Elgar Publishing Ltd.

- Hanna, S., Folke, C., and Maler, K. (1995). Property rights and environmental resources. In S. Hanna and M. Munasinghe (Eds.), *Property rights and the environment: Social and ecological issues*, (p. 15-29). Washington, DC: The World Bank.
- Hanna, S.S., Folke, C. and Maler, K. (1996). Property rights and the natural environment. In S.S. Hanna, C. Folke and K. Maler (Eds.), *Rights to nature: Ecological, economic, cultural, and political principles for institutions for the environment*, (p. 1-10). Washington, DC: Island Press.
- Harding, G. (1968). The tragedy of the commons. *Science*, 162, 1243-1248.
- Hardy, A.L. and Beeton, R.J.J. (2001). Sustainable tourism or maintainable tourism: Managing resources for more than average outcomes. *Journal of Sustainable Tourism*, 9(3), 168-192.
- Hawkins, D.E. and Lamoureux, K. (2001). Global growth and magnitude of ecotourism. In D. Weaver (Ed.), *The encyclopedia of ecotourism*. New York: CABI Publishing.
- Hermanides, C. and Nijkamp, P. (1998). Multicriteria evaluation of sustainable agricultural land use: A case study of Lesvos. In E. Beinart and P. Nijkamp (Eds.), *Multicriteria analysis for land use management*, (p. 61-78). Dordrecht: Kluwer Academic Publishers.
- Horton, B., Colarullo, G., Bateman, I.J. and Peres, C. (2002). *Evaluation of non-users willingness to pay for the implementation of a proposed national park in Amazonia: A UK/Italian contingent valuation study*. CSERGE Working Paper, ECM 02-01. Centre for Social and Economic Research on the Global Environment (CSERGE).
- Hufschmidt, M.M., James, D.E., Meister, A.D., Bower, B.T. and Dixon, J.A. (1983). *Environment, natural systems and development: An economic valuation guide*. Baltimore and London: John Hopkins University Press.
- Humphries, S.E., Groves, R.H. and Mitchell, D.S. (1994). Plant invasions: Homogenizing Australian ecosystems. In C. Moritz and J. Kikkawa (Eds.), *Conservation biology in Australia and Oceania*, (p. 149-170). Chipping Norton: Surrey Beatty and Sons.
- Innes, J.E. (1996). Planning through consensus building: A new view of the comprehensive planning ideal. *Journal of the American Planning Association*, 62(4), 460-472.
- International Union for the Conservation of Nature (IUCN). (1980). *World conservation strategy: Living resource conservation for sustainable development*. Switzerland: Author.
- Irving, M. (15 October 2002). Land review has stations in fear over their future. *The West Australian*, p. 8-9.
- Isaacs, J.C. (2000). The limited potential of ecotourism to contribute to wildlife conservation. *Wildlife Society Bulletin*, 28(1), 52-60.
- Jakeman, A. and Letcher, R.A. (2001). Integrated assessment and information systems for catchment management. In *Proceedings of the international congress on modelling and simulation, MODSIM, 10-13 December 2001, Canberra*.
- Janssen, R. (1992). *Multiobjective decision support for environmental management*. Dordrecht: Kluwer Academic Publishers.

- Janssen, R. (2001). On the use of multi-criteria analysis in environmental impact assessment in the Netherlands. *Journal of Multi-Criteria Decision Analysis*, 10, 101-109.
- Jones, T.M., Wicks, A.C. and Freeman, E.R. (2002). Stakeholder theory: The state of the art. In N.E. Bowie (Ed.), *The Blackwell guide to business ethics*, (p. 19-38). Massachusetts and Oxford: Blackwell Publishers Inc.
- Keeney, R.L. and Raiffa, H. (1993). *Decisions with multiple objectives: Preferences and value tradeoffs*. Cambridge: Cambridge University Press.
- Kininmonth, I. (2000). *Identifying areas of agricultural significance*. Perth: AgPlan, Agriculture Western Australia.
- Klaus Richter and Associates. (1999). Preliminary feasibility study for the development of eco lodge facility, North-West Cape, Western Australia. In Adams and Associates Pty Ltd., *North West Cape eco lodge development proposal*. Perth: Western Australian Tourism Commission.
- Krutilla, J.V. (1967). Conservation reconsidered. *American Economic Review*, 57(4), 777-786.
- Lahdelma, R., Salminen, P. and Hokkanen, J. (2000). Using multicriteria methods in environmental planning and management. *Environmental Management*, 26(6), 595-604.
- Landsberg, J., James, C.D., Morton, S.R., Hobbs, T.J., Stol, J., Drew, A. and Tongway, H. (1997). The effects of artificial sources of water on rangeland biodiversity. (Online). Environment Australia.
http://www.crin.gov.au/biodiversity/publications/technical/artificial_water/index.htm.
- Lawson, R., Merrett, T. and Williams, J. (1996). *The social impacts of tourism: A review of the literature with special emphasis on New Zealand*. Report prepared for the Tourism Policy Group, Ministry of Commerce. Wellington: Ministry of Commerce.
- Lecomber, R. (1975). *Economic growth versus the environment*. London: Macmillan.
- Ledoux, L., Beaumont, N., Cave, R. and Turner, R.K. (2002). *Towards integrated catchment/coastal zone management: Science, policy and scenarios*. CSERGE Working Paper ECM 02-05. Centre for Social and Economic Research on the Global Environment (CSERGE).
- Legislative Council of Western Australia. (1995). *First report of the legislative council select committee on Cape Range National Park and Ningaloo Marine Park*. Perth: Author.
- Lele, S. (1991). Sustainable development: A critical review. *World Development*, 19(6), 607-621.
- Lourensz, R.S. (1981). *Tropical cyclones in the Australian region July 1909 to June 1980*. Department of Science and Technology, Bureau of Meteorology.
- Lumley, S. (1999). Interpreting economics, rhetoric and sustainable development: Some implications for policy determination. *Australian Geographer*, 30(1), 35-49.
- MacArthur, J. (1997). Stakeholder analysis in project planning: origins, applications and refinements of the method. *Project Appraisal*, 12(4), 251-265.

