Rescuing the Rangelands

Management strategies for restoration and conservation of the natural heritage of the Western Australian rangelands after 150 years of pastoralism

by

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Foreword

This compelling book is about the rangelands of Western Australia. The term 'rangelands' may not be immediately familiar to all readers, but it is destined to become so, as it is increasingly used by scientists and managers. It evokes an image of wide open spaces, and land management on a broad canvas. It is the land of Banjo Patterson, of Mary Grant Bruce, of Arthur Upfield. This is the land that is so embedded in the Australian psyche that even hardened city dwellers think of the rangelands with affection as 'the outback', and the 'real Australia'. Although it is often seen by them on television, it is less frequently experienced directly. This country is also known as the pastoral region. It is the place where stock are grazed on rather sparse native vegetation in an area of relatively low rainfall, and vast tracts of land are managed by few people. Rainfall in these parts is erratic, low and dwindling, and even a casual observer can see that the land has been deteriorating, and that it cannot be possible to maintain the stocking rates of the earlier halcyon years of pastoral settlement.

Yet wonderful landscape values remain. And after the characteristically unpredictable rainfall events, the landscape is transformed by stunning tracts of white, yellow, and pink everlasting flowers, and red, yellow or blue-flowered shrubs. This display is just a sample from a large reservoir of biodiversity in the rangelands. Here grow plants with life histories that fit them well for survival in areas of low and erratic rainfall. But those plants, and the native animals which they sustain, continue to be under threat from inappropriate land management practices.

In recent years, however, changes in the economic and environmental viability of maintaining pastoral leases provided opportunities for government to acquire appropriate tracts of land for the conservation estate, for management in perpetuity.

Tony Brandis has long been at the forefront of formulating government strategies to choose the land that is to be incorporated into the conservation estate, and to help lay the foundations for its ongoing management - tasks that require extensive knowledge, drive, and tact. Tony was encouraged by his collaborators, colleagues and department to write an integrated account of this work and have it examined for the award of a professional doctorate from the University of Notre Dame, Fremantle, Western Australia. The success of this process and award of the doctorate gives Tony's contribution the stamp of independent approval.

The volume now before us makes Tony's work more widely available to the public. It covers a wide range of issues: land deterioration in the pastoral areas; economic, social and administrative issues; the need for expanding the conservation estate by acquiring lands to make up a representative suite of conservation reserves in rangeland areas; and the issues that need to be addressed for their ongoing management.

As you read the book you can sense Tony's concern for the land and the people living on it, and hear him quietly explaining to you the reasons why decisions were taken. I hope you enjoy reading this volume as much as I have done.

Emeritus Professor Arthur McComb FAA,
School of Environmental Science, Murdoch University.

Author's Preface

I have been interested in the impact of the agricultural and pastoral industries on the environment for many years – even when, as a student, I worked in the northern agricultural zone and noted the encroachment of salt into what had previously been good productive agricultural land. I worked on a sheep station in the late 1960s, and couldn't ignore the impact of intense grazing impacts around water points, or in holding paddocks, and how the country had obviously been eroded in fairly recent times. Although I knew that I loved the country and the characters who had toiled to make a successful business in a very harsh climatic and economic setting, I was both puzzled and concerned about the acceptance of the adverse environmental impacts that resulted from grazing by many thousands of sheep. I later traveled quite extensively throughout the rangelands, working on a number of sheep and cattle stations during mustering, and noted the same impacts wherever I went, with the same inevitable acceptance that environmental impact didn't seem to matter provided the economic trends for the business were mostly positive.

Later, my post graduate studies in environmental science provided me with the knowledge to explore the interrelationships between these modern human activities and the environment, realizing that both economic and social factors played an important part in the equation. It was no accident that the first opportunity to apply my knowledge and research skills saw me tackling the issues of assessing environmental impact in a small part of the rangeland, and relating this to pastoral practices which had occurred over a relatively short time – perhaps only 70 or 80 years in some cases. I was fascinated to find that even though there appeared to be environmental safeguards built into the prevailing statutes, there was extensive environmental degradation that was left mostly unnoticed by the majority of those not involved in the industry.

I was seconded to the Environmental Protection Branch of the Department of Conservation and Land Management in late 1997 as the Department's Rangeland Coordinator, primarily to address the acquisition of pastoral land for inclusion in the formal conservation network. This role required consideration of the existing policy framework – which didn't appear to provide adequate scope for this new work. It was also necessary to develop a process using environmental and other criteria as a framework for making valid and repeatable assessment and evaluation of strategic conservation values on pastoral land identified as available for acquisition by government. As I progressed with this work I was also able to visit much of the pastoral area contained within the Gascoyne-Murchison Rangeland Strategy region, and saw again the impacts that 150 years of unrelenting grazing has had on the vegetation and soils of the area. I also began reading about issues of sustainability of the industry, viability of the industry and its economic

contribution to the State's economy, and the results of the rangeland condition surveys conducted throughout the pastoral rangelands by the Department of Agriculture in Western Australia.

During the course of this work it was suggested to me that I should consider writing up the methodology and results of the pastoral land acquisition program. Initially, I was surprised to think that others would be interested in this work as I had been beavering away mostly by myself for some time, without looking beyond the work I was doing. However, I was encouraged to consider putting all this work down on paper as nothing on this scale had been achieved in Australia, or perhaps the world before. While there had been numerous researchers developing models for conservation reserve selection, often utilizing the advantages of computers to process information, these mostly ignored socio-political, cultural and economic issues in relation to acquiring land for conservation purposes. I have tried to tie these issues into the decision making process, and have achieved results within the context of competing land uses. This represents a real-world outcome.

In this thesis I have aimed to provide a clear context for the need to establish a comprehensive, adequate and representative conservation reserve system as well as looking at ways of encouraging pastoral leaseholders to consider conserving important components of the landscape themselves, and the need for broader environmental sustainability if the industry is to survive in the longer term. In assessing the future of the industry within the environmental, economic and socio-political framework I have provided a contextual background upon which to draw some important conclusions about the future of the industry in the Western Australian rangelands. In the later chapters, I provide a detailed discussion of the need for a conservation reserve system in the rangelands and review some of the theoretical models that have been developed for selecting the best array of land containing the highest possible landscape and ecosystem diversity. I then provide a detailed description of a process that I have developed and used in acquiring pastoral land for inclusion in the conservation reserve system of Western Australia recognizing the social, economic, cultural and environmental issues necessary for achieving political and biodiversity conservation outcomes. The use of geographic information systems (GIS) and a computer-based approach to assessing the potential contribution to the reserve system in comparison to existing reserve system attributes is discussed.

In 1938 Francis Rattcliffe wrote about the need to make public the information about the terrible damage inflicted on the pastoral lands in eastern Australia. He wrote,

> "Faced with the progressive deterioration of her inland pastoral country and the alarming spread of erosion and drift, there is a very real danger of Australia stimulating the ignorant invalid. Anxiety to do something, anything, to stop the rot is almost certain to lead to

> the waste of money and human effort. If those on whom the responsibility of decision must fall appreciate the true state of affairs, this danger will be lessened. As I believe that my diagnosis of the situation is the only one that can be made to fit the facts, I cannot see that anything but good should result from making it public."

I share this sentiment, and have therefore attempted to address a wide spectrum of topics that provide the context for evaluating the future of an industry mostly at odds with the carrying capacity of the natural resources it is based on. If this thesis helps provide others with a better appreciation of the plight of the semi-arid and arid rangelands in the face of unrelenting grazing pressure, and the need to consider the conservation of our unique biodiversity, then I will have achieved my aim.

Tony Brandis,
Harvey,
Western Australia,
2008

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Abstract

The rangelands of Western Australia cover about 85% of the State and include the sub-tropical savanna of the Kimberley, the semi arid and arid spinifex, the southern mulga shrublands and the extensive chenopod plains of the Nullarbor. About 40% of the rangelands are managed for the production of meat and wool under a pastoral lease system. A large range of ecosystems occur within these pastoral leases where, after a relatively short period of time, many changes to native flora and fauna populations have occurred. Biological diversity in the rangelands is declining most noticeably with the extinction, or reduction in the distribution and abundance, of many medium sized (40 – 4000 gram) mammal species. Introduced predators, such as cats and foxes, weeds, changed burning regimes and the impacts of sheep and cattle are the principal factors that are believed to be responsible for the demise of plant and animal species. The recognition of the need to conserve the full array of indigenous ecosystems and species within the pastoral region has occurred at all community and political levels in various international, national, state and territory, and local settings. One of the fundamental strategies to conserving the State's biological diversity is the establishment of a comprehensive, adequate and representative conservation reserve system.

As most biodiversity occurs outside the conservation reserve system there is recognition of the need for cooperative management of off-reserve land having high conservation value, as well as the need for the introduction of ecologically sustainable management practices on all other land outside the reserve system. The Western Australian government is committed to the conservation of native flora and fauna through the establishment of an expanded system of terrestrial reserves and the setting of environmental objectives for other land uses. A targeted pastoral lease acquisition program has been progressively implemented with the cooperation of all major interest groups. To date (February 2004) over three and a half million hectares of land held under pastoral lease has been purchased for inclusion in the conservation reserve system. Off-reserve management agreements have also been developed with pastoral lessees.

While there is an extensive body of literature on the theoretical principles of reserve system establishment, there is little that addresses the real-world political, economic, and social issues that need to be addressed before an adequate, comprehensive, and representative reserve system can be established.

This research evaluates the conservation reserve design literature, and describes a pragmatic approach to achieving a comprehensive, adequate and representative conservation reserve system within the prevailing land use framework, while recognizing the political, social, cultural, economic and planning constraints. It

also reviews issues related to dealing with pastoralists, pastoral industry bodies, and relevant government agencies that were faced throughout the acquisition program.

Summary

Background

Increasing community concern about the loss of Australia's biological diversity (biodiversity) has resulted in governments reacting with a range of strategic policy documents aimed at addressing the decline in native plant and animal populations and their distribution. The overarching policy for land use in Australia is ecologically sustainable development. The establishment of a comprehensive, adequate and representative conservation reserve system is a key goal of commonwealth, state and territory governments in Australia for the conservation of biodiversity.

It is recognized that landscapes and ecosystems change throughout time, but it is the rate and extent of change that is of concern to Australians now. Much of the Australian environment has been altered to some degree by clearing for infrastructure and urban development, agriculture, and the introduction of exotic plants and animals. The loss of biodiversity is perhaps the most serious environmental problem in Australia with the potentially irreversible nature of the destruction of ecosystems, and the uncertainty about the significance of what is being lost, requiring new thinking and approaches to the use of our natural resources.

Within the Western Australian pastoral zone, which contains much of the semi-arid and arid region and supports grazing by sheep and cattle, there has been extensive modification of the native vegetation, soils, and the range of native animals that exist there. Pastoralism is the dominant land use based on the utilization of the native vegetation, and where rainfall is insufficient to support agricultural cropping or for improved pastures.

About 87% (215 million hectares) of Western Australia is rangeland supporting a significant number of endemic plants and animals, unique ecosystems, and habitats of threatened or endangered species.

Settlement of the rangelands for pastoral activities began in the 1860s following the reports of early explorers, who often traveled along major drainage systems including the riverine plains. Pastoral activities initially relied on shepherds to manage flocks of sheep usually within close proximity to natural surface water and better feed. Few fences existed at this time other than yards often constructed from local materials used to hold animals overnight or for particular flock management activities such as shearing. This method of stock management restricted the area of land that could be accessed for feed due to the need for stock to remain within easy walking distance to water, particularly in drier periods, with the result that vegetation within a restricted area around water, often highly fragile, was seriously impacted.

Once flocks were spread following the construction of fences and wells equipped with windmills, the size of the flock increased rapidly. The early expectations regarding the carrying capacity of the country were overestimated resulting in degradation of vegetation and soils. Rising economic returns in the early1900s added reason to maintain high stock numbers, but when prices for wool and beef fell combined with the inevitable drought periods, stock numbers fell dramatically. However, much of the better grazing country along watercourses had suffered severe impact with loss of vegetative cover and plant species decline exposing soils to increased erosion. Many of these impacts are still apparent today.

The pastoral industry

Pastoral rangelands are administered primarily under the Land Administration Act 1997, and the Soil and Land Conservation Act 1945, although other legislation such as the Wildlife Conservation Act and the Sandalwood Act, are also relevant. Pastoral enterprises are conducted on Crown land that is leased for the purpose of depasturing stock and for certain developments such as fencing and necessary buildings. The term of pastoral leases in Western Australia varies up to a maximum of 50 years. At the end of the lease term, they are usually rolled forward for a period equal to the previous term – known as a 'rolling lease' arrangement. The Land Administration Act 1997 establishes a Pastoral Lands Board and sets out its functions which *inter alia* are to administer pastoral leases in accordance with the legislation. These functions include the development of policies to prevent land degradation, or to rehabilitate degraded land, and to ensure pastoral leases are managed on an ecologically sustainable basis.

The economic viability of the industry is dependent on external market forces including the Commonwealth Government's monetary policies and the demand for wool and meat. These factors determine the costs of, and returns from, production. The industry faces economic uncertainty due to fickle export markets and changing monetary policy, as well as highly variable climatic conditions that also dictate production levels.

A number of inquiries into the pastoral industry, particularly the pastoral wool industry have been conducted since 1950. Two of these inquiries have recommended that Government intervention was necessary to facilitate the withdrawal of a number of non-viable leases by way of surrender of the lease or by amalgamation with neighbouring leases. No action was taken in relation to these recommendations. There is recognition of increases in debt levels and falling incomes, while investment in infrastructure maintenance and development has declined. A significant number of pastoral wool enterprises are considered to be unviable with from 30% to 60% of pastoralists considered to be in this position.