- MacTiernan, A. (2002a). Future pastoral land tenure and exclusions from pastoral leases. In *Proceedings of the Gascoyne Muster pastoral industry forum, 4-5 May 2002, Carnarvon*. Perth: Pastoral Lands Board.
- MacTiernan, A. (2002b). Coastal strategy adds Ningaloo. *Minister for Planning and Infrastructure Media Release*, 21 September 2002.
<http://www.mediastatements.wa.gov.au/media/media.nsf/recentreleases/Mannah+MacTiernan>.
- MacTiernan, A. (2002c). Better protection for Ningaloo coast. *Minister for Planning and Infrastructure Media Release*, 28 November 2002.
<http://www.mediastatements.wa.gov.au/media/media.nsf/recentreleases/Mannah+MacTiernan>.
- Markandya, A. and Pearce, D. (1994). Natural environment and the social discount rate. In J. Weiss (Ed.), *The economics of project appraisal and the environment*, (p. 31-51). Aldershot: Edward Elgar Publishing Ltd.
- McManus, P. (1996). Contested terrains: Politics, stories and discourses of sustainability. *Environmental Politics*, 5, 48-73.
- Meadows, D.H., Meadows, D.L., Randers, J. and Behrens, W. (1972). *The limits to growth: A report for the Club of Rome's project on the predicament of mankind*. New York: Universe Books.
- Meric, H.J. and Hunt, J. (1998). Ecotourists' motivational and demographic characteristics: A case study of North Carolina travellers. *Journal of Travel Research*, 36(4), 57-61.
- Michael Robinson and Associates. (2002). *Technical appendix 6: Coral Bay boating facility, report on archaeological and anthropological issues*. (Online).
http://www.dpi.wa.gov.au/inline/whats_new/coral_bay.html
- Mirovitskaya, N. and Ascher, W. (Eds.). (2001). *Guide to sustainable development and environmental policy*. Durham and London: Duke University Press.
- Monnikhof, R.A.H. and Bots, P.W.G. (2000). On the application of MCDA in interactive special planning processes: Lessons learnt from two stories from the swamp. *Journal of Multi-Criteria Decision Analysis*, 9, 28-44.
- Moriki, A., Coccossis, H. and Karydis, M. (1996). Multicriteria evaluation in coastal management. *Journal of Coastal Research*, 12(1), 171-178.
- Moscardo, G., Pearce, P., Green, D. and O'Leary, J.T. (2001). Understanding coastal and marine tourism demand from three European markets: Implications for the future of ecotourism. *Journal of Sustainable Tourism*, 9(3), 212-227.
- Muller, H. (1997). The thorny path to sustainable tourism development. In L. France (Ed.), *The Earthscan reader in sustainable tourism*. London: Earthscan Publications Ltd.
- Munasinghe, M. (1993). *Environmental economics and sustainable development*. Washington, DC: World Bank.
- Munda, G. (1996). Cost-benefit analysis in integrated environmental assessment: Some methodological issues. *Ecological Economics*, 19, 157-168.

- Munda, G., Nijkamp, P. and Rietveld, P. (1998). Environmental decision making: a comparison between cost-benefit analysis and multicriteria analysis. In S. Faucheux, M. O'Connor and J. van der Straaten (Eds.), *Sustainable development: Concepts, rationalities and strategies*. Dordrecht: Kluwer Academic Publishers.
- Nardini, A. (1997). A proposal for integrating environmental impact assessment, cost-benefit analysis and multicriteria analysis in decision-making. *Project Appraisal*, 12(3), 173-184.
- Newsome, D., Moore, S.A. and Dowling, R. (2001). *Natural area tourism: Ecology, impacts and management*. Buffalo, New York: Channel View Publications.
- Ningaloo Reef Outback Coast Association. (2002). *The NROCA project: Sustainability in practice on the Ningaloo Coast, Western Australia*. Unpublished draft report.
- North, D.C. (1991). Institutions. *Journal of Economic Perspectives*, 5(1), 97-112.
- Notzke, C. (1995). A new perspective in Aboriginal natural resource management: comanagement. *Geoforum*, 26(2), 187-209.
- Ostrom, E. (1990). *Governing the commons: The evolution of institutions for collective action*. New York: Cambridge University Press.
- Ostrom, E. and Schlager, E. (1996). The formation of property rights. In S.S. Hanna, C. Folke and K. Maler (Eds.), *Rights to nature: Ecological, economic, cultural, and political principles for institutions for the environment*, (p. 127-156). Washington, DC: Island Press.
- Park, J. and Seaton, R.A.F. (1996). Integrative research and sustainable agriculture. *Agricultural Systems*, 50, 81-100.
- Partidario, M.R. (1999). Strategic environmental assessment – principles and potential. In J. Petts (Ed.), *Handbook of environmental impact assessment, volume one*, (p. 60-73). Oxford: Blackwell Science Ltd.
- Pastakia, C.M.R. and Jensen, A. (1998). The rapid impact assessment matrix (RIAM) for EIA. *Environmental Impact Assessment Review*, 18, 461-482.
- Payne, A.L., Curry, P.J. and Spencer, G.F. (1987). *An inventory and condition survey of rangelands in the Carnarvon Basin, Western Australia*. Technical Bulletin No. 73. Western Australia: Department of Agriculture.
- Pearce, D. (1998). Cost-benefit analysis and environmental policy. *Oxford Review of Economic Policy*, 14(4), 84-100.
- Pearce, D. and Barbier, E. (2000). *Blueprint for a sustainable economy*. London: Earthscan Publications Ltd.
- Pearce, D., Barbier, E. and Markandya, A. (1990). *Sustainable development: Economics and environment in the third world*. London: Earthscan Publications Ltd.
- Pejovich, S. (1998). *Economic analysis of institutions and systems*. (2nd ed.). Massachusetts: Kluwer Academic Publishers.
- Perman, R., May, Y., McGilvray, J. and Common, M. (1999). *Natural resource and environmental economics* (2nd ed.). Essex: Pearson Education Ltd.