Inquiries into the pastoral cattle industry show similar results with the Kimberley Pastoral Industry Inquiry of 1985 indicating that almost half the leases are considered unviable.

Rangeland deterioration

Rangeland surveys conducted by the Western Australian Department of Agriculture and the Department of Land Administration (now Department of Planning and Infrastructure) have revealed a reduction in range condition with widespread degradation. These surveys are based on transects of pastoral leases and have now been completed for the majority of the pastoral zone. A monitoring program has also been established and is based on permanent plots within a range of different vegetation types. There are some limitations to the interpretation of the results of this monitoring program, which is not based on the random selection of sites, does not account for grazing impact, nor the potential for soil erosion to occur.

Rangeland condition surveys conducted since the late 1960s are based on the assessment of perennial vegetation at a series of condition sites that allow patterns of variation, either natural or grazing induced, to be revealed. By observing these patterns it is possible to construct vegetation condition classes defined as very good, good, fair, poor or very poor. Overall, about 24% (20 million hectares) of the area surveyed show considerable impact from grazing and are now classed as being in poor condition; about 30% (25 million hectares) in fair condition, with the remaining 46% in good condition. Impacts do not occur uniformly throughout the landscape and there are differences between survey areas. For example, only 20% of the west Kimberley, and 21% of the Murchison remains in good condition, while 77% of the Pilbara is considered to be in good condition.

The broader issue of degradation of the natural ecosystems within the pastoral zone as a result of increased total grazing pressure, and the inevitable heavy damage caused in periods of drought, raises serious concerns apparently supported by the results of the rangeland condition surveys.

The causes of rangeland degradation include overstocking, lack of flexibility in adjusting stock numbers to seasonal conditions, the impact of preferential grazing causing some plants to decline, even disappear from some landscapes, the slow rate of regeneration of perennial plants, and the frequency of droughts. The spatial distribution of artificial water resources, and the associated grazing within the piosphere surrounding these, has not only opened up much more country to the impact of grazing but has created a habitat loss gradient being most severe closest to the water point grading gradually to less severe as distance increases. The concept of total grazing pressure is important in recognizing that a range of native and introduced herbivores are also contributing to the unrelenting pressure

on native vegetation. Controlling sheep or cattle numbers must be undertaken in the context of total grazing management, and efforts made to reduce the overall grazing impact.

The economic costs of rangeland deterioration are ultimately passed onto the wider community through declining production (input into the State's economy), costs of rehabilitation, drought relief, taxation relief and income smoothing, and the loss of biodiversity. In 1989 the Western Australian Department of Agriculture estimated the gross value of losses due to vegetation decline using the area of land considered to be in poor condition. Within the pastoral wool industry losses were estimated at almost $29 million per annum; within the pastoral cattle industry losses estimated at $8 million per annum. These estimates are likely to be conservative as they do not take into account the area of land considered to be in fair condition, which must also have a decreased carrying capacity. The Collaborative Soil Conservation Study of 1975-77 estimated that the vast majority of the pastoral rangelands requires rehabilitation following range deterioration including vegetation decline, soil erosion and woody weed invasion.

The Gascoyne-Murchison Rangeland Strategy

The Gascoyne-Murchison area of Western Australia is situated within the southern rangelands. The southern rangelands contain an area of about 850,000 square kilometers containing the semi-arid and arid shrublands extending from the Nullarbor through the Goldfields to the Pilbara. Within the southern rangelands about 85% of the land is utilized for a range of land use activities including pastoralism, mining, tourism and Aboriginal cultural activities. The remainder is unutilized. The climate of the area is unpredictable with irregular rainfall and long periods of drought. Sheep and wool production is the primary land use.

The Gascoyne-Murchison area suffered a serious economic downturn from the late 1980s due to the collapse of the Reserve Price Scheme for wool in 1989, the serious drought conditions in the upper Gascoyne and Meekatharra areas in 1993 and 1994, and the depressed beef prices in 1995 to 1996. The area covers about 59 million hectares and contains 253 pastoral leases. It has generally poor range condition and a lack of drought reserves resulting from historic land-use practices that had little concern for the need to conserve the vegetation and soil.

Despite a number of previous inquiries into the viability of the industry reporting the need for government to address the long-term viability of the industry, which in many instances was not able to show a positive economic outcome, little or no action has arisen. The development of the Gascoyne-Murchison Rangeland Strategy was carried out within this historic context. The steering committee established to begin the development of the Strategy in line with government policy, and in consultation with the community, consisted of local pastoralists

with support from relevant government agencies. The Strategy was required to include proposals for restructuring directed at achieving sustainable pastoral use including opportunities for diversification, the establishment of a comprehensive, adequate and representative conservation reserve system, mining activities and meeting Aboriginal interests. The final report of the steering committee was made to the Ministerial Committee and government in 1997. The report claimed strong support from the regional community which had high expectations for action and the achievement of positive outcomes. It outlined four main areas of activity over the life of the Strategy including business and development grants; industry research aimed at identifying options for diversification of the industry; restructuring of pastoral leases to address issues of viability; and, better regional environmental management practices. The Strategy recognizes the need for industry development that addresses the principles of Ecologically Sustainable Development within the context of the range of Commonwealth and State government strategic policy settings. The Strategy sets out the regional vision: "management of the Gascoyne-Murchison rangelands so as to preserve biodiversity and ecological sustainability through the development and implementation of sound environmental objectives and the creation of a comprehensive, adequate and representative conservation reserve system".

Conservation of biodiversity

There is clear recognition that Australia's ecosystems have been extensively altered, often degraded, since European settlement. Perhaps our greatest challenge now is to ensure there is no further decline in biodiversity, but this must be viewed in light of a range of economic, social and political settings. Finding ways to protect and manage the rangeland environment will continue to challenge industry, the community and relevant government agencies. Policy development directed at the utilization of our natural resources, some of which result in the drastic alteration of ecosystems, landscapes or wildlife populations must increasingly take into account the attachment of more and more people to the need to manage our environment in a sustainable way. Any actions aimed at the conservation of biodiversity must recognize that the majority of ecosystems have been altered and that the full range of options including the establishment of a conservation reserve system as well as off-reserve conservation management and broader sustainable management of the rangeland environment will be required.

The lack of biological inventory data including taxonomic information over the majority of the Western Australian rangelands is a severe impediment to conservation planning and management. However, given the high level of species richness and endemism in the Strategy region, a failure to protect species and ecosystems from the range of threatening processes including pastoral activities,

introduced animals and plants, mining and townsite developments, may result in further loss of biodiversity including the extinction of species.

Conservation reserve system establishment

Conservation reserve systems allow for the management of land aimed at achieving an outcome that is otherwise not achievable under other land management systems. The establishment of the conservation reserve system in Western Australia, like most other countries, has been the result of *ad hoc* and unscientific selection of land. Often land with little or no worth for agricultural development was taken up for inclusion in the reserve system. The conservation reserve system in Western Australia is far from being representative of the full range of land surfaces, habitats and species.

Reserve system selection processes encompassing the use of land surfaces and vegetation associations that are assumed to reflect a degree of diversity are used extensively in the rangelands. These land surface vegetation associations are known as surrogates for other forms of biodiversity – ecosystems are most readily defined by their characteristic plant formations.

The identification of biogeographic regions throughout Australia provides the framework for the evaluation of the existing conservation reserve system and the establishment of the National Reserve System. The level of reservation is not uniformly distributed across all biogeographic regions with some requiring substantial improvement in the level of representation. There may also be a high degree of bias towards reserves appearing in some land types much more than others.

Reserve system design

The existing system of rangeland conservation reserves is the result of historic land selection rather than careful selection based on the analysis of carefully prepared scientific data. The existing conservation reserve system is neither comprehensive nor adequate and requires expansion if it is to meet policy and convention requirements. Australia has international commitments in relation to the conservation of biodiversity and has developed a framework for establishing a national reserve system. A range of approaches aimed at developing a comprehensive, adequate and representative conservation reserve system in Australia has been developed to address the need for a reliable methodology. Due to the limitations of our current knowledge about species, their distribution, richness and diversity, planning for conservation reserve systems has relied on the use of information about land systems and vegetation that is used as a surrogate for biodiversity.

There are many limitations to the use of surrogates as reliable indicators of biodiversity including:

- difficulty in establishing relationships between land or vegetation classes and the distribution and abundance of species;
- broad scale vegetation mapping contains a degree of heterogeneity making reserve system planning aimed at achieving a representative sample of all species difficult;
- there is limited knowledge about threatened species, species restricted in their distribution, or species requiring specific habitat requirements such that it is likely the use of surrogates for biodiversity will continue;
- many species require a combination of habitats not recognized by land class or vegetation mapping.

There exists a range of reserve system design tools, often relying on computer manipulation of relevant data to arrive at the best regional framework of land areas considered to meet the needs of a reserve system. There is an array of theoretical reserve system selection models, although the limitations to the availability of land for conservation make the application of many of these models doubtful as they all appear to assume that all land will be available. None of the models reviewed contained cultural, economic, social, or heritage values – all important considerations in selecting suitable areas for the establishment of a conservation reserve system.

Within the Gascoyne-Murchison Rangeland Strategy region there are extrinsic features such as competition for land use activities which make the achievement of a comprehensive, adequate and representative reserve system difficult. The establishment of a conservation reserve system in the Strategy region is opportunistic and voluntary. The development of a set of criteria that could be used for the assessment of a range of values was developed to provide consistency and repeatability in the way different conservation values on pastoral leases were then assessed and evaluated. This evaluation process is subjective and uses a range of information such as vegetation types and their distribution, land system mapping if available, special features such as riverine land systems that are poorly represented in the existing reserve system, or the rarity of species or ecosystems, and includes planning decisions about land considered valuable for conservation. Landscape and vegetation condition have also been used in the evaluation of pastoral leases. The focus of the reserve system establishment process in the Strategy region has been in regions identified through the Interim Biodiversity Regionalization of Australia (IBRA) process as having a high priority for improving the reserve system.

There is clear recognition that biodiversity and the threats to it extend across tenure boundaries, and that the majority of biodiversity remains outside the conservation reserve system. The need for cooperative management of the environment across land use and administrative boundaries is important if conservation of biodiversity is to be achieved. Land within the Strategy region,

but outside the existing conservation reserve system containing high biodiversity has been identified providing focus for developing working relationships with land users for the conservation of biodiversity. Sustainable pastoral management is a statutory requirement although little effort has been invested in defining this in a practical sense such that pastoralists might implement land use management practices across the broader landscape.

Managing the conservation reserve system

The Department of Conservation and Land Management is responsible for actively managing pastoral land acquired for inclusion in the formal conservation reserve system. Even though grossly under-resourced, the Department aims to implement a range of actions allowing the recovery of altered ecosystems while at the same time controlling feral animal impacts. All activities will be carried out within the context of management planning which will be undertaken soon after the land is acquired.

The retention of people on some of the ex-pastoral leases is an important consideration within the context of maintaining a range of services including roads, education, and communications.

Changes to the management regimes will result in conflicts with neighbours – an important issue recognized by the Department which has begun extensive liaison with adjoining land users, local government, industry bodies and Aboriginal people. Issues such as the control of feral animals, introduced weeds, fire, boundary fence maintenance, and native animal population numbers, particularly kangaroos, are recognized as requiring careful management in cooperation with other land users.

The development of recreation and tourism opportunities has the potential to impact on local, regional and state economies. The attraction of many of the State's natural areas such as contained within the conservation reserve system has resulted in a greatly increased level of tourism activity. Such development must ensure that the environmental qualities of the land are maintained in the long term. Recreation and tourism provide educational opportunities through which management for conservation of biodiversity and broader environmental issues can be fostered.

Conservation reserve system status

There has been considerable improvement in the conservation reserve system in the Strategy region as a result of the acquisition program with land containing important conservation values now managed for conservation increasing from 1.4 million hectares to 5.2 million hectares. The increase in area alone should not be seen as the most significant outcome of the program, rather the improvement in

the level of representativeness of the range of ecosystems within the region should be used as an important measure. At the beginning of the program nearly 93% of the vegetation types in the region were either not represented at all or were represented at less than 10% of their original areal extent. At the end of June 2003 the number of vegetation types represented within the reserve system had doubled and the number of vegetation types now represented at greater than 10% had quadrupled. About 44% of vegetation types within the region still remain outside the reserve system, many of which are considered to be restricted in their distribution. A number of areas containing high biodiversity also occur outside the reserve system.

At the regional level the conservation reserve system is still not comprehensive with the majority of ecosystems not represented at all or not sufficiently represented.

Future land management in the rangelands

If there is to be a sustainable future for the rangelands there must be sufficient effort by governments, industries, and people to ensure that the economic, social and environmental pressures placed on the natural systems are balanced and managed in accordance with ecologically sustainable development principles. The alteration of the natural systems within the pastoral rangelands, in particular, that has led to the loss of biodiversity must be recognized before changes to the way land is managed can hope to be accepted.

The viability of much of the pastoral industry has been questioned over a long period of time with a number of inquiries indicating that a proportion of the industry is not viable – a fact recognized in the Gascoyne-Murchison Rangeland Strategy. The perception by the broader community about the continued degradation of the pastoral rangelands has caused many to question why governments have allowed the continuance of much of the industry. Governments will have to address the issue of economic viability of the industry and how this impacts on the natural capital as well as social issues.

Future conservation of biodiversity measures must include off-reserve conservation measures that complement the management objectives of the conservation reserve system.

Chapter 1: Introduction

1.1 Background

The general awakening of the Australian community to the loss of biodiversity is made apparent in The National Strategy for the Conservation of Australia's Biological Diversity (DEST 1996) which acknowledges the need to strengthen conservation activities across Australia. The Strategy also recognizes the need for developing an integrated approach to conservation aimed at conserving biological diversity while meeting community expectations.

Biological diversity, or biodiversity, is the variety of all life forms – the different plants, animals and microorganisms, the genes they contain, and the ecosystems of which they form part (DEST 1996).

Due to millions of years of isolation from other continents, Australia's plants and animals have evolved in different ways to other places. As a result many Australian species occur nowhere else in the world. About 82% of Australia's animal species, 45% of its birds, 85% of its flowering plants, 89% of its reptiles and 93% of its frogs are found only on this continent (DEST 1996).

While human activities have been modifying Australia's ecosystems for perhaps as long as 50,000 years, it is in the 200 years since the arrival of Europeans that the rate and extent of change has impacted so dramatically on our natural environment. Much of Australia has been degraded or fundamentally altered through clearing for agriculture, infrastructure and urban development, with most parts of the land modified to some extent by a range of influences imposed on native vegetation and fauna, such as introduced herbivores and predators, exotic plants and changed fire regimes. The result of this increase in impact on the landscape is that there have been dramatic declines in the distribution and abundance of many native species, most notably with the extinction of many native mammal species (Burbidge and McKenzie 1989; Morton 1990; Flannery 1992).

The State of the Environment Advisory Council (SEAC 1996) considers loss of biodiversity as perhaps the most serious environmental problem in Australia. Farrier (1995) suggests that the potentially irreversible nature of the destruction of biodiversity and the lack of certainty about the significance of what is being lost will require a prudent approach to biodiversity conservation.

Governments have responded to the community requirement for our environment to be managed on a sustainable basis with the development of national strategies such as the National Strategy for the Conservation of Australia's Biological Diversity, the National Strategy for Ecologically Sustainable Development (Anon 1992) and the National Principles and Guidelines for Rangeland Management (ANZECC and ARMCANZ 1999). These strategic

frameworks provide guidance for governments wishing to develop policy related to industry sectors reliant on the use of natural resources (DEST 1996). Australia is also a signatory to the Convention on Biological Diversity, which deals with the conservation and sustainable use of biodiversity at a global level.

The focus of this thesis is part of the Western Australian Rangelands that has and continues to support much of the state's pastoral wool industry. Rangelands in general, and in particular that part of the rangelands supporting the pastoral wool industry, have suffered from the impacts of increased levels of grazing over the last 150 years or so. Detailed rangeland resource and condition surveys conducted by the Western Australian Departments of Agriculture and Land Administration clearly indicate the extent of modification to the native vegetation and soils of the rangelands following the development of the pastoral industry (Wilcox and McKinnon 1972; Payne *et al*. 1988; Curry *et al*. 1994; Pringle *et al.* 1994).

The development of a regional rangeland strategy addressing a range of environmental and socio-economic issues confronting the pastoral industry in 1997 provided the necessary focus for developing sustainable land use practices including the establishment of a comprehensive, adequate and representative conservation reserve system. This strategy - the Gascoyne-Murchison Rangeland Strategy, provides a framework based on the broader state and commonwealth government policies related to the conservation of biodiversity through the establishment and management of a more representative reserve system, management for the conservation of biodiversity outside the conservation reserve network, and education and extension programs aimed at changing pastoral industry attitudes and behaviour in managing the environment for economic and ecological sustainability.

The five-year period following the launch of the Strategy in 1998 has seen, amongst a range of achievements, the acquisition of a significant area of pastoral land having high conservation values that will be added to the existing conservation reserve system. Conservation reserves in the Strategy region were amongst the least representative in Australia at the commencement of the Strategy (Thackway and Cresswell 1995; Brandis and Mitchell 2000; McNamara, Brandis and Hopkins 2000). Through the lease acquisition program, which is entirely voluntary, an additional 3.8 million hectares of land has been acquired at a cost of about nine million dollars (Aus.).

1.2 Reserve system design

Lease acquisitions in the Gascoyne-Murchison region are based on a systematic approach to the assessment and evaluation of a number of criteria considered essential for the development of a representative reserve system. Reserve design and selection has been supported by gap analysis procedures using broad

scale vegetation association mapping as a surrogate for identifying ecosystems (McNamara, Brandis and Hopkins 2000).

Historically, throughout Australia, the reserve system has been developed in an *ad hoc* way (Pressey and Tully 1994; Pressey 1995) with the land set aside for reservation being land that had little or no productive capacity, or development potential, or for its recreational or spectacular scenery values (Terborgh and Winter 1983). This approach to reservation of land had little to do with the conservation of biodiversity and often related to other factors considered significant such as outstanding scenic values. This *ad hoc* approach existed in other parts of the world, and in America for example, Steinbeck (1962) wrote "it is my opinion that we enclose and celebrate the freaks of our nation and of our civilization. Yellowstone National Park is no more representative of America than Disneyland". Sullivan and Schaffer (1975) suggested that if the *ad hoc* approach to reserve selection continued the result would be a network of reserves that did not conserve the full range of ecosystems. Pressey (1994) maintains that the success of future conservation reserve networks representing most elements of biodiversity will depend on the careful selection of reserves in a world where the available options are diminishing. Pressey (1994) outlines three main causes of *ad hoc* reservations which require attention if the future selection of reserve areas is to more adequately conserve biodiversity. These include:

- political attitudes towards reservation have tended to consider that reservation of economically valuable land was a waste of productive land. This attitude has limited the establishment of the conservation reserve system to the least productive land, and most cheaply available areas for which public support can be mustered;
- necessary information about conservation and other values has not been available with the result that areas where information is available have been promoted for reservation without the consideration of alternative areas that may be more valuable or in greater need; and
- emphasis on reservation goals other than the conservation of biodiversity have often conflicted with those of conserving biodiversity (Brown and Hickey 1990).

Pressey (1994) considers two principles need to be applied to future planning for more effective conservation reserves. Firstly, the principle of urgency – that some natural features are less likely to persist under prevailing land uses and hence have a higher need for reservation than others. He sees this as a reversal of the 'worthless lands' approach. Secondly, any reserve that is not aimed at the efficient representation of biodiversity will most likely increase costs in relation to the resources needed to achieve a representation goal.

Fortunately there has been considerable progress in the development of appropriate policies and frameworks for developing the conservation reserve network in this country (DEST 1996; WA Govt. Rangeland Policy 1999;

Gascoyne-Murchison Rangeland Strategy 1998; ANZECC and ARMCANZ 1999). While these policies address the need for a comprehensive, adequate and representative reserve system, it is always going to be difficult to convince people that land having high production value should be set aside as part of the conservation reserve network. Then there is the issue of political expediency raised by Pressey (1994) who takes the cynical view that, at least in the past, *ad hoc* reservations have been the result of electioneering and political promises, rather than being based upon the rigorous application of reserve system design principles.

Pastoral land acquisition

In the Gascoyne-Murchison Rangeland Strategy region of Western Australia, pastoral leases containing high conservation values could be purchased for inclusion in the conservation reserve system, thus improving the level of representation of the range of regional ecosystems, while at the same time addressing other important economic and social issues. A comprehensive set of selection criteria have been developed, providing a repeatable and accountable assessment and evaluation process by which the conservation, scenic, wilderness, economic and planning values contained within a pastoral lease could be identified and compared. This approach is based in the need for a pragmatic process that addresses the theoretical principles of conservation reserve design while at the same time achieving the existing policy outcomes within the funding timeframe of the Strategy.

Purchase negotiations are initiated only if the values identified on a lease improve the level of comprehensiveness, adequacy and representativeness of the reserve system. Given that the lease acquisition process is voluntary it has been possible for the Department of Conservation and Land Management to establish and enhance good relationships with pastoralists and to a lesser extent with the industry as a whole (Pringle *et al*. 2003). This positive relationship building would not have been possible under a government land resumption program which could have resulted in a much more negative relationship between industry and government agencies.

Considerable progress has been made in acquiring pastoral leases or parts of leases having high conservation value, or in some cases, important strategic value where land has been acquired to extend an existing conservation reserve. Approximately 3.84 million hectares of land has been acquired for inclusion in the reserve system improving the level of comprehensiveness, adequacy and representativeness considerably.

This study quantifies changes in the reserve area using Biogeographic Regions as the initial criteria in selecting land for inclusion in the conservation reserve system, (Thackway and Cresswell 1995), and the improvement in the level of representativeness based on broad scale vegetation association mapping.

Conservation of biodiversity on non-reserve land

Conservation reserves alone cannot protect the biodiversity of the region. Even if 10% of every ecosystem could be included, which is highly unlikely, in the protected area network, most species would not be included. Any conservation reserve system will fail if the broader land use management practices ignore the conservation of biodiversity in off-reserve areas (Burgman and Lindenmayer 1998; Pringle *et al.* 2003).

The Gascoyne-Murchison Rangeland Strategy recognizes the need for broader sustainable rangeland management in the region in recognition of the fact that the "condition of the rangeland resource has undoubtedly deteriorated since the introduction of pastoralism…" The ecological sustainability of the pastoral industry is a statutory requirement (Land Administration Act 1997) although it remains ill defined in terms of on-the-ground management activities. A program of education and extension to address the way pastoral leases are managed has been developed and good progress made in engaging pastoralists to look at better management practices on their land aimed at making enterprises more economically and environmentally sustainable (Pringle and Tinley 2001; Pringle *et al.* 2003). Pringle and Tinley have developed an approach to pastoral land management that addresses the compatibility of good stock management and retaining good habitat for native plants and animals using pastoralist's knowledge about their leases. Pastoralists are able to consider the outcomes of the process in their planning for stock distribution, resting paddocks to allow the recovery of vegetation, or to address the need for remedial action if required. They may wish to develop a property management plan to guide future decisions for their business enterprise that will address environmental health issues at the same time. In the future the accreditation of a pastoralist's management plan and activities, may provide an advantage in a market growing more sensitive to sustainable production processes.

The concept of developing conservation management agreements between government agencies with responsibility for the conservation of biodiversity and pastoralists has met with limited success (Brandis and Mitchell 2000). This is due to a range of social, political and economic barriers arising from the attitude of pastoralists who perceive the imposition of land use decisions that are not made by themselves as an affront to their position as land-holder. However, most decisions to take action on conservation issues in the end come down to economics, particularly given that pastoralists are being asked to manage a part of their lease for a broader public good, often at the cost of running less stock in the area. Just one formal conservation management agreement has been developed in the Strategy region over part of a lease useless for grazing due to the occurrence

of toxic plants (*Gastrolobium* spp.). The development of other agreements has faltered over the provision of adequate compensation for pastoral values forgone by the lessee.

Ongoing management

The Western Australian government's commitment to the establishment and management of a comprehensive, adequate and representative reserve system has resulted in the allocation of additional but limited resources necessary for land acquisition and the immediate and future management activities (Gascoyne-Murchison Rangeland Strategy 1998).

The Department of Conservation and Land Management has the statutory responsibility for the conservation of biodiversity in Western Australia including the establishment and management of conservation reserves (Conservation and Land Management (CALM) Act 1984; Wildlife Conservation Act 1950).

The production of area management plans is a statutory requirement under section 56 of the CALM Act (1984). However, changing the land tenure from pastoral leasehold to a conservation tenure can be a protracted process involving the assessment of provisions for access to a range of natural resources including minerals, oil and gas, general access by the public, future development proposals resulting from various planning processes, other public assets such as water-catchment infrastructure, while retaining the need for flexibility for future government requirements.

As an interim measure Departmental managers are required under the CALM Act (1984) to prepare Interim Management Guidelines outlining and prioritizing activities considered necessary for immediate ongoing operational management. The preparation of management guidelines is a requirement prior to any 'necessary operations', such as controlled burning, works aimed at reducing visitor safety risks, access track development and ongoing tourism activities. The key ongoing management issues include fire management, safety risk assessment and remediation, access, tourism and recreation activities, feral animal control, closing down of artificial water sources, weed control, liaison with neighbours, local government and industry and boundary fence maintenance to ensure stock on neighbouring leases do not encroach and impact the land set aside for conservation management.

This study draws on the extensive experience of the author in planning and operational activities in providing a summary of the key issues confronting front line managers.

Regional overview of results of the acquisition program and status report

There has been a significant increase in the area of land acquired as part of the Gascoyne-Murchison Rangeland Strategy, which will be added to the conservation

reserve system. However, the area of land alone should not be considered as the most important outcome, and the increase in the level of representativeness of the new reserve system is comprehensively assessed to provide an insight into the improvement in the level of representativeness of regional ecosystems that has been made over the course of the Strategy. The increase in reserve area is reviewed using the framework provided by the Interim Biogeographic Regionalization of Australia process, and area changes are reported by biogeographic regions (Thackway and Cresswell 1995).

A gap analysis based on broad-scale vegetation mapping units is provided, indicating that the reserve system will require further additions to improve the overall level of representativeness of ecosystems. A number of high priority (for increasing the reserve system) biogeographical regions remain below the 10% to 15% target set in the Gascoyne-Murchison Rangeland Strategy.

Identifying the remaining gaps in the reserve system is necessary to provide focus on land containing important conservation or other values outside the reserve system. Once the remaining gaps are identified it is possible to evaluate the range of criteria including the degree of naturalness, special features such as rarity, the level of threat to biodiversity conservation, and establish priorities for action. Competition for grazing land, economic and other resource constraints, or socio-political issues, may mean that most of this land may not be able to be acquired for inclusion in the conservation reserve network (Pringle *et al.* 2003).

A comprehensive analysis of the results of the land acquisition program is reported in this study. Results of the program indicate significant progress towards achieving a more representative conservation reserve system, even though the area and percentage targets set out in the Gascoyne-Murchison Rangeland Strategy have not been fully met.