- Petts, J. (1999). Environmental impact assessment – overview of purpose and process. In J. Petts (Ed.), *Handbook of environmental impact assessment, volume one*, (p. 3-11). Oxford: Blackwell Science Ltd.
- Poon, A. (1993). *Tourism, technology and competitive strategies*. Wallingford: CAB International.
- Prato, T. and Hajkovicz, S. (2001). Comparison of profit maximisation and multiple criteria models for selecting farming systems. *Journal of Soil and Water Conservation*, 56(1), 52-55.
- Preece, N., van Oosterzee, P. and James, D. (1995). *Two way track. Biodiversity conservation and ecotourism: an investigation of linkages, mutual benefits and future opportunities*. Biodiversity Series Paper No. 5. Canberra: Biodiversity Unit, Environment Australia.
<http://www.ca.gov.au/biodiversity/publications/series/paper5/index.html>.
- Proctor, W. (2001). *Valuing Australia's ecosystem services using a deliberative multi-criteria approach*. Paper presented at the European Society for Ecological Economics, Frontiers 1 Conference: Fundamental Issues of Ecological Economics, July 3-7 2001, Cambridge, England.
- Productivity Commission (2002). *Pastoral leases and non-pastoral land use*. Productivity Commission Research Paper. Canberra: AusInfo.
- Qureshi, M.E. and Harrison, S.R. (2001). A decision support process to compare riparian revegetation options in Scheu Creek catchment in North Queensland. *Journal of Environmental Management*, 62, 101-112.
- Randall, A. (1987). *Resource economics: An economic approach to natural resource and environmental policy*. (2nd ed.). New York and Toronto: John Wiley and Sons, Inc.
- Rathe, G. (1990). *The wreck of the Barque Stefano off the North West Cape of Australia in 1875*. Western Australia: Hesperian Press.
- Resource Assessment Commission (RAC). (1992). *Multi-criteria analysis as a resource assessment tool*. RAC Research Paper No. 6. Canberra: Australian Government Publishing Service.
- Ridgely, M.A. and Heil, G.W. (1998). Multicriterion planning of protected area buffer zones: An application to Mexico's Izta-Popo National Park. In E. Beinart and P. Nijkamp (Eds.), *Multicriteria analysis for land use management*, (p. 298-309). Dordrecht: Kluwer Academic Publishers.
- Robinson, J. (2000). Does MODSS offer an alternative to traditional approaches to natural resource management decision-making? *Australian Journal of Environmental Management*, 7, 170-180.
- Sagoff, M. (1988). *The economy of the earth*. Cambridge: Cambridge University Press.
- Samuelson, P.A. (1954). The pure theory of public expenditure. *Review of Economics and Statistics*, 36(4), 387-389.
- Samuelson, P.A. (1955). Diagrammatic exposition of a theory of public expenditure. *Review of Economics and Statistics*, 37(4), 350-356.
- Sanderson, P.G. (1997). *Cuspate forelands on the west coast of Western Australia*. Unpublished doctoral dissertation, University of Western Australia, Western Australia.

- Santos, J.M.L. (1998). *The economic valuation of landscape change: Theory and policies for land use and conservation*. Cheltenham and Massachusetts: Edward Elgar Publishing Ltd.
- Sharpley, R. (2000). Tourism and sustainable development: Exploring the theoretical divide. *Journal of Sustainable Tourism*, 8(1), 1-19.
- Simon, H.A. (1958). *Administrative behaviour*. New York: MacMillan.
- SMEC Australia. (2001). *Draft Carnarvon coastal strategy*. Prepared for the Shire of Carnarvon and Shire of Exmouth. Carnarvon: Shire of Carnarvon.
<http://www.planning.wa.gov.au/cgi-bin/index.cgi?page=/publications/content.html>
- Stewart, T.J. and Joubert, A. (1998). Conflicts between conservation goals and land use for exotic forest plantations in South Africa. In E. Beinart and P. Nijkamp (Eds.), *Multicriteria analysis for land use management*, (p. 17-31). Dordrecht: Kluwer Academic Publishers.
- Teale, A. and Duckstein, L. (1992). A procedure for selecting MCDM techniques for forest resources management. In A. Goicoechea, L. Duckstein and S. Zionts (Eds.), *Multiple criteria decision making. Proceedings of the ninth international conference: Theory and applications in business, industry and government*. New York: Springer-Verlag New York Inc.
- Tisdell, C. and Wilson, C. (2001). Wildlife-based tourism and increased support for nature conservation financially and otherwise: Evidence from sea turtle ecotourism at Mon Repos. *Tourism Economics*, 7(3), 233-249.
- Tiwari, D.N., Loof, R. and Paudyal, G.N. (1999). Environmental-economic decision-making in lowland irrigated agriculture using multi-criteria analysis techniques. *Agricultural Systems*, 60, 99-112.
- Van Herwijnen, M., Janssen, R. and Nijkamp, P. (1993). A multi-criteria decision support model and geographical information system for sustainable development planning of the Greek islands. *Project Appraisal*, 8(1), 9-22.
- Van Pelt, M.J.F. (1993a). *Ecological sustainability and project appraisal: Case studies in developing countries*. Aldershot: Avebury.
- Van Pelt, M.J.F. (1993b). Ecologically sustainable development and project appraisal in developing countries. *Ecological Economics*, 7, 19-42.
- Van Pelt, M.J.F., Kuyvenhoven, A. and Nijkamp, P. (1990). Project appraisal and sustainability: methodological changes. *Project Appraisal*, 5(3), 139-158.
- Venn, T.J. and Harrison, S.R. (2001). Appropriate multi-criteria decision support tools for aiding indigenous decision-makers in Aurukun Shire, Cape York Peninsula. In *Proceedings of the international congress on modelling and simulation, MODSIM, 10-13 December 2001, Canberra*.
- Welsh, T. and McGin, N. (1998). Toward a methodology of stakeholder analysis. In H. Costin (Ed.), *Readings in strategy and strategic planning*. Orlando: The Dryden Press, Harcourt Brace and Company.
- Western Australian Labour Government. (2001). *Ecotourism strategy for Western Australia*. 2001 Election Policies. (Online). <http://www.ministers.wa.gov.au/policies/Ecotourism.pdf>.

- Western Australian Planning Commission (WAPC). (1997). *State planning strategy*. Perth: Author.
<http://www.planning.wa.gov.au/cgi-bin/index.cgi?page=/publications/content.html>
- Western Australian Planning Commission (WAPC). (1998). *Esmond-Learmonth (North West Cape) structure plan*. Perth: Author.
<http://www.planning.wa.gov.au/cgi-bin/index.cgi?page=/publications/content.html>
- Western Australian Planning Commission (WAPC). (2001a). *Coastal zone management policy for Western Australia: Draft*. Perth: Author.
<http://www.planning.wa.gov.au/cgi-bin/index.cgi?page=/publications/content.html>
- Western Australian Planning Commission (WAPC). (2001b). *Draft statement of planning policy: state coastal planning policy*. Perth: Author
<http://www.planning.wa.gov.au/cgi-bin/index.cgi?page=/publications/content.html>
- Western Australian Planning Commission (WAPC). (2002). *Carnarvon coastal strategy, stage one: Summary of public submissions*. Perth: Author.
<http://www.planning.wa.gov.au/cgi-bin/index.cgi?page=/publications/content.html>
- Western Australian Tourism Commission (WATC) and Department of Conservation and Land Management (CALM). (1997). *Nature based tourism strategy for Western Australia*. (Online).
http://www.calm.wa.gov.au/projects/pdf_files/nature-based_tourism_strategy.pdf
- Western Australian Tourism Commission (WATC). (2000). *Gascoyne tourism research review*. Perth: Author.
- Western Australian Tourism Commission (WATC). (2001). *Annual report 2001*. Perth: Author.
<http://www.tourism.wa.gov.au/AboutWATC/annualreports.asp>
- Western Australian Tourism Commission (WATC). (Undated). *Value of tourism: Nature-based tourism*. (Online). <http://www.tourism.wa.gov.au/industry/nature.asp>
- White, K. (2002). *Comparative gross margins – medium Merino versus exotic breeds*. Carnarvon: Department of Agriculture.
- Wight, P.A. (1996). North American ecotourists: Market profile and trip characteristics. *Journal of Travel Research*, 34(4), 2-10.
- Wilkie, D.S. and Carpenter, J.F. (1999). Can nature tourism help finance protected areas in the Congo Basin? *Oryx*, 33(4), 332-338.
- Wood, D.S. and Dowling, R.K. (2002). *Tourism surveys in North West Cape region 1989-2002*. A summary report prepared for the Department of Planning and Infrastructure.
- Wood, D.S. and Hopkins, D. (2001). *Diversification through tourism in a most sensitive environment*. Draft unpublished report.
- World Commission on Environment and Development (WCED). (1987). *Our common future*. Oxford: Oxford University Press.
- World Tourism Organisation (WTO). (1998). Ecotourism. *WTO News*, 1st quarter. Madrid: Author.

- World Tourism Organisation (WTO). (2000). *Tourism Highlights 2000*. (2nd ed.). Madrid: Author.
- World Tourism Organisation (WTO). (2002). Latest trends in the main ecotourism source markets. *WTO News*, 1st quarter. Madrid: Author.
- Wyre, G. (2002). Exclusions from pastoral leases in 2015 for conservation. In *Proceedings of the Gascoyne Muster pastoral industry forum, 4-5 May 2002, Carnarvon*. Perth: Pastoral Lands Board.
- Zhu, X., Walker, D. and Mayocchi, C. (2001). Integrating multi-criteria modelling and GIS for sugercane allocation. In *Proceedings of the international congress on modelling and simulation, MODSIM, 10-13 December 2001, Canberra*,(p. 1103-1108).
- Zionts, S. (1992). The state of multiple criteria decision making: Past, present and future. In A. Goicoechea, L. Duckstein and S. Zionts (Eds.), *Multiple criteria decision making. Proceedings of the ninth international conference: Theory and applications in business, industry and government*. New York: Springer-Verlag New York Inc.

9 APPENDICES

APPENDIX I – VISITATION SCENARIOS

This appendix provides the spreadsheet calculations for the visitation scenarios for all alternatives. Table 9.2 presents the background data and assumptions used to calculate visitation. Table 9.3 presents the calculations for the number of monthly campsites for the pastoral alternatives (both high and low visitation scenarios). Table 9.4 presents the calculations for visitor nights for all alternatives for the wilderness camping and Gnaraloo 3-mile campground. These figures provide the visitation levels used in the CBA. Finally, table 9.5 provides the calculations for tourism expenditure that are incorporated into the MCA as scores for the 'tourist expenditure in regional economy' attribute. Tables 9.2 to 9.4 all use the data presented in table 9.2.

Throughout this appendix, the alternatives are referred to using the letters A through D for management alternatives and numbers one to two for visitation scenarios. Table 9.1 provides a guide to these labels.

Table 9.1 Guide to Labels Used to Denote the Alternatives in Appendix One

Management Alternative	Visitation Scenario	Label
Pastoral	High	A1
	Low	A2
Shires and CALM	High	B1
	Low	B2
Gnulli and CALM	High	C1
	Low	C2
CALM	High	D1
	Low	D2

Table 9.2 Assumptions for Visitation Calculations and Regional Tourism Expenditure

Assumptions

Pastoral options

Visitation growth rate Pastoral - Low		
	Yr 1-10	Yr 11-25
Peak	0.05	0.025
Off-peak	0.1	0.05

Visitation growth rate Pastoral - High		
	Yr 1-10	Yr 11-25
Peak	0.05	0.025
Off-peak	0.2	0.05

To calculate visitation nights

	Normal	School Holidays*
People/campsite	1.5	3
Number of weeks	4	2
Days/week	7	

* School holidays occur for 2 weeks during April, July and October

CALM managed options (Shires & CALM, Gnulli & CALM, CALM)

Initial visitation 40000

Visitation growth rates			
Low visitation		High visitation	
Yr 1-10	Yr 11-25	Yr 1-10	Yr 11-25
0.05	0.025	0.1	0.025

Gnaraloo Campground

	# Months	Occupancy rates
Jun-Aug	3	0.9
Ap-May & Sep-Oct	4	0.7
Nov-Mar	5	0.1

Visitation growth rates		
	Yr 1-10	Yr 11-25
Low visitation	0.01	0
High visitation	0.025	0

total campsites	50
people/per campsite	2
days/month	30

Visitor Expenditure

	% of non-WA visitors		Expenditure/p erson/day
	Year 1-10	Year 11-25	
Pastoral alternatives	0.4	0.45	70
Non-pastoral alternatives	0.54	0.6	70

Discount rate 0.08

Table 9.3 Visitation Calculations for the Pastoral Alternatives

Pastoral Alternatives											Maximum Campsites	250
Assumed Number of Campsites (Pastoral - Low)												
Year	J	F	M	A	M	J	J	A	S	O	N	D
1	10	10	30	100	200	250	300	250	150	50	30	10
2	11	11	33	105	210	263	315	263	165	55	33	11
3	12	12	36	110	221	250	300	250	182	61	36	12
4	13	13	40	116	232	250	275	250	200	67	40	13
5	15	15	44	122	243	250	250	250	220	73	44	15
6	16	16	48	128	250	250	250	250	242	81	48	16
7	18	18	53	134	250	250	250	250	250	89	53	18
8	19	19	58	141	250	250	250	250	250	97	58	19
9	21	21	64	148	250	250	250	250	250	107	64	21
10	24	24	71	155	250	250	250	250	250	118	71	24
11	25	25	74	159	250	250	250	250	250	124	74	25
12	26	26	78	163	250	250	250	250	250	130	78	26
13	27	27	82	167	250	250	250	250	250	136	82	27
14	29	29	86	171	250	250	250	250	250	143	86	29
15	30	30	90	176	250	250	250	250	250	150	90	30
16	32	32	95	180	250	250	250	250	250	158	95	32
17	33	33	100	184	250	250	250	250	250	166	100	33
18	35	35	105	189	250	250	250	250	250	174	105	35
19	37	37	110	194	250	250	250	250	250	183	110	37
20	38	38	115	199	250	250	250	250	250	192	115	38
21	40	40	121	204	250	250	250	250	250	202	121	40
22	42	42	127	209	250	250	250	250	250	212	127	42
23	44	44	133	214	250	250	250	250	250	222	133	44
24	47	47	140	219	250	250	250	250	250	233	140	47
25	49	49	147	225	250	250	250	250	250	245	147	49
Assumed Number of Campsites (Pastoral - High)												
Year	J	F	M	A	M	J	J	A	S	O	N	D
1	10	10	30	100	200	250	300	250	150	50	30	10
2	12	12	36	105	210	263	315	263	180	60	36	12
3	14	14	43	110	221	250	300	250	216	72	43	14
4	17	17	52	116	232	250	275	250	250	86	52	17
5	21	21	62	122	243	250	250	250	250	104	62	21
6	25	25	75	128	250	250	250	250	250	124	75	25
7	30	30	90	134	250	250	250	250	250	149	90	30
8	36	36	107	141	250	250	250	250	250	179	107	36
9	43	43	129	148	250	250	250	250	250	215	129	43
10	52	52	155	155	250	250	250	250	250	250	155	52
11	54	54	163	159	250	250	250	250	250	250	163	54
12	57	57	171	163	250	250	250	250	250	250	171	57
13	60	60	179	167	250	250	250	250	250	250	179	60
14	63	63	188	171	250	250	250	250	250	250	188	63
15	66	66	198	176	250	250	250	250	250	250	198	66
16	69	69	207	180	250	250	250	250	250	250	207	69
17	73	73	218	184	250	250	250	250	250	250	218	73
18	76	76	229	189	250	250	250	250	250	250	229	76
19	80	80	240	194	250	250	250	250	250	250	240	80
20	84	84	250	199	250	250	250	250	250	250	250	84
21	88	88	250	204	250	250	250	250	250	250	250	88
22	93	93	250	209	250	250	250	250	250	250	250	93
23	97	97	250	214	250	250	250	250	250	250	250	97
24	102	102	250	219	250	250	250	250	250	250	250	102
25	107	107	250	225	250	250	250	250	250	250	250	107