Aims of the study

The opportunity to acquire land on the scale provided by the Gascoyne-Murchison Rangeland Strategy has not arisen anywhere else in the Australian rangeland. The need to develop a pragmatic, yet repeatable process aimed at systematically assessing and evaluating conservation and other values became necessary with the approval of the Strategy by State government in 1998. The development of this assessment process in the short time frame available, combined with the need for almost immediate outcomes, was greatly facilitated by the existence of the vegetation association mapping across the state of Western Australia.

This study reviews the relevant literature available on the theoretical design of conservation reserve networks and places this in the context of the more pragmatic demands of the land acquisition program of the Gascoyne-Murchison Rangeland Strategy.

National and international conservation planning and achievements in establishing comprehensive, adequate and representative reserve systems have also been reviewed. This review has been unable to find direct comparisons of the achievement of target areas of a regional scale with similar climatic, land use, tenure, socio-economic and political conditions, driven by Government and industry as part of a regional strategy aimed at improving economic and social conditions as well as improving environmental management, and improving the conservation reserve system.

For example, the Wildlands Project in the United States of America is of a continental scale, was proposed by an individual with high conservation ideals, with the vision of establishing "…vast interconnected areas of true wilderness…, off-limits to human exploitation" (McDonnell 2002). This project is funded through public, corporate, and benevolent foundation donations, and is driven by over 35 activist groups. Large animals are the central focus of the Wildlands Project, particularly the large wide-ranging predators like the grizzly and black bear, wolves, cougars, jaguars and lynx. Efforts aimed at protecting animals appear to focus heavily on petitioning for listing animals as threatened or endangered, and filing law suits for the listing of another 2,000 species (McDonnell 2002).

The conservation plan for the Cape Floristic Region in South Africa arose from the need for conservation of one of the world's recognized biodiversity hotspots (Mittermeier *et al.* 1998; Myers *et al.* 2000), is driven by the Cape Action Plan for the Environment, and funded by the Global Environment Facility (Cowling *et al.* 2003). The plan is centred on the Cape Floristic Region containing an area of 87,892 km2, and which has about 30% of its area cleared for agriculture. The area contains a high concentration of plants and animals considered endemic. Implementation of the plan is scheduled for a 20-year period.

The framework for terrestrial biodiversity targets in the Murray-Darling Basin sets out a conservation plan for the Murray-Darling Basin Commission, and is one part of a strategic approach to manage environmental targets in the Basin including "maintaining key ecological processes; maintaining or re-establishing viable populations of native species and the integrity of ecological communities (especially vegetation); and controlling threats to biodiversity (James and Saunders 2001). The establishment of this framework is just one of the initial phases in a broad strategy aimed at increasing the conservation reserve system in the Basin. Work on finalizing conservation targets, and acquiring land with identified conservation values is yet to begin.

This study outlines the planning and operational management requirements necessary for the ongoing management of the conservation reserve system, including the need for engagement with neighbours and the broader community, industry and local government. It will show that, despite extensive land degradation

including habitat fragmentation, loss of biodiversity and the introduction of non-indigenous plants and animals into the pastoral zone of Western Australia, it is possible to select, acquire and manage areas of former pastoral land as conservation reserves which contain examples of major ecosystems of the region still in relatively good condition.

This research provides an original and far-reaching case study of conflict resolution, establishment and management of a suite of rangeland reserves, including co-operative conservation management agreements with pastoralists aimed at meeting broader conservation objectives. It evaluates the real-world results in the context of the prevailing land use framework, including recognition of political, social, cultural, economic and planning constraints. Thereby it constitutes a substantial step towards achieving a better reserve system in the rangelands of regional Western Australia.

Chapter 2: The Western Australian Rangelands

2.1 Introduction

The term 'rangeland' is unfamiliar to most Australians. Few understand what is being referred to by this term, nor where these lands occur, though they pride themselves in knowing about and visiting the semi-arid or arid lands which they refer to as the 'outback' – that part of their country with endless plains of red brown soil, scantily clad with spinifex and mulga, with the only relief provided by elegant white-trunked trees against a backdrop of spectacular rock faces and rugged, angular hills. These are the images of Australia, which are portrayed as the country's heritage so often featured in paintings, poetry, or photographs seen in coffee table books, travel guides and calendars. While there is little doubt that this vision is what makes up part of the Australian psyche and culture, the importance of the outback way of life to contemporary Australians is waning, and irrelevant to many.

The word rangeland is not referred to in either the Concise Oxford, or the Macquarie dictionaries although the word 'range' is defined as it applies to land. The Concise Oxford Dictionary (1993) describes range as a "large open stretch of grazing or hunting ground; tract over which one ranges". The Macquarie Encyclopedic Dictionary (1995) describes range as "an area or tract that is or may be ranged over". The Dictionary of Americanisms on Historical Principles (1951) provides a broader view where range is defined as "an area of uncultivated ground or wild country over which domestic stock or wild animals range for food, now especially a cattle range" - "An area, space or stretch of ground over which ranging (i.e. wandering or roaming of men or animals) takes place or is possible…". It appears that the word rangeland has arisen from the linking of the two words, and that it probably arose in America.

The term rangeland, now widely used by those who have some direct association with these areas, is taken to mean the "semi-arid and arid regions of the world where pastoralism is the dominant land use" (Proceedings of the VI International Rangeland Congress 1999). The National Principles and Guidelines for Rangeland Management in Australia (ANZEEC and ARMCANZ 1999) defines rangeland as "the internationally recognized term for land where livestock are grazed extensively on native vegetation, and where the rainfall is too low or erratic for agricultural cropping or for improved pastures". These definitions do not include any reference to that semi-arid or arid land over which man and animal range, that is not suited, for whatever reason, to pastoral activities; the definitions are economically or industry based.

A more realistic and useful definition that accommodates the full range of land uses could be: a large area of uncultivated, open land over which man and

animals, both domesticated and wild, are able to wander, and on which a number of economic, scientific, social and cultural activities take place. Ludwig *et al.* (1997) refer to a more recent development of the traditional definitions that includes reference to the grazing of these lands by feral and native herbivores, which then leads to the development of the concept of total grazing pressure.

2.2 Rangelands in Western Australia

In Western Australia, approximately 87 per cent of the state is rangeland (see Figure 1). This is about 215 million hectares in area containing vast tracts of semi-arid and arid lands receiving low or very low rainfall. However, the rangelands also include the areas north of the Tropic of Capricorn, which receive seasonally high rainfall. The main economic activities are pastoral, mining, recreation and tourism. Aboriginal people also utilize parts of the rangelands as living areas or for their pursuit of a range of traditional cultural activities, while the conservation reserve system occupies a considerable area of land.

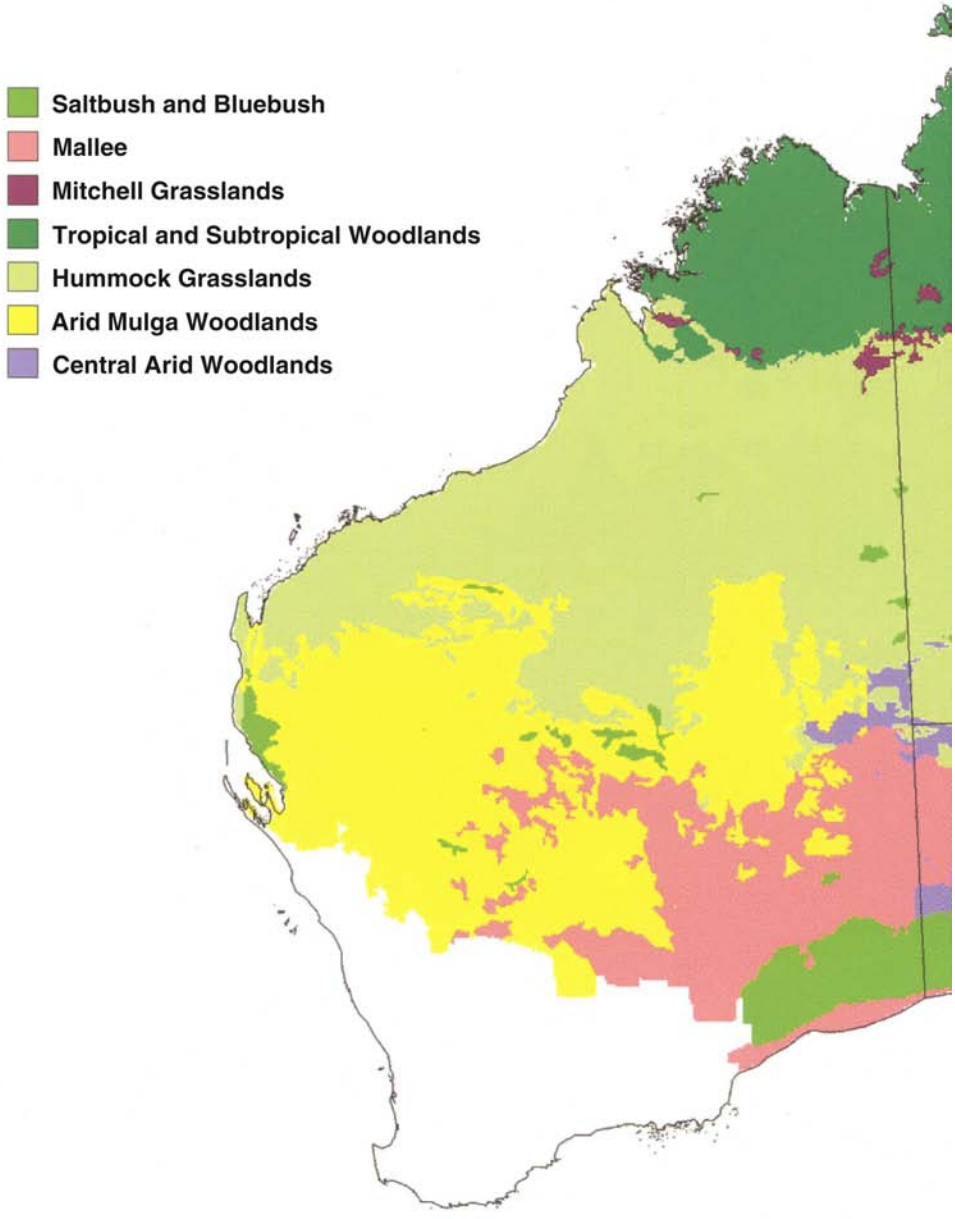
The rangelands of Western Australia are extensive and, to the untrained observer, appear to show little evidence of change or occupation by humans. Mining activities and the development of towns or pastoral industry infrastructure are localized, isolated developments. The remainder of the country appears unaffected. Upon closer inspection, however, widespread changes to the native vegetation are obvious, although sometimes quite subtle, and range from areas which are denuded of vegetation and eroding, to areas which have been colonized by introduced grasses and which appear to be undisturbed, even though there has been massive disruption to the natural balance of native plants and animals.

The main ecosystems within the Western Australian rangelands include the chenopod grasslands of the Nullarbor plain, the arid mulga (*Acacia aneura*) woodlands, the spinifex plains and ranges of the Pilbara, the spinifex sandplains of the arid interior and the tropical savanna in the north (Beard 1990). The major ecosystems occurring within Western Australia are also shown in Figure 1. Rangelands support a significant number of endemic plants and animals, unique ecosystems, and habitats of threatened or endangered species.

2.3 Early settlement

Pastoral settlement in the Western Australian rangelands began in the early 1860s following glowing reports of the early explorers (Burnside 1979; Curry *et al.* 1994). Following the establishment of settlements along the coastal areas of the state, those with an eye to expansion moved up the major river systems where water and feed were available, and took up small holdings on which they eventually established homesteads and some basic infrastructure to facilitate

Figure 1: Major ecosystems occurring within Western Australia



their pastoral activities. These people already had some idea of the aridity of the inland, its searing daytime temperatures in summer, its sometimes chilling winters and erratic, unpredictable rainfall, but were prompted to move into new areas by the competition for land on the coast and from more general pressure as land available for settlement in the eastern states was becoming more and more expensive (Burnside 1979).

Fortunately an important lesson had been learnt from America where disputes over the right to possess a piece of land often resulted in the lawless use of firearms. In Western Australia all land was decreed to belong to the Crown and land could then be purchased or leased from the Crown with a range of prescribed conditions relating to land use, period of lease and monetary remittances required. Most pastoral land in Western Australia fall into the category of leasehold land. There are some very small areas of freehold pastoral land.

Early settlement in the Pilbara occurred in the mid 1860s in the Nickol Bay area following a report prepared by Gregory, one of the state's early explorers (Burnside 1979). By the end of 1865 over 1.2 million hectares of land was held as pastoral lease running 16,000 sheep, 300 cattle and 120 horses. By the 1870s settlement had expanded to the Onslow and Ashburton areas.