Table 9.4 Visitation Calculations for all Alternatives – Wilderness Camping and Gnaraloo 3-mile Campground

Visitor Nights						
Year	A1	A2	B1=C1=D1	B2=C2=D2	Gnaraloo A1=B1=C1=D1	Gnaraloo A2=B2=C2=D2
1	67830	67830	40000	40000	18000	18000
2	71883	73206	42000	44000	18180	18450
3	72115	75158	44100	48400	18362	18911
4	72951	77817	46305	53240	18545	19384
5	73988	79488	48620	58564	18731	19869
6	76598	83035	51051	64420	18918	20365
7	78470	86885	53604	70862	19107	20874
8	80119	91446	56284	77949	19298	21396
9	81913	96856	59098	85744	19491	21931
10	83864	102777	62053	94318	19686	22480
11	84925	103997	63604	96676	19686	22480
12	86034	105271	65195	99093	19686	22480
13	87191	106603	66824	101570	19686	22480
14	88400	107995	68495	104109	19686	22480
15	89663	109450	70207	106712	19686	22480
16	90982	110971	71963	109380	19686	22480
17	92360	112562	73762	112114	19686	22480
18	93800	114224	75606	114917	19686	22480
19	95305	115963	77496	117790	19686	22480
20	96878	117601	79433	120735	19686	22480
21	98521	118443	81419	123753	19686	22480
22	100239	119320	83455	126847	19686	22480
23	102035	120232	85541	130018	19686	22480
24	103913	121182	87679	133269	19686	22480
25	105876	122171	89871	136600	19686	22480

Table 9.5 Calculations for Regional Tourism Expenditure

Regional Tourism Expenditure								
Year	Tourism Expenditure				Discounted Tourism Expenditure			
	A1	A2	B1=C1=D1	B2=C2=D2	A1	A2	B1=C1=D1	B2=C2=D2
1	2403240	2403240	2192400	2192400	2225222	2225222	2030000	2030000
2	2521764	2566368	2274804	2360610	2162006	2200247	1950278	2023843
3	2533352	2633938	2361056	2544365	2011056	2090905	1874282	2019799
4	2561906	2721632	2451346	2745188	1883077	2000481	1801812	2017795
5	2596128	2781985	2545872	2964753	1766881	1893373	1732678	2017761
6	2674442	2895199	2644845	3204901	1685352	1824467	1666701	2019631
7	2732153	3017279	2748483	3467656	1594185	1760553	1603713	2023344
8	2783698	3159591	2857017	3755242	1503945	1707028	1543557	2028840
9	2839325	3326035	2970688	4070108	1420369	1663845	1486084	2036067
10	2899408	3507192	3089752	4414943	1342987	1624509	1431153	2044973
11	3295267	3984007	3498213	5004526	1413283	1708672	1500324	2146356
12	3330179	4024150	3564998	5106036	1322460	1598045	1415710	2027677
13	3366639	4066104	3633452	5210083	1237906	1495098	1336013	1915737
14	3404721	4109953	3703618	5316732	1159175	1399279	1260938	1810140
15	3444499	4155787	3775538	5426047	1085850	1310078	1190207	1710516
16	3486054	4203701	3849255	5538094	1017546	1227020	1123561	1616517
17	3529469	4253793	3924816	5652943	953906	1149668	1060756	1527815
18	3574831	4306166	4002266	5770663	894598	1077614	1001563	1444103
19	3622233	4360929	4081652	5891326	839315	1010480	945768	1365091
20	3671771	4412528	4163023	6015006	787772	946700	893169	1290509
21	3723545	4439059	4246428	6141778	739704	881845	843577	1220099
22	3777661	4466671	4331918	6271719	694865	821602	796815	1153623
23	3834231	4495410	4419545	6404908	653028	765637	752716	1090854
24	3893371	4525328	4509363	6541427	613982	713641	711124	1031579
25	3955202	4556477	4601426	6681359	577530	665327	671891	975598
NPV					31586002	35761336	32624389	42588268
EAA					2958938	3350078	3056213	3989617

APPENDIX II – COST BENEFIT ANALYSIS CALCULATIONS

This appendix presents the spreadsheet calculations for the CBA. Tables 9.7 to 9.11 provide the data and assumptions used. These are broken down into the following categories: pastoral operation, wilderness lodge operation and camping and management operation. Table 9.7 presents the data for the pastoral operation and table 9.8 the data for the wilderness lodge operation. Tables 9.9 to 9.11 relate to the camping and management operation. Table 9.9 presents data and assumptions for visitor revenues and campsite infrastructure costs. Table 9.10 provides data for roading infrastructure and maintenance costs. Table 9.11 provides data for management operating costs.

Table 9.12 provides the calculations for the pastoral and wilderness lodge operations. Table 9.13 provides the calculations for the camping and management operations and table 9.14 presents the calculations for the total discounted returns – all operations.

Throughout this appendix, the alternatives are referred to using the letters A through D for management alternatives and one to two for visitation scenarios. Table 9.6 provides a guide to these labels.

Table 9.6 Guide to Labels Used to Denote the Alternatives in Appendix Two

Management Alternative	Visitation Scenario	Label
Pastoral	High	A1
	Low	A2
Shires and CALM	High	B1
	Low	B2
Gnulli and CALM	High	C1
	Low	C2
CALM	High	D1
	Low	D2

Table 9.7 Data for Pastoral Operation Calculations

Pastoral Operation

APPROXIMATE AREAS					
	<i>Coast length</i>	<i>Total km</i>	<i>Ha</i>	<i>Station size¹</i>	<i>Coastal strip % of whole</i>
Ningaloo	65	130	13000	49731	26.14
Cardabia	33	66	6600	199876	3.30
Warroora	45	90	9000	107653	8.36
Gnaraloo	58	116	11600	91328	12.70
Total	201	402	40200		
	% stocked	0.7	Total Ha Stocked		28140

Stocking rate (ha/DSI) ²	6
Income/DSI ²	19.47
Direct Costs/ DSI ²	10.61
% of overheads	0.2
Overheads	7322.6

OVERHEAD SCHEDULE ³	
Accountant	2549
Admin./Phone	2884
Freight - General	1526
Vermin & Shire Rates	3044
Lease Payments	3874
Stores	8796
Subscriptions	821
Travelling	219
Vehicle Registration	1500
Fuel & Oil:	11400
Overheads	36613

FERAL GOATS	
ha/goat	10
Turnoff rate	0.3
Price/hd	20
Labour cost	600
Direct cost/hd	5.1
Goat income	17369

INFRASTRUCTURE SCHEDULE ³					
<i>Item description</i>	<i>No</i>	<i>Cost/unit</i>	<i>Salvage value</i>	<i>Life Years</i>	<i>Infrastructure Replacement</i>
Shearing Shed	0.3	75000	0	100	no replacement
Shearing Quarters	0.3	150000	0	100	no replacement
Fences	200	1368	0	20	100 km replaced in years 10 and 15
Trap Yards (1 paddock)	8	1500	0	15	4 replaced in years 12 and 15
Trap Yards (2 paddock)	0	2500	0	15	
Waters	15	7000	0	30	5 replaced in years 10, 15 and 20
Truck	1	15000	1000	10	1 replaced in years 5 and 16
Ute	1	20000	500	10	1 replaced in years 1, 11 and 21

Notes

1. Station size from Payne *et al.* (1987).
2. From K. White (2002).
3. Adapted from K. White (2002).

Table 9.8 Data for Wilderness Lodge Operation Calculations

Wilderness Lodge Investment Costs

	<i>quantity</i>	<i>rate</i>	<i>total</i>
CENTRAL PLANT & EQUIPMENT			
Power generation			1000000
Water supply			
Bore			120000
Rainwater tanks			50000
Sewage disposal			500000
			1670000
ACCOMMODATION FACILITIES			
Accommodation units	40	21000	840000
Shared ablution & service centres	4	79200	316800
			1156800
MANAGER'S RESIDENCE			
Residence	1	135000	135000
Garages	1	10000	10000
			145000
CENTRAL FACILITIES			
Guests & Admin facilities			875000
Beachside facilities			37500
Central plant enclosures			350000
			1262500
SITE WORKS & SITE SERVICES			
Roads, car parking & paved areas			215250
Walkways			75000
Landscaping & enhancements			205000
			495250
FURNITURE, FITTINGS & EQUIPMENT			
private lodge accom.	40	8000	320000
ablution & service centres	4	2000	8000
managers residence	1	20000	20000
Central facilities building			500000
beachside facilities			10000
maintenance & workshop			20000
			878000
OTHER			
External lighting			50000
Water reticulation			125000
Power reticulation			125000
Security services			50000
Communication services			10000
			360000
Consultant fees (10%)			596755
Contingency sum			500000
Total			7890248

inflation since 1999

0.11691776

Wilderness Lodge Operations

OCCUPANCY & RATE INFO.			
Days/year			365
# rooms			40
Occupancy rate			0.5
double occupancy factor			0.7
	Rack rate	Bus. level	
	Mar-Sep	150	0.75
	Oct-Feb	120	0.25
Industry discount factor			0.2
Av. Room rate			193.8

FOOD & BEVERAGE	
<i>Revenues</i>	
Food income (per person)	60
Bev. Income (per person)	15
Food rev	744600
Bev rev.	186150
<i>Costs</i>	
Cost of sales (Food)	0.35
Cost of sales (Bev)	0.34
Salary & wages	349962
Other expenses	55656

OTHER OPERATING DEPARTMENTS	
<i>Revenues</i>	
Souveneirs (Inc per person)	10
Activities (% of room rev.)	0.6
Other income (% of room rev.)	0.02
Souvenir Revenue	124100
Activity Revenue	848844
Other income (net)	28295
<i>Costs</i>	
Cost of sales (souven)	0.6
Cost of activities	0.4
Souveneirs	74460
Activities	339538

ACCOMMODATION	
<i>Revenues</i>	
Room revenue	1414740
<i>Costs</i>	
Other expenses (rooms)	141620
Supervisor	40768
Reception FT	0
Reception Casual	79040
Cleaner	54750

STAFF				
	Hours	Weeks	Hourly Wage	Wage
Supervisor	28	52	28	40768
Receptionist FT		52	16	0
Receptionist PT	76	52	20	79040
Cleaner	3042		18	54750
BK (PT)	20	52		45000
Mgmt couple				90000
Other payroll costs				43531
				353089

OVERHEADS	
Management couple	90000
Bookkeeper	45000
Other payroll costs	43531
Other expenses	112382
Marketing	148429
Heat, light & power	173168
Repairs & Maintenance	168220
	780730

Table 9.9 Data for Visitor Revenue Calculations and Campsite Infrastructure

Visitor Revenues

FEE STRUCTURE				
<i>Co-management & CALM options</i>			<i>Pastoral options</i>	
Visitor type	Yr 1-10	Yr 11-25		
1-2 persons	10	15		
school child.	2	4		
Visitor type	Proportion			
# couples	0.8			
# singles	0.05			
# school	0.15			
			Yr 1-10	Yr 11-25
Visitor passes (annual income)			100000	200000
			<i>Gnaraloo Campground (all options)</i>	
			Yr 1-10	Yr 11-25
fee per person			12	15
costs (% of revenue)			0.5	