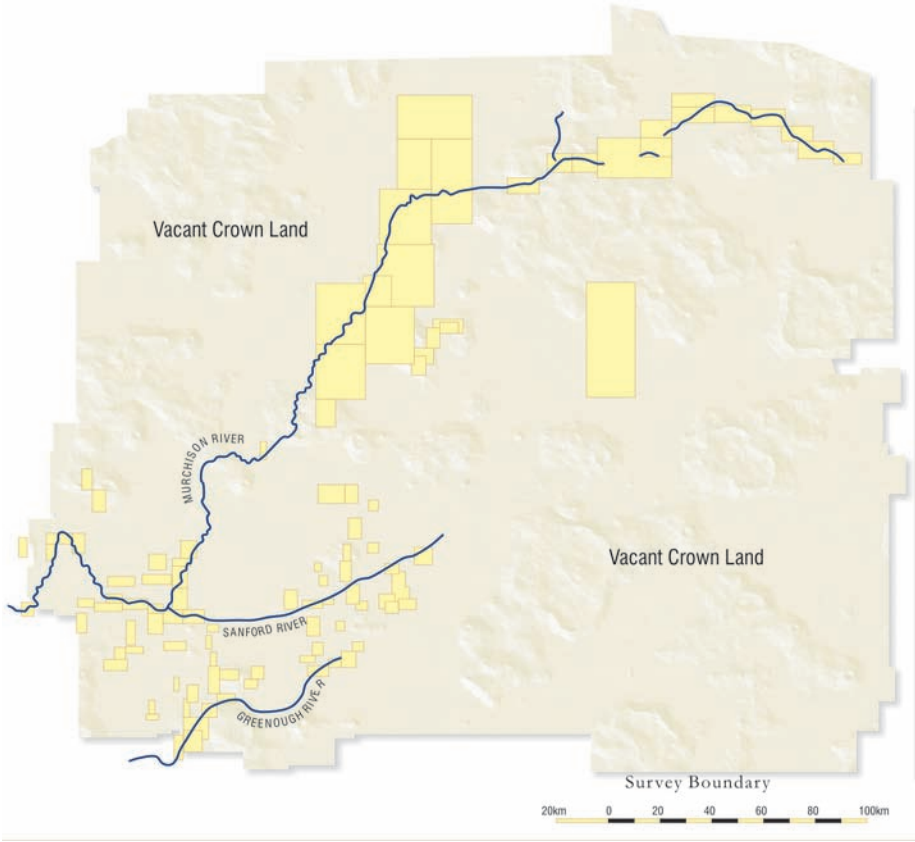
The early leases were taken up along the major river systems (see Figure 2) but later expanded further into the interior, often as the result of the activities of the gold industry (Burnside 1979; Curry *et al.* 1994; Faithfull 1994). For example the Sandstone area was not developed for pastoral activities until the 1920s (Senior 1995). Some country types such as areas of granite, and the extensive, often waterless, sandplain were avoided by the early developers.

Early reports of the Murchison described the country "proving to be fine and healthy grazing for both sheep and cattle, and that quality water was available in abundant quantity at quite shallow depths" (Nixon and Lefroy, undated). These words inspired many who came to the area seeking an ideal patch of land on which to settle and make a good living. The first pastoralists employed shepherds, often Aboriginal people, to manage the grazing of their flocks, usually within the vicinity of surface water sources or shallow wells, many of which remain today. Fences were not constructed and shepherds would bring sheep back to water daily, where they would be held overnight before returning to their pasture next day. Higher country away from the rivers was ignored.

Sheep were shorn with blade shears and the wool carted to the coast by horse or camel teams. As clean wool, as opposed to dusty wool, was valued more highly by the buyers, the wool was often washed and then dried on the properties before being baled and carted off for sale.

While flocks remained concentrated around the many shepherd's wells, their numbers none-the-less increased as did the prosperity of the lessees. The practice

Figure 2. Map showing early settlement along Murchison River.



This map from the 1880s shows the many small holdings taken up along the major watercourses in the Murchison region. Source, Curry *et al.* 1994.

of shepherding placed restrictions on the number of sheep that could be run on a lease, as well as having serious impacts on the vegetation within a restricted area around wells or water points. Flocks could not be spread out to access feed further than the distance that a shepherd could move sheep away from water and still return within a day or two, particularly during summer. The result of this level of concentrated grazing has left a legacy still obvious today, where severely degraded and eroded country, or that which is in poor condition can easily be noticed (Pringle *et al.* 2003).

As the financial situation of the early pastoralists improved, wire fences were constructed allowing flocks to be spread which ended their reliance on shepherds. Water was provided from deeper wells, which were dug at places away from the major rivers. Later, bores equipped with windmills would replace the reliance on having to employ well sinkers to dig often quite deep wells, which sometimes

provided only a limited quantity of water. The size of the flock increased quite rapidly, given the expectations of the carrying capacity of the country. As an example, an early description of Milly Milly station, which appeared in the West Australian newspaper in 1887 (see Nixon and Lefroy, undated), claimed that the lease was capable of accommodating 100,000 sheep. Today the Department of Agriculture has established a recommended carrying capacity of this lease of 14,600 – a far cry from that claimed in 1887. The Inventory and Condition Survey Report for the Murchison River catchment and surrounds (Curry *et al.* 1994), concludes that unpredictable seasonal conditions experienced led to pastoralists maintaining high stock numbers on the same country, and that this initiated the degradation of vegetation and eventually the soils of the area, particularly on the river frontage plains.

The 1870s also saw expansion into the eastern goldfields with sheep being driven inland from around Albany, with Balladonia and Mundrabilla stations selected about this time.

By the 1870s four areas of development could be identified: the Nickol Bay and coastal Pilbara; the lower Gascoyne; the upper Greenough and Murchison Rivers area; and the Balladonia – Eucla area (Burnside 1979).

Following a government-backed expedition by Alexander Forrest in 1869, a rush to acquire leasehold land occurred and by the end of 1883, 21 million hectares of pastoral land was held under lease. The first sheep were introduced into the west Kimberley in 1879 by Brockman and cattle were driven to the east Kimberley from Queensland from 1883 to 1885. By 1900 cattle numbers had risen to 205,000 and sheep to 250,000 (Burnside 1979).

Legislation was proclaimed aimed at increasing the area of land and level of development in the pastoral industry. Rents, lease terms, and rewards for stocking leases resulted in an increase in the rate of settlement, which was further enhanced by the discovery of gold in the 1880s and 90s, first in the Kimberley and then the Murchison and Kalgoorlie areas.

The cattle industry in the Kimberley enjoyed a period of good commodity prices until about 1919 when prices fell, and droughts, along with the degradation of river frontage land as a result of overstocking, meant that herd and flock numbers fell. Stations producing wool reacted by establishing watering points away from rivers and were able to sustain a recovery with flock numbers again increasing (Burnside 1979).

While the cattle industry did not recover from the problems of low prices and degraded pastures, the sheep industry now faced plummeting prices for wool. During the period from 1935 onwards the pastoral industry suffered the worst drought years yet experienced. Stock numbers fell dramatically with the greatest impact in the Murchison where sheep numbers fell by about 60% (Curry *et al.* 1994).

In 1945 K.M. Durack wrote about the lack of development of the industry, attributing some of the problem to inefficient pasture management. He considered that uncontrolled stocking levels lead to denudation and pasture destruction through erosion, and drew attention to the serious level of pasture degradation along river frontages. It is interesting to note that in the 1960s the state government began a program of revegetating severely eroded land in the Ord River catchment, primarily as a means of reducing the sediment load of the river which would allow the Ord dam project to proceed (Burnside 1979, de Salis 1993). About 1 million hectares of land was resumed by the government from leases in the area, and stock were excluded to allow for the rehabilitation of the area (de Salis 1993; Payne *et al*. 2004). Also of interest is the outcome of research conducted by the Department of Agriculture which promoted the introduction of buffel grass (*Cenchrus ciliaris*) and kapok bush (*Aerva javanica*) to areas of severely degraded and scalded country as a means of rehabilitating them as well as providing an alternative stock feed source (de Salis 1993; Payne *et al*. 2004). Both of these plants are now recognized as environmental weeds (Anon. 1999).

Much of the sheep pastoral country south of the Kimberley suffered a major drought in the period from 1936 to 1941 which caused severe hardship in the industry, with many workers having to seek employment elsewhere (Burnside 1979). There were also major impacts on the flock with numbers plummeting to around two thirds of the total number carried in the state. Regions such as the Murchison and the Sandstone-Yalgoo areas were affected even more dramatically with numbers in the Murchison falling from 840,000 sheep prior to the drought to about 250,000 in 1940 (Burnside 1979). Falling stock numbers were the result of a dramatic reduction in available feed during this drought. Perennial plant death was widespread with 75% of the saltbush (*Atriplex* spp.) and 25% of the acacias considered destroyed (Fyfe 1940). The financial collapse of the industry during this period was so extreme that the Surveyor General of the day was called upon to conduct a Royal Commission into the financial and economic position of the pastoral industry (Fyfe 1940).

Labour shortages during the Second World War placed further strain on the industry which was desperately attempting to restructure. Wool prices rose again due to the war, and during this time the British Government purchased the entire wool clip produced in Western Australia (Crowley and de Garis 1969). However pastoral properties have never regained the excessively high sheep numbers witnessed prior to the 1935-1941 drought. Stock numbers continued to rise after 1950 and improved conditions saw some recovery of pastures. High wool prices resulting from demand during the period of the Korean War offset the reduction in sheep numbers. The high prices paid for wool continued until the mid 1960s but they fell again in the 1970s, a period when the industry faced declining seasonal conditions culminating in a severe drought in the late 1970s to early

1980s. World wool prices plunged in 1991 leading to the sale of some pastoral leases, and many lessees were forced to seek alternative employment as a means of supplementing station incomes. Following this world price decline the Australian Wool Corporation removed the Reserve Price Scheme in 1991, causing further difficulties for pastoralists (Faithfull 1994).

Following the major downturn in the industry in the 1970s a number of labour saving methods have been developed such as the use of motor bikes and aeroplanes which are now used extensively for mustering (Faithfull 1994). This has led to a much lower reliance on a permanent labour force with pastoralists assisting one another in mustering and other operations, resorting to hiring seasonal labour only where necessary. These changes, along with the introduction of the minimum wage in 1966, have resulted in the loss of the full-time labour force, many of whom were Aboriginal people (Burnside 1979).

Quite clearly the expectations of the early settlers about the productive capacity of the land and the stock management practices of the first few decades following the land being taken up, have led to extensive changes in vegetation composition and cover, with some parts of the landscape being degraded to the point from which it is difficult to foresee complete recovery (Wilcox 1964; McKeon *et al*. 2004).

2.4 Conclusion

The establishment of the pastoral industry in the arid and semi-arid areas of the state followed the need for additional land for meat and wool production, at least in part due to the prospect of economic reward, but also as part of government intentions to open up the vast interior. The early stages of the industry are characterized by the use of shepherding focused on natural surface water. This practice confined sheep to relatively small areas around water, which soon became overgrazed causing the decline of vegetation and beginnings of soil erosion. The results of these animal management practices saw the beginning of land deterioration, which has continued to the present day.

Quite clearly, the high expectations of the early pastoralists for economic returns could not be sustained and the level of production has declined, particularly following the period of the 1935-1941 drought. Given that the industry is dependent almost entirely on native vegetation, it is unlikely that production will increase significantly in the future.

None-the-less, the early exploration and settlement of the arid interior provides present day Australians with a sense of pride, connection with the land, and a rather romantic vision of what makes them Australian. Very few Australians understand the extent of hardship endured by contemporary pastoralists, nor do they have much idea of the contribution the pastoral industry has made to the State's economic development.

Chapter 3: Land Administration in the Rangelands

3.1 Introduction

The pastoral rangelands in Western Australia are administered under the Land Administration Act of 1997 (which replaced the Land Act of 1933 under which rangelands were previously managed). The most extensive commercial enterprise within the rangelands is sheep and cattle grazing on pastoral leases. A pastoral lease is an administrative arrangement between the Crown and a lessee, providing for the use of land for the depasturing of stock (sheep and/or cattle), and the development of certain infrastructure that is deemed necessary for this purpose. A lease rental and certain management requirements such as maximum numbers of stock, are imposed on the lease. The Crown retains ownership of resources such as timber, soil and minerals. The Crown also retains the right to resume land for a range of purposes including for Public Works such as road, rail and communications corridors. The Native Title Act 1993 provides native title claimants the right to access land for conducting traditional activities such as ceremonial activities or hunting. At the beginning of 2001 there were 504 pastoral leases (operated as 450 businesses) occupying about 45 per cent (980,000 km^2.) of the rangelands, although some were not actively managed as pastoral enterprises. Land leased under pastoral tenure is required to be managed for the purposes of running stock unless permission to destock has been obtained.

The term of pastoral leases in Western Australia varies, although they cannot exceed 50 years, and is determined in the conditions of the lease. Pastoral leases are administered under both the Land Administration Act (1997) and The Soil and Land Conservation Act (1945). Land other than that utilized for pastoral enterprises is comprised of Unallocated Crown Land, conservation land and Aboriginal land, each managed under a range of different Acts and Regulations including the Conservation and Land Management Act (1984), the Wildlife Conservation Act (1950) and the Aboriginal Heritage Act (1972).

3.2 Legislation (pastoral lands administration)

3.2.1 The Land Administration Act (1997)

Section 94 establishes a Pastoral Lands Board (PLB) and sets out its functions under section 95 which, *inter alia*, are to administer pastoral leases in accordance with the legislation. Other important functions of the PLB set out in this section include the development of policies to prevent land degradation (95,d), to ensure pastoral leases are managed on an ecologically sustainable basis (95,c) and to

develop policies aimed at the rehabilitation of degraded land (95,e).

Section 101 provides that the Minister may grant a pastoral lease over any Crown land provided the PLB is satisfied that the land will be capable of being worked on an economically and ecologically sustainable basis (101,5a), or that the lease is to be amalgamated with an adjoining lease.

Section 136(1) restricts the area of land held by a person to 500,000 hectares unless the Minister is satisfied that the granting of an area greater than this limit will "not result in so great a concentration of control of pastoral land as to be against the public interest".

Section 103 provides for the Minister to include certain conditions, terms or covenants related to the management of the land in consultation with the PLB.

Section 105(1) fixes the term of all pastoral leases to a maximum of 50 years except that where leases change hands the term of the new lease may not be greater than that set for that lease. All pastoral leases expire on 30 June 2015.

Sections 111 – 113 provide for the level of stocking and the annual notification to the PLB of stock carried. Stock numbers must be held to within the recommended stocking levels determined from time to time by the PLB. Also in section 111(3) is the provision of the requirements for the control of declared animals and plants. Pastoralists are required to submit an annual return providing information about stock numbers carried throughout the year, as well as particulars about improvements made and the costs thereof.