Camping Infrastructure Costs

LARGE CAMPSITES				MEDIUM CAMPSITES			
camping bays		20		camping bays		10	
size per bay (m2)		30		size per bay (m2)		30	
loop (m)		400		loop (m)		250	
<i>component</i>	<i>cost</i>	<i>units</i>	<i>total</i>	<i>component</i>	<i>cost</i>	<i>units</i>	<i>total</i>
Parking/campsites	12	2200	26400	Parking/campsites	12	1300	15600
Bollards	12	300	3600	Bollards	12	175	2100
Signage			1500	Signage			1500
Toilets	4000	3	12000	Toilets	4000	2	8000
Picnic tables	400	4	1600	Picnic tables	400	2	800
Rubbish bins	68	4	272	Rubbish bins	68	2	136
Walktrail	4	500	2000	Walktrail	4	500	2000
Miscellaneous			4737	Miscellaneous			3014
Total			52109	Total			30136
SMALL CAMPSITES							
camping bays		4		<i>Number of campsites</i>	<i>Pastoral (high & low)</i>	<i>Non-pastoral (high & low)</i>	
size per bay (m2)		30		Large	4	4	
loop (m)		40		Medium	8	8	
<i>component</i>	<i>cost</i>	<i>units</i>	<i>total</i>	Small	0	10	
Parking/campsites	12	280	3360	Dayuse	0	2	
Bollards	12	40	480	Day use sites 60000			
Signage			500				
Toilets	4000	1	4000				
Picnic tables	400	0	0				
Rubbish bins	68	1	68	Fencing	cost/km	km	km
Walktrail	4	300	1200		2000	100	250
Miscellaneous			961				
Total			9608				

Table 9.10 Data for Roothing Infrastructure and Maintenance Costs

Roothing Infrastructure and Maintenance Costs

BEFORE UPGRADE								
			Pastoral High & Low		Shire/Gnulli High & Low		CALM High & Low	
	<i>% maint.</i>	<i>cost/km</i>	<i>km</i>	<i>maint.d</i>	<i>km</i>	<i>maint.d</i>	<i>km</i>	<i>maint.d</i>
	<i>annually</i>		<i>roads</i>		<i>roads</i>		<i>roads</i>	
Grade & Roll (2pa)	1	1200	130	130	130	130	130	130
Grade & Roll (1pa)	1	600	0	0	0	0	0	0
Grade only (1pa)	0.6	200	100	60	100	60	100	60
Total maintenance costs				168000		168000		168000

AFTER UPGRADE								
			Pastoral High & Low		Shire/Gnulli High & Low		CALM High & Low	
	<i>% maint.</i>	<i>cost/km</i>	<i>km</i>	<i>maint.d</i>	<i>km</i>	<i>maint.d</i>	<i>km</i>	<i>maint.d</i>
	<i>annually</i>		<i>roads</i>		<i>roads</i>		<i>roads</i>	
Grade & Roll (2pa)	1	1200	130	130	130	130	100	100
Grade & Roll (1pa)	0.8	600	50	40	70	56	160	128
Grade only (1pa)	0.6	200	65	39	60	36	0	0
Total maintenance costs				187800		196800		196800

PASTORAL OPTIONS (HIGH & LOW)					
<i>Infrastructure</i>	<i>Existing roads</i>	<i>Upgrade</i>	<i>End infrast.</i>	<i>Cost km</i>	<i>Total cost</i>
Scaled					
Unsealed Grade 1				24000	
Unsealed Grade 2	130		130	12000	0
Unsealed Grade 3	100	15	115	3000	45000

CO-MANAGEMENT OPTIONS (HIGH & LOW)					
<i>Infrastructure</i>	<i>Existing roads</i>	<i>Upgrade</i>	<i>End infrast.</i>	<i>Cost km</i>	<i>Total cost</i>
Scaled					
Unsealed Grade 1				24000	
Unsealed Grade 2	130	70	200	12000	840000
Unsealed Grade 3	100	30	60	3000	90000

CALM OPTIONS (HIGH & LOW)					
<i>Infrastructure</i>	<i>Existing roads</i>	<i>Upgrade</i>	<i>End infrast.</i>	<i>Cost km</i>	<i>Total cost</i>
Scaled					
Unsealed Grade 1		100	100	24000	2400000
Unsealed Grade 2	130	130	160	12000	1560000
Unsealed Grade 3	100	0	0	3000	0

Table 9.11 Data and Assumptions for Management Costs

Management Costs

STAFF				
	Pastoral options		Non-Pastoral options	
	<i>cost/unit</i>	<i>units</i>	<i>cost/unit</i>	<i>units</i>
Ranger	34500	0	34500	3
Maintenance workers	42000	0.5	42000	1
Caretakers	600	8	1400	15
Station staff	25000	8		0
Support staff			40000	

OTHER COSTS				
	Pastoral options		Non-Pastoral options	
	<i>cost/unit</i>	<i>cost p/a</i>	<i>cost/unit</i>	<i>cost p/a</i>
Facility maintenance		40000		90000
Toilet replacement	4000		4000	
Rubbish disposal		3600		3600
Administration costs	20000		20000	

	All options		
	<i>cost/unit</i>	<i>units</i>	<i>cost p/a</i>
Vehicle costs	18000	2	36000

PEST CONTROL					
	<i>cost/unit</i>	Pastoral options		Non-Pastoral options	
		<i># p/a</i>	<i># units</i>	<i># p/a</i>	<i># units</i>
Fox baiting					
Aerial (km ²)	7.92	2	200	4	400
Ground (km)	8000	1	20	1	25

Discount Rate 0.08

Table 9.12 Calculations for Pastoral and Wilderness Lodge Operations

PASTORAL OPERATIONS				WILDERNESS LODGE OPERATIONS					
	Investment	Net Revenue	Disc. Returns	Investment Costs		Net Revenue		Discounted Returns	
Year	A1=A2	A1=A2	A1=A2	B1=C2=D1	B2=D2	B1=C2=D1	B2=D2	B1=C2=D1	B2=D2
1	20000	51600	29259					0	0
2		51600	44239	7890248	15780495			-6764616	-13529231
3		51600	40962			1235651	2471302	980899	1961799
4		51600	37928			1235651	2471302	908240	1816480
5	15000	51600	24909			1235651	2471302	840963	1681926
6		51600	32517			1235651	2471302	778670	1557339
7		51600	30108			1235651	2471302	720990	1441981
8		51600	27878			1235651	2471302	667584	1335167
9		51600	25813			1235651	2471302	618133	1236266
10	171300	51600	-55444			1235651	2471302	572345	1144691
11	20000	51600	13553			1235651	2471302	529949	1059899
12	6000	51600	18108			1235651	2471302	490694	981388
13		51600	18973			1235651	2471302	454346	908692
14		51600	17568			1235651	2471302	420691	841382
15	176800	51600	-39468			1235651	2471302	389529	779057
16	15000	51600	10683			1235651	2471302	360675	721349
17		51600	13946			1235651	2471302	333958	667916
18		51600	12913			1235651	2471302	309220	618441
19		51600	11956			1235651	2471302	286315	572630
20	34500	51600	3669			1235651	2471302	265107	530213
21	20000	51600	6278			1235651	2471302	245469	490938
22		51600	9491			1235651	2471302	227286	454572
23		51600	8788			1235651	2471302	210450	420900
24		51600	8137			1235651	2471302	194861	389723
25		51600	7535			1235651	2471302	180427	360854
NPV			360300					4222188	8444375

Table 9.13 CBA Calculations for Camping and Management Operations

CAMPING MANAGEMENT OPERATIONS									
	Infrastructure Costs			Operating Costs		Camping Revenues			
Year	A1=A2	B=C	D1=D2	A1=A2	B=C=D	A1	A2	B1=C1=D1	B2=C2=D2
1	160000	820000	1600000	432328	477972	389010	389010	400000	400000
2	166718	669218	2184218	500068	539922	406881	413982	410680	421900
3	195153	217653	952653	620968	661172	408933	424836	421851	445788
4	172653	172653	172653	652768	688172	413499	438689	433537	471856
5		48040	48040	676368	765572	418907	448519	445762	500319
6		48040	48040	676368	765572	430842	466193	458555	531410
7		60000	60000	676368	765572	439732	485201	471943	565387
8		60000	60000	676368	765572	447714	507227	485954	602532
9				676368	765572	456303	532847	500620	643157
10				676368	765572	465554	560669	515973	687603
11				676368	765572	705728	852005	815140	1079164
12	24000	24000	24000	676368	765572	713011	860379	826828	1096928
13	24000	44000	44000	676368	765572	720618	869131	838807	1115137
14	32000	44000	44000	676368	765572	728562	878279	851086	1133800
15	32000	20000	20000	676368	765572	736861	887841	863672	1152930
16		20000	20000	676368	765572	745530	897836	876573	1172538
17		8000	8000	676368	765572	754587	908286	889796	1192637
18		8000	8000	676368	765572	764050	919212	903349	1213238
19				676368	765572	773939	930637	917242	1234354
20				676368	765572	784273	941401	931482	1255998
21				676368	765572	795074	946936	946078	1278183
22	24000	24000	24000	676368	765572	806364	952696	961039	1300923
23	24000	44000	44000	676368	765572	818165	958692	976373	1324231
24	32000	44000	44000	676368	765572	830503	964933	992091	1348122
25	32000	20000	20000	676368	765572	843402	971431	1008203	1372610

CAMPING MANAGEMENT OPERATIONS

Discounted Returns									
Year	A1	A2	B1	B2	C1	C2	D1	D2	
1	-188257	-188257	-831456	-831456	-831456	-831456	-1553678	-1553678	
2	-222827	-216739	-684551	-674932	-684551	-674932	-1983419	-1973800	
3	-323239	-310615	-362761	-343759	-362761	-343759	-946228	-927226	
4	-302775	-284259	-314070	-285904	-314070	-285904	-314070	-285904	
5	-175224	-155070	-250352	-213222	-250352	-213222	-250352	-213222	
6	-154723	-132446	-223746	-177835	-223746	-177835	-223746	-177835	
7	-138075	-111544	-206339	-151816	-206339	-151816	-206339	-151816	
8	-123535	-91382	-183485	-120502	-183485	-120502	-183485	-120502	
9	-110088	-71796	-132542	-61238	-132542	-61238	-132542	-61238	
10	-97648	-53591	-115613	-36115	-115613	-36115	-115613	-36115	
11	12592	75327	21259	134494	21259	134494	21259	134494	
12	5021	63543	14795	122055	14795	122055	14795	122055	
13	7446	62054	10750	112355	10750	112355	10750	112355	
14	6875	57848	14134	110387	14134	110387	14134	110387	
15	8982	56577	24620	115807	24620	115807	24620	115807	
16	20188	64645	26562	112952	26562	112952	26562	112952	
17	21140	62680	31412	113260	31412	113260	31412	113260	
18	21942	60772	32477	110026	32477	110026	32477	110026	
19	22608	58917	35144	108622	35144	108622	35144	108622	
20	23151	56862	35596	105220	35596	105220	35596	105220	
21	23582	53750	35859	101833	35859	101833	35859	101833	
22	19497	46413	31540	94058	31540	94058	31540	94058	
23	20063	43997	28409	87654	28409	87654	28409	87654	
24	19261	40460	28783	84929	28783	84929	28783	84929	
25	19717	38412	32508	85718	32508	85718	32508	85718	
NPV	-1584326	-773443	-2901069	-1297406	-2901069	-1297406	-5505626	-3901963	

Table 9.14 CBA Calculations for all Operations – Total Discounted Returns

TOTAL - ALL OPERATIONS								
Discounted Returns								
Year	A1	A2	B1	B2	C1	C2	D1	D2
1	-158998	-158998	-831456	-831456	-831456	-831456	-1553678	-1553678
2	-178588	-172500	-7449167	-14204163	-684551	-7439547	-8748035	-15503031
3	-282277	-269653	618138	1618040	-362761	637140	34672	1034573
4	-264847	-246332	594170	1530577	-314070	622336	594170	1530577
5	-150314	-130161	590611	1468704	-250352	627741	590611	1468704
6	-122206	-99929	554924	1379504	-223746	600834	554924	1379504
7	-107967	-81436	514651	1290165	-206339	569175	514651	1290165
8	-95657	-63504	484099	1214666	-183485	547082	484099	1214666
9	-84275	-45983	485591	1175028	-132542	556895	485591	1175028
10	-153092	-109035	456733	1108576	-115613	536231	456733	1108576
11	26145	88880	551208	1194393	21259	664444	551208	1194393
12	23129	81651	505489	1103443	14795	612749	505489	1103443
13	26419	81027	465096	1021048	10750	566702	465096	1021048
14	24443	75416	434825	951769	14134	531078	434825	951769
15	-30486	17109	414149	894864	24620	505335	414149	894864
16	30871	75328	387237	834301	26562	473627	387237	834301
17	35086	76626	365370	781176	31412	447218	365370	781176
18	34855	73684	341697	728467	32477	419246	341697	728467
19	34565	70874	321459	681253	35144	394938	321459	681253
20	26820	60531	300702	635433	35596	370327	300702	635433
21	29859	60027	281328	592771	35859	347302	281328	592771
22	28988	55905	258826	548631	31540	321344	258826	548631
23	28851	52785	238859	508555	28409	298104	238859	508555
24	27398	48597	223645	474652	28783	279790	223645	474652
25	27252	45947	212935	446572	32508	266145	212935	446572
NPV	-1224026	-413143	1321119	7146969	-2901069	2924782	-1283439	4542412
EAA	-114665	-38703	123761	669519	-271769	273990	-120231	425528