Sections 115 – 122 set out arrangements for permits to engage in activities otherwise not prescribed in the pastoral lease conditions. These include permits to clear land, to sow non-indigenous pastures for agricultural purposes, and for tourism activities. Permits are issued when the impacts on broader environmental conservation requirements are shown to be negligible.

Pastoralists are required to pay rent on the lease to the value determined by the Valuer- General as set out in sections 123 to 128.

Sections 129 – 133 deal with the issuing of default notices and forfeiture of leases. Default notices may be issued where a pastoralist fails to comply with the provisions of the lease or a soil conservation notice. The default notice sets out the detail of the breach and requires the lessee to comply forthwith. Failure to comply with the conditions of a default notice may result in the lessee's liability to a fine as set out in section 130. Under section 131, if the Minister is satisfied that a pastoral lessee has not complied with the conditions of the lease or any provision of the Act, the lease is liable to forfeiture.

Under section 139 the PLB may investigate the lessee's management of the land to determine compliance with the conditions of the lease.

Part 9 of the Act deals with the compulsory acquisition of interests in land where required by the Crown for public works. Public works are generally defined

as pertaining to the supply of water, gas or electricity, the construction of roads and railways or ports. However, the Crown is authorized by the Land Administration Act, the Public Works Act or any other Act to acquire land. Section 15 (1) of the CALM Act 1984 is more specific in relation to land required for the protection of biological diversity within the formal reserve system in that it clearly deals with the issue of the compulsory taking of land "required with a purpose of, or incidental to, a State forest, timber reserve, national park, conservation park, nature reserve, marine nature reserve or marine park" by the responsible Minister. The Minister responsible for the administration of the Land Administration Act therefore has the power to compulsorily take land for the establishment of conservation reserves. Adequate compensation for any land compulsorily acquired is dealt with in part 10 of the Land Administration Act.

3.2.2 The Soil and Land Conservation Act (1945)

This Act provides for the prevention and mitigation of land degradation; the promotion of soil conservation; and the encouragement and education of land managers towards sustainable land management practices. This Act is administered by the Minister for Agriculture, Fisheries and Forestry through the Commissioner of Soil Conservation. The Commissioner chairs the Soil and Land Conservation Committee whose membership is dealt with in section 9 of the Act.

Section 14 sets out the duties of the Commissioner. These duties include the following:

- carry out surveys and investigations to determine the nature and extent of land degradation in Western Australia;
- development of preventative and remedial measures related to land degradation;
- carry out experiments and demonstrations in relation to soil conservation and reclamation;
- record and publish results of surveys, experiments and demonstrations;
- disseminate information relating to soil conservation or reclamation issues; and,
- instruct landholders in matters related to soil conservation.

Section 19 deals with the alienation, disposal, occupation, care or use of any Crown land where the issue of land degradation is relevant. Section 19A provides for the Commissioner to advise the Minister administering the Mining Act 1978 or the Minister administering the Land Administration Act 1997 in relation to any condition or term of any lease granted under the Mining Act or Land Administration Act that may lead to land degradation.

Sections 26 and 27 deal with the establishment and control of soil conservation reserves. This land may be Crown land or private land acquired under the provisions of the Land Administration Act.

Sections 31 and 32 refer to the Commissioner's powers to issue a notice to any landholder controlling land on which land degradation has occurred or is likely to occur. A notice may direct the landholder to refrain from specified land management practices, refrain from clearing land or carry out such actions specified for the prevention of soil degradation.

3.3 Tenure of pastoral leases

Under the provisions of the Land Administration Act (1997) all pastoral leases in Western Australia expire on June 30, 2015. The Act requires that the Minister notify lessees by December 1997 whether their leases are to be renewed, or otherwise, on that date. Up to that date the term of a pastoral lease varied up to a maximum of 50 years. Section 105 (2) of the Land Administration Act (1997) specifies that "a pastoral lease that expires on June 30, 2015 may be renewed for a term commencing on July 1 2015 and runs for the same length of time as the expiring lease". That is, a lease currently held for a term of 15 years or 32 years will be renewed for the same term following renewal.

A number of amendments were made to the Land Administration Act 1997 that took effect on December 7 2000. Amongst these, land may be excluded from a pastoral lease for a public purpose at the time of lease renewal in 2015. Public purpose includes for "conservation, a national park, a nature reserve or a purpose which serves or is intended to serve the interests of the public…" The Minister is required to advise pastoral lessees in writing of changes to leases not later than two years after the day on which the amendment came into operation. Lessees may accept the conditions of the new lease, withdraw from the lease or enter into negotiations with the Minister on the area to be excluded from the lease within a two-year period from the date of notification. The PLB has indicated that it will assess all notifications to change the area of leases on the basis of lease viability. The excision of land from a lease for public purposes will not affect the term of the lease but provides Government with an opportunity to manage land identified as important for the conservation of biodiversity (or other Public Work).

In submissions to the Legislative Assembly Select Committee into Land Conservation (House 1991. Discussion Paper No. 3) from the pastoral industry and individual pastoralists, a number of concerns with the existing tenure system were put forward. These relate to the lack of security which impacts on the availability of finance for development, effective long-term sustainable management (instead of short term exploitive management) and rehabilitation programs, and the influence of uncertainty on the industry and local economies. In 1985 the state government established a Pastoral Tenure Study Group to review the tenure system and to recommend alternative approaches to tenure. In the Final Report on Land Tenure the Study Group (1986) recommended that the lease system be

changed to provide for continuous use rights through the granting of a perpetual lease. There were objections to this proposal from the Conservation Council and the National Parks and Nature Conservation Authority on the grounds that land degradation would continue, that perpetual leases would pre-empt land use planning making it more difficult to implement conservation reserve proposals, and that many of the issues related to difficulty in attracting sufficient finance has more to do with the viability of a lease than the term of a lease. No amendments to bring perpetual leases into effect have been made.

3.4 Viability of the pastoral sheep industry

The viability of the industry largely depends on external market forces including the Federal Government's monetary policies and the demand for wool and meat on the export market (Jennings *et al.* 1979). These factors determine the costs of and returns for production. Along with the economic uncertainty faced by pastoralists, highly variable weather patterns also dictate the level of production. Statistically, the long-term records indicate that the majority of the arid and semi-arid rangelands are likely to receive below average rainfall more often than average or above average rainfall. In Western Australia 54 years in 100 years will experience drought conditions (Reynolds *et al.* 1983).

The pastoral sheep industry occurs mostly in the southern rangelands, with very few sheep being managed in other rangeland areas. This was not always the case as many sheep were once run in the Pilbara and Kimberley regions of the State. One third of all the sheep leases support less than 4,000 sheep and 51 per cent of these leases support between 4,000 to 12,000 sheep (Holm *et al.* 1995).

Since 1930 there have been five Government sponsored inquiries into the tenure of leases and the viability of the industry. As a result of the depressed economic state of the pastoral industry in the late 1930s a Royal Commission was held to inquire into and report on the financial and economic position of the pastoral industry. The reports into drought effects on the pastoral industry in the Goldfields region (Anon. 1972) and the future of the pastoral wool industry (Jennings *et al*. 1979) both concluded that there was a case for Government intervention to facilitate the withdrawal of a number of non-viable leases either by surrender of the lease, or by amalgamation with neighboring leases. Other significant inquiries include the Pastoral Wool Industry Task Force, 1993 (Anon. unpubl.) and the Legislative Assembly Select Committee into Land Conservation (1991). These latter reports also recognized that a large portion of the pastoral sheep industry was unviable and that government had a responsibility to take action to rectify the situation.

Jennings *et al.* (1979) reported that many pastoralists were in quite serious financial trouble due to worsening terms of trade, and a consequent decline in

profit margins, increased indebtedness and reduced capital investment. The level of indebtedness was calculated from two flock sizes – 8,000 and 15,000 sheep, to show the relative economic states of these enterprises. A producer maintaining a flock of 15,000 sheep had an average debt level about half that of a producer with 8,000 sheep. The Short Study of the Gascoyne Wool Industry 1993 (Cited in the Pastoral Wool Industry Task Force Report, Anon. 1993) indicated that debt levels had increased significantly and it has been concluded in the Report of the Pastoral Wool Industry Task Force (Anon. 1993) that average debt levels were in excess of twice that suggested by Jennings *et al.* in 1979. Jennings *et al.* (1979) considered that there was up to 150 pastoral wool enterprises (almost half) that were unviable and that those leases carrying less than 5,000 sheep had little chance of survival in the long term. Leases with 10,000 sheep were at the time able to show a small profit margin. The number of leases considered viable or not viable is set out in Table 1 (Jennings *et al.* 1979).

Table 1. Viability of leases in southern rangelands.

District	No. of viable leases	No. of non-viable leases
Goldfields	53	54
Murchison	50	47
Gascoyne	31	54
Pilbara	38	22
Total	**230**	**208**

The Pastoral Wool Industry Task Force (Anon. 1993) indicated that the economic situation of the industry was at a critical stage due, in the main, to low wool prices with nearly all specialist wool producers recording a net loss in 1991-92. An economic analysis completed at the time indicates that virtually no pastoral wool enterprises in Western Australia generated a positive cash income given the prevailing wool prices. According to the report of the Wool Industry Task Force the average business profit fell from $27,000 in 1987/88 to a loss of $40,800 in 1991/92. The result of this situation is that pastoralists reduce expenditure on maintaining and improving the infrastructure of the lease and may, where possible, draw on other income not derived from the wool business. The conclusion of the Task Force is "that while individual pastoral businesses will continue to operate profitably, the pastoral wool industry in its current form will not survive in the future under the current wool price outlook" (p. 18). The report goes on to indicate that between 30% and 60% of the pastoral wool enterprises "will have to leave the industry". Furthermore, this report suggests that leases carrying less than 8,000 sheep could be classified as unviable due to the continued decline in the terms of trade. This indicates a continued decline in the economic profitability of the industry from 1979 when Jennings indicated an enterprise viability dimension of

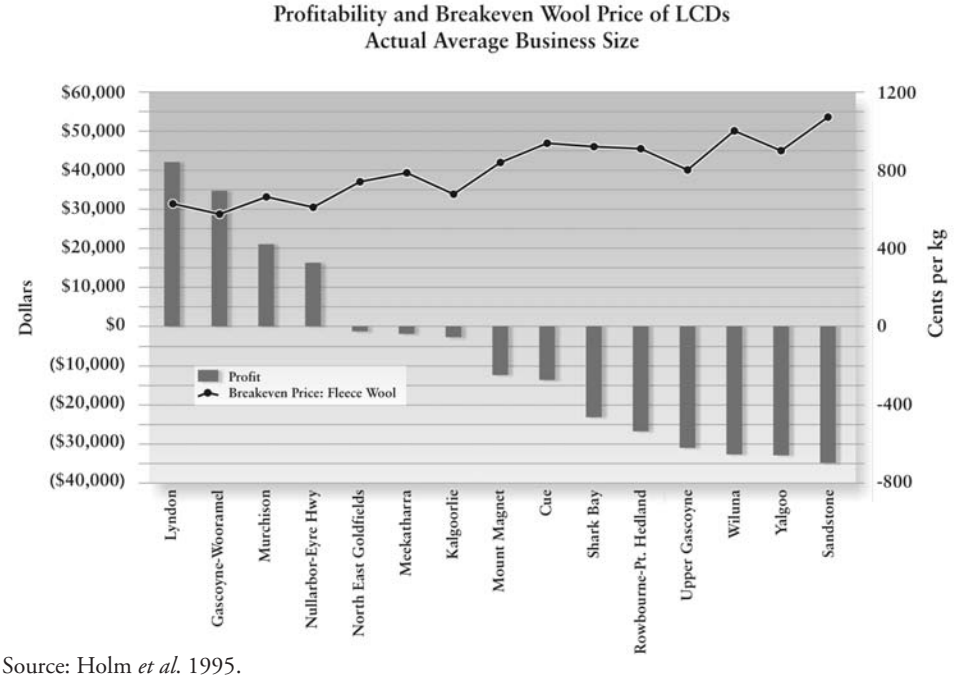
5,000 sheep. However, the Task Force (Anon. 1993) recognized the difficulties in defining viability and suggested the amalgamation of non-viable leases with those which were viable or marginally viable.

Further analysis of the viability of the pastoral wool industry was carried out and reported in 1995. The report, Regional Relativities of Sustainable Pastoral Sheep Production in Western Australia (Holm *et al.* 1995), updates some of the work of Jennings *et al.* (1979) and provides additional information. This review, which recognizes that there are regional differences (the review is based on Land Conservation Districts - LCDs) in the economic state of the industry, used two approaches to assess the regional relativities of pastoral sheep production. Firstly, it used a weighted index model consisting of production and cost indices to provide a profitability index. Secondly, an economic analysis is used to compare profit or loss of business enterprises within each region. Production indices include an analysis of factors such as seasonal growth (soil moisture), land capability (the productivity of the land types which relates to carrying capacity and requires consideration of the condition of the vegetation and climatic variations), wool characteristics (prices paid for the various types of wool, including fiber diameter, length and strength), and sheep production (including lambing percentage, wool cut per head, long term carrying capacity). Cost indices are derived from freight costs, fencing costs, fuel, and water supply costs. The pastoral profitability index is then calculated by subtracting the cost index from the production index.

The results of this analysis indicated that, not surprisingly, the most profitable areas have high pastoral value country associated with relatively low production costs while the least sustainable have low pastoral value country combined with high production costs. A number of additional factors influencing pastoral production are discussed in the concluding section of this report and include water availability and quality; the ability to produce finer wools in some areas while not in others; potential long-term stocking rates; restrictions to further development due to the vegetation of the area and the restriction this places on the number of sheep that can be carried; and range condition which has been shown to be declining across all LCDs in the study (Holm *et al.* 1995). Based on a standard business size of 10,000 sheep, the least sustainable LCDs are Sandstone, Upper Gascoyne, Wiluna and Yalgoo. When actual business size is used to calculate the relativities the majority of the LCDs are shown to be unprofitable (see Figure 3).

More recently, Bartle (2004) has shown that overhead costs are continuing to escalate, while productivity over the last three years has been relatively low. Pastoral productivity is driven by nutrition, which is the result of matching stocking rate to carrying capacity. Bartle (2004) was able to show that pastoralists have little understanding of the need to match these two factors, and that the average stocking rate across the Gascoyne-Murchison Rangeland Strategy region actually increased as the drought of the last three to four years continued, with

Figure 3. Regional relativities in relation to enterprise profitability



Source: Holm *et al.* 1995.

some stations increasing stocking rates over threefold. The consequences of this action are likely to affect both economic and environmental capital. Bartle (2004) contends that the stocking rates across the Strategy region are about double what they should be. However, the majority of the businesses reviewed by Bartle (2004) indicated a profit despite the severe and prolonged drought, with the best performing enterprises (the top 20%) averaging 14.6% return on assets managed, while the mean for these businesses showing a return of 3.7%. These figures need to be considered in context; only 58 businesses out of over 200 in the Strategy region have participated in the review. The reason for volunteering to participate in the program, and their relative long-term economic performance would be important in making sense of the profitability of the industry within the region. Bartle (2004) concludes that over 30% of the industry with an equity of less than 70% "…are of major concern" in terms of their long-term survival.

In 1991/92 the Western Australian pastoral wool industry contributed approximately six per cent of the State's total wool production (worth $35,641,000) from 2.4 million sheep run over approximately 68.5 million hectares. The gross value of pastoral wool and sheep sales in the same year was about one and a half per cent or $42,618,000 (Pastoral Wool Industry Task Force Anon. 1993).

Recent upward economic trends for both wool and sheep following the dispersal of the wool stock pile, the increasing value of the Australian dollar, a reduction

in sheep numbers such that demand is now outstripping supply, and a number of successive good seasons, has meant that economic returns to many pastoral enterprises has improved. However, several LCDs are now drought declared and have not had good winter rains for four years, which will at least slow any recovery in these areas.

3.5 Viability of the pastoral cattle industry

Pastoral leases producing cattle only are mostly confined to the Kimberley and Pilbara although there is more recently a trend towards cattle production within the region of the state once considered as sheep production country only. For example a number of leases in the Wiluna and Upper Gascoyne districts now run cattle only, where, as recent as ten years ago, pastoral enterprises in these districts were based almost entirely on sheep production.

Cattle leases in the Kimberley are large and generally poorly developed (Select Committee into Land Conservation 1991). The lack of capital and the high costs of transport hamper improvements to productivity. The issue of relatively high purchase prices of Kimberley leases is also considered to hamper profit margins.

The Kimberley Pastoral Industry Inquiry (1985) addressed the issue of viability of the pastoral cattle industry and found that just one of the businesses in the north Kimberley is non viable while 24 of the 86 leases in the west and east Kimberley are non viable. This analysis is based on the need to run 4,000 cattle to maintain an income year in/year out. When this figure is used without further qualification, the number of cattle leases in the Kimberley considered non-viable at the time of investigation rose to 48%. This figure contrasts with that derived by the 1979 Inquiry into the Pastoral Industry (Jennings *et al.*) which found that 28 of the leases (32%) were non-viable based on a carrying capacity of 4,000 head of cattle.

The 1985 Inquiry found that herds of between 10,000 and 12,000 cattle when properly managed (without causing range deterioration) could produce sufficient income to service debt up to $450,000 and make improvements to infrastructure. At the time of the Inquiry only 12 per cent of the Kimberley leases had adequate stock numbers (10,000 to 12,000) to generate adequate cash flow to cover debt and cover the costs associated with development.

More recent trends in live cattle exports to Indonesia have boosted the economic outlook of the pastoral cattle industry. However, the market continues to be somewhat unpredictable due to fluctuations in demand resulting from the discovery of disease in overseas herds, and industry subsidy schemes in other parts of the world making it difficult to compete in the international arena.

3.6 Conclusion

The provision of legislation aimed at the efficient administration of the pastoral rangelands appears sufficient, and although a comprehensive review of the workings and success, or otherwise, of the statutes and their application is outside the aims of this research, there are some outstanding examples of mal-administration. For example, the widely accepted recognition that land degradation has continued throughout the history of the pastoral industry suggests that administrators, including the Pastoral Lands Board, have not been willing to enforce the statutory requirements associated with pastoral leases. The requirement for lessees to control declared plants and animals, though clearly a condition of the pastoral lease, is an area of responsibility that has not been adequately monitored nor controlled by administrators.

Pastoral lease tenure has remained an issue for pastoralists for some time. Attempts to address this issue have not provided any shift from the *status quo* due to lack of support for change from other stakeholders. Any attempt to change tenure to some other form, considered by pastoralists as offering greater security and stability, will require considerable discussion amongst the forum of interested stakeholders. It will be difficult to change tenure arrangements unless stakeholder's views on responsible stewardship of the land are considered. Aboriginal people's views will also have to be considered in this process (Pringle *et al*. 2003).

The viability of the industry has been the focus of a number of government-sponsored inquiries over a considerable period of time. A consistent finding of these inquiries is that a significant proportion of pastoral enterprises are now, and will continue to be, unviable due principally to the limited size of their flock or herd (related to land capability). According to a number of inquiries into the economic viability of the industry, about half to two thirds of pastoral wool enterprises are unviable, and without supplementary income from alternative sources, the long-term economic position seems impossible. Pastoral lessees running enterprises that are clearly unviable, or marginally so, are likely to resort to alternative income generating activities. This may lead to a reduction in the level of management of stock and infrastructure leading to the further decline of rangeland resources and production levels. Some pastoralists may be in a position to utilize part of their non-pastoral income for the improvement of stock husbandry and infrastructure so that their leases are maintained or improved. However, the continued lack of action by government over the long-term viability of pastoral leases is likely to result in the overall decline of the industry coupled with further environmental degradation.

Given the relatively minor economic contribution to the state's domestic product (particularly the pastoral wool industry) when put into the overall context of cost to the state for the provision of roads, health, administration,

communications, education and economic relief provisions, other stakeholders' concerns about continuing expenditure and environmental sustainability must be considered. The debate about the need for a balance between economic, social and environmental constraints must continue if there is to be responsible management of the natural resources of the rangelands.

Chapter 4: Land-use Issues in the Rangelands

4.1 Introduction

The establishment of the pastoral industry in the mid to late 1800s in Western Australia heralded the beginning of a period of excessive grazing pressure on native vegetation which has resulted in the degradation of much of the rangelands (Wilcox 1964; Burnside 1979; Curry *et al*. 1994; ANZEEC and ARMCANZ 1999; McKeon *et al*. 2004). The reduction in vegetation cover, loss of soil through erosion, introduction of exotic grasses and expansion of available watering points have given rise to considerable concern by governments and communities about the long-term future of the pastoral industry and its impacts on the environment.

The main land use issues in the pastoral zone are the problems of range deterioration and the general impacts of the industry on the natural resources. This chapter outlines the nature of some of these issues and the impacts that are now coming to light through extensive surveys and monitoring programs. It also looks at the need for a greater understanding of how rangeland ecosystems function in the face of modern grazing pressures.

4.2 Range deterioration

Rangeland condition surveys conducted by the Department of Agriculture Western Australia have uniformly revealed a reduction in range condition (Wilcox and McKinnon 1972; Payne *et al*. 1987; Curry *et al.* 1994; Pringle *et al*. 1994). These surveys focus on the productivity of the vegetation important to pastoral activities but do not include information about the full range of plants; neither do they provide any information about the distribution and abundance of native animals. Survey data is derived from transects which follow lease access tracks. Other information about trends in the condition of vegetation, changes to vegetative structure and composition, is gathered from permanent plots established within pastoral leases. These permanent plots are established as part of a monitoring system known as the Western Australian Rangeland Monitoring System (WARMS) (Watson 2003). The data from WARMS sites are unlikely to provide information about areas not developed, which are in good condition, nor areas in poor or very poor condition, as these are considered of little importance to stock grazing. The WARMS sites are not selected on a random basis across the landscape but are stratified according to pastoral values (Watson *et al.* 2001 unpubl.). The WARMS system is used to estimate vegetation condition as improving or declining using three vegetation indicators (total canopy cover, density, and the occurrence of perennial plants). However, it is claimed that the system does not take into account the impact of grazing on vegetation nor the potential for soil erosion to occur (James *et al.*

Submission to the Select Committee into Land Conservation 1991). Furthermore, the information obtained from the WARMS system is retrospective and strategic in outlook rather than tactical; it provides information at the regional, district or vegetation type scale (Watson 2003).

As an outcome of extensive personal contact with pastoralists by the author, it is apparent that lessees are quite conscious of the longer-term trends in the native vegetation on which they are so dependent. A negative outcome from the measurement of the monitoring sites is most likely to result in changes to stocking regimes, although such management changes are not universal. Positive outcomes are seen as validation of responsible stock management. However, the reason for positive results from the monitoring sites, as with negative results, needs to be carefully evaluated before making management changes. For example, the outcome of the most recent measurement of the WARMS sites indicates an overall improvement in the condition of native vegetation (Watson *et al*. 2001). Watson (2003) provides a cautionary note on the interpretation of the latest positive results given the run of good seasons prior to the latest measurement program. He indicates that it is not possible to clearly show that the improvement in vegetation condition is a result of better stock management or a response to better than average climatic conditions over the preceding years.

The WARMS system was developed to monitor pastoral industry values and does not record the broader range of information that would allow for the assessment of temporal or spatial changes in biological diversity. However, it is possible to include additional parameters in the monitoring system thus providing more comprehensive information about broader biodiversity values. While the original objectives of the monitoring system remain as important today as when they were developed, we should not be blind to the need for updating our approaches to accommodate contemporary conditions and developments, rather than continue with the same linear thinking that the process cannot be changed.

The long-term adverse impacts of grazing practices on the rangelands are recognized at a national and state level by pastoralists and governments. For example, the Australian Conservation Foundation considers the "continued degradation of the pastoral region as one of the most important conservation issues facing Western Australia" (submission to the Select Committee into Land Conservation 1991). The National Principles and Guidelines for Rangeland Management (1999) states that "past management practices have led to significant areas of the rangelands being degraded calling into question their long term sustainability under current uses". At a regional level the Rangeland Condition Survey Reports published by the Department of Agriculture clearly indicate the adverse impacts of the pastoral industry on native plants, soils and landscapes (for example Wilcox and McKinnon 1972; Payne *et al.* 1987; Curry *et al.* 1994; Pringle *et al.* 1994; Payne *et al.* 1988).

The Environmental Protection Authority of Western Australia considers range deterioration to be a major environmental problem due to the extent and degree of the problem.

4.3 Landscape function

In order to appreciate the impact of introduced herbivores on the fragile ecosystems of the rangelands, it is important to understand the natural drivers of the environment and then to consider pastoral management decisions over time, and the resulting impacts, within this context.

The most significant impact on the natural environment is climate (Harrington *et al.* 1984; McKeon *et al*. 2004). In arid and semi arid environments climatic events, such as rainfall, provide the main driver (or trigger) for vegetative, biological and physical activities (Ludwig *et al.* 1997). While seasonal temperatures are essentially reliable and predictable, rainfall is far less so. The lack of reliable rainfall, and therefore soil moisture, in much of the Western Australian rangelands is the major limiting factor for plant growth. Heavy rain may result in a significant pulse in plant and animal population regeneration. Noy-Meir (1973) refers to rainfall events as the 'master input' into an ecosystem which he describes as water controlled, although others (Whitford *et al.* 1987, Gutierrez *et al.* 1988) have indicated that nutrients play an equally important role in regulating the response of plants to moisture. Just as good seasonal rainfall acts as a trigger for biological and physical activity, the lack of sufficient moisture (which occurs most years) can have an equally significant impact with plant and animal populations often declining over a period of time until the next rainfall event which then causes another pulse in activity.

4.4 Soil – the basic resource

Soils are the natural body formed by the accumulation of organic and inorganic materials at the earth's surface' (Gerrard 1981) and are a 'dynamic' medium. Soils gain and lose materials and energy at their boundaries, are organized within the landscape, and occur at different thickness depending on relative rates of deposition, removal and formation.

A range of factors determine soil movement, including rainfall intensity, soil erodibility, slope angle, plant cover and management practices. These variables have been used to predict soil loss and are grouped into what is known as the universal soil loss equation (Wischmeier and Smith 1958).

The movement of soil by natural agents of wind, water, gravity and temperature results in a familiar landscape (Mabbutt 1977; Douglas 1977; Hennig 1998). The

relatively flat Australian landscape has been formed over an extremely long period by the action of wind and water, slowly modifying the shape of the land surface. Accelerated soil loss due to human activities may cause relatively rapid changes to a landscape, which we are able to observe. In other places the accelerated movement of soil, particularly by water, has occurred as a result of pastoral activities, leading to surface deflation which has occurred over perhaps 100 years and is therefore much more subtle (Hennig 1998).

Different soil types have varying resistance to erosion. Some have a protective crust or layer of armour in the form of stony mantles, hard-setting surfaces, high level of porosity or well developed cryptogam crusts (Hennig 1998; Pringle 1998). Soils protected by a mantle of stones, or soils which have developed surface crusts, are less likely to be affected by the impact of rain drops and water movement – but this may inhibit water infiltration. However, these soils may become much more vulnerable to water erosion if the hard hoofs of sheep, goats or cattle have broken through the crust or disturbed the protective mantle (Hennig 1998)(see Figure 4).

Condon's (2002) analysis of soil erosion processes identifies a range of processes he describes as: scalding, wind sheeting, sand drift, and sheet erosion by water.

Condon (2002) maintains that scalding occurs where duplex/texture-contrast soils (i.e. a loam or sandy loam surface on clay subsoil with a high proportion of exchangeable sodium) occur, and that once the clay subsoil is exposed, a near-impermeable surface results facilitating high runoff and soil loss. These texture-contrast soils are particularly susceptible to erosion because:

- the sandy loam surface is easily pulverized by excessive trampling;
- stock concentrate on these soils because of nutritional quality due to high sodium levels in soil and rapid response of vegetation to light rainfall;
- these soils occur as elevated components of the landscape; and
- feed quality and soil conditions are favourable to rabbits.

Condon (2002) considers that these soils had suffered greatly due to high stock numbers and rabbits since the late 1800s.

Wind sheeting

Wind sheeting results in eroded surfaces on non-duplex soils where the influence of sodium on soil characteristics is absent. Although the surface is swept smooth, some moisture is able to infiltrate, and the original soil characteristics are maintained.

Sand drift

Sand drift is identifiable by the occurrence of miniature dunes where course sand is left behind on the eroded surface and is arranged into ripples; and fine and

Figure 4. Erosion resulting from sheep pad.

Overland water runoff has been channelled along this sheep pad causing soil erosion. (Photo. Courtesy Dept. Agric. WA). Source: Payne *et al.* 1998.

medium sand forming small and large dunes. Wind erosion has been a major component of land degradation where easily transported material (organic matter, clay, silt, and fine sand) has been removed with the resultant loss of associated plant nutrients (McTainish and Leys 1993). Wind erosion is affected by soil particle size, cohesion between particles, and surface roughness. Vegetation cover, including trees, shrubs and litter, increases roughness and partially absorbs wind-force, hence reduces drag on the soil surface.

The breaking of the soil crust increased the risk of wind erosion by 30 times (Leys 1991), and the damage done by sheep in breaking up surface crusts is regarded as a major cause of erosion (Bowen 1987; Tynan 2000). In drought periods involving wind-driven soil erosion, climate variability and stock management decisions that result in the reduction of vegetative cover, have contributed to soil erosion (Ward and Russell 1980; McTainish and Leys 1993).

The above erosion processes impact on plant productivity in a number of ways:

- scalding results in a reduction in water infiltration, while sheet erosion allows the more rapid transportation of water from the system (Condon 2000);
- loss of soil from profiles in which nutrients are highly concentrated (e.g. infertile land supporting mulga) results in a lower potential for plant growth (Miles 1993);
- invasion of woody weeds results in lower surface cover of grasses, reduced infiltration and greater loss of water and nutrients;
- regeneration of sites with altered surface or soil characteristics as a result of erosion, is difficult, and often requires water retention works and seeding with alternative plant species.

Sheet erosion by water

Water flowing across the landscape may lead to the formation of rills which join up lower in the profile to increase velocity and cutting power, leading to shallow gullies which cut back up-slope. Condon (2002) points out that substantial ground cover is necessary to prevent this erosion process, and that tree roots and shrubs are ineffective in preventing the process. Gullying of flats at the bottom of slopes may result in run-on or overland-flow being drained from the landscape, depriving plants of moisture and increasing flood problems further downstream (Purvis 1986).

Accelerated soil degradation in the rangelands has led to soil structure decline, vegetation decline and the mass movement of soil into drainage systems in some areas (Curry *et al.* 1994; Hennig 1998). Changes to the soil will result in changes in productivity of ecosystems for very long periods of time.

4.5 Vegetation decline

Baseline information about plant species diversity and vegetation cover of the rangelands can only be inferred from areas not subject to commercial grazing activities. It is, however, unlikely that any part of the rangelands has not had grazing impacts imposed by introduced herbivores (including a range of feral animals particularly the rabbit) (Landsberg *et al*. 1997).

In terms of pastoral production, long-lived perennial plants and annual species provide the foundation upon which the industry is based. Long-lived plants, rather than short-lived plants, provide the economic and environmental stability necessary for the industry to survive. Perennial plants range from grasses such as spinifex (*Triodia* spp.), bushes such as saltbush (*Atriplex* spp.) and blue bush (*Maireana* spp.), mulga trees (*Acacia aneura*) to large trees such as beefwood (*Grevillea striata*). Rangeland deterioration may occur once perennial plant species are substantially degraded (Payne *et al.* 1987; McKeon *et al*. 2004). Perennial plants respond to irregular rainfall events and probably respond best after periods of more than 15 days of moisture availability, while the annuals may require periods in excess of 30 days for seedling establishment and survival (Wilcox and McKinnon 1972). The importance of the perennials in stabilizing ecosystems while at the same time providing suitable fodder for grazing animals cannot be underestimated given that rainfall events of at least 15 days plus are more likely to occur than the 30 plus days of moisture availability required by the annuals. Where perennials have all but disappeared from the landscape, the area is considered to have a lower chance of producing feed for pastoral production than areas where perennial plants have been maintained (Wilcox and McKinnon 1972). This renders the country less able to carry stock, reducing the overall carrying capacity particularly in periods of drought when feed from annuals is not available. Unfortunately overgrazing during drought periods has resulted in considerable alteration to the composition of perennial plant populations and in some instances the loss of plants altogether (Ratcliffe 1953; Curry *et al.* 1994). The extensive root systems of perennial plants help hold soils intact. This is not the case with the annuals which have shallow and sparse root systems and do little to prevent soil erosion.

Woody weeds are unpalatable perennial species that have the capacity to rapidly increase in numbers following major vegetation or soil disturbance. They are long lived, the area of infestation is difficult to rehabilitate and they reduce both the ecological and economic productivity of the rangelands (Noble and Hodgkinson 1992). Woody weed infestations are symptomatic of dysfunctional landscapes (Ludwig *et al.* 1997). Ludwig *et al.* contend that overgrazing is the major cause of landscape dysfunction. However, Pringle and Tinley (2003) consider that scrub encroachment is related to landscape desiccation initiated by stock concentrating

in areas of preferred grazing. They claim that scrub encroachment is being driven by biophysical interactions rather than grazing *per se*.

The vegetation of the rangelands has evolved under grazing pressure exerted by a range of native herbivores in a harsh environment. Ludwig *et al.* (1997) make the distinction between production overgrazing and landscape overgrazing. Production overgrazing occurs when livestock become malnourished due to lack of nutrients as when all palatable vegetation have been removed, and animals show visible signs of poor health. Landscape overgrazing occurs when vegetation patches are reduced leading to soil instability and disruption of landscape functions such as the hydrological and nutrient cycles. Landscape overgrazing has the potential to impact on landscape function, the sustainability of the pastoral industry and conservation values.

Harrington *et al.* (1984) discuss the issue of the impact of domestic stock on native vegetation in relation to the timing of the pressure exerted. High grazing pressure occurs at times when feed supply is under pressure as a result of the lack of moisture, and is low when pasture is readily available. Furthermore, grazing animals do not graze across the landscape in an even way. Herbivores select preferred areas of feed and these plants are grazed preferentially. During drought periods all edible plants continue to be grazed, apart from those which defoliate, which may eventually result in their entire removal from the association (Wilcox 1964).

The results of reduced vegetation cover also include an increase in soil temperature and increased oxidation of soil organic matter making conditions for plant survival and reproduction even harsher. These conditions may lead to a further decline in vegetation health and cover and reinforce the "degradational trend" (Johns *et al.* 1984; Milton *et al*. 1994).

One of the most obvious features of rangeland ecosystems is the great change occurring in vegetation cover as a result of seasonal conditions that range from flood, through normal rainfall seasons, to drought. The fact that vegetation, in the main, recovers from dry periods once replenishing rains return, suggests that rangeland ecosystems are resilient in the face of the these harsh environmental conditions (Holling 1973, 1980). Resilience is defined as an "ability to respond markedly to outside pressures but with a strong tendency to return to the original state once the pressure is lifted" (Harrington *et al.* 1984). This implies that the changes observed do not alter the way ecosystems function. Harrington *et al.* consider that the changeability of resilient ecosystems is not considered a lack of equilibrium between species but is a sensitive interaction between all components of the system. The requirement by pastoralists for a sustained economic return is at odds with the natural system that reacts to temporal variations. This leads to "unrelenting, unresponsive grazing pressures on at least some of the Australian rangeland systems" (Harrington *et al.* 1984).

The Clementsian succession model, which theorizes that changes in species composition caused by grazing may be reversed once this pressure is removed, does not hold if the soil surface has been degraded to the point where erosion has stripped away part of the system, nor where landscape structures (patches of vegetation) have been altered or removed (Ludwig *et al.* 1997).

Recent studies using computer models to simulate the dynamics of perennial plants known to have declined as a result of livestock grazing impact, indicate that some desirable plants (those preferentially grazed by stock) continue to decline (Watson *et al*. 1997). Watson used a model that simulates the dynamics of a single palatable plant species (*Eremophila maitlandii*) in this work. The key outcome of the simulation analysis (within the Gascoyne region of Western Australia) is that shrub populations declined about 40% during the period of pastoral activities under low stocking rates. Similarly for all the stocking rates used in the model (from Low to High) there is shown to be a decline in plant population density. The model indicates that as a result of the drought of 1935 to 1940 the greatest decline in the shrub population occurred, although degradation of perennial plants under a range of stocking rates had already occurred by this time (Curry *et al.* 1994). Not surprisingly, it has been shown from this analysis that earlier drought periods had contributed to shrub decline under even low stocking levels. It is considered that the climatic and grazing conditions since the mid to late 1940s have been such that major increases in shrub population density would not be likely. It should be noted that recent results from the WARMS program indicate that there has been an improvement in vegetation cover, recruitment and diversity (Watson 2003).

Ludwig *et al.* (1997) discuss the effects of fire on vegetation in the context that it is a consumer of plant material, thus, another competitor, in the same way herbivores compete for vegetation; that is, fire may contribute to vegetation decline. While fire is certain to affect the recycling of nutrients it will also contribute to a net loss of above-ground organic carbon. Other nutrients may be exported from the site in the form of ash. Fire may also reduce patch density and size and has the capacity to reduce all the vegetative cover, unlike herbivores which will reduce cover only in the lower storey. Fire may also impact on the recovery of vegetation following a rainfall event sufficient to allow regeneration, and in the absence of pastoral grazing. Episodic fire, in the absence of grazing, may have little overall effect on the vegetation when seen from long-period time frames. However, fire which occurs on a regular basis, or as a result of human activity, may deplete existing vegetation as a result of natural seeding or regenerative periods being interrupted. Nutrient cycles may also be interrupted with the vegetation composition on the site altered to favour a different suite of plants.

Landsberg *et al.* (1997) were able to detect changes in plant cover and composition as distance from stock watering points increased. The proportion

of bare ground also decreased with distance from water. These findings were consistent in the ways that abundance varied in relation to distance from the grazing pressure around water points. Plants closest to water consistently showed the increaser (unpalatable plants) pattern of response in that their abundance increased closer to the water source. There is an associated decreaser (more palatable plants) pattern of response as the distance from water increased. A number of species showed little change in abundance in relation to their proximity to watering points. The provision of artificial water points for stock has clearly changed the abundance and distribution of many plant species. These changes are not noticeable in terms of total species richness, but more obvious in the vegetation composition at varying distances from water. As a result of this work it has been shown that between 15% and 38% of plant and animal species reach their greatest abundance at water-remote sites, with few areas left in the pastoral zone that are more than five to eight kilometers away from water and not grazed by sheep or cattle (Landsberg and Gillieson 1996). This has led James *et al*. (1997) to suggest that changes to plant and animal species distribution and abundance are likely to be directly related to the provision of artificial water points.

What these researchers observed and reported had been noticed many years earlier by Francis Ratcliffe who wrote in his book first published in 1937, "Once I was shown a little corner, a long way from the nearest water, which had managed to survive in something like its virgin state. It was a sight for sore eyes, and a very useful indication of the extent of the changes which had taken place since the white man settled the land. There was actually grass about, and the foliage of the shrubs grew down to the very ground; and I saw little bushes here which had practically vanished from the general landscape" (1953, pp. 208-09). Some of these 'little corners' still exist across the rangeland, often at distance from water as observed by Landsberg *et al*. (1997), but also areas that have not been developed at all due perhaps to the quality or depth of underground water or the quality of the feed, or to the presence of one or more native plants toxic to stock, for example, *Gastrolobium* spp.

4.6 The extent of vegetation decline

About 87% of the pastoral rangelands have been assessed as part of the resource inventory and condition surveys conducted by the Western Australian Department of Agriculture and the Department of Land Administration since the late 1960s. Resource condition information related to the extent and type of soil erosion and the condition of the perennial vegetation is gathered during vehicle traverses of pastoral leases. Total erosion estimates are derived from the combination of wind and water erosion ratings as shown in Table 2.

Table 2. Derivation of total erosion.

Wind erosion +	Water erosion	= Total erosion
nil	nil	**nil**
nil	minor	
minor	nil	**minor**
minor	minor	
nil	moderate	
minor	moderate	
moderate	nil	**moderate**
moderate	minor	
moderate	moderate	
nil	severe	
minor	severe	
moderate	severe	
severe	nil	**severe**
severe	minor	
severe	moderate	
severe	severe	

Source, Payne *et al,* 1987.

This information is combined into a range condition rating, using five categories – very good, good, fair, poor, and very poor as shown in Table 3.

The range condition classes as defined by Payne *et al.* (1979) are described as:

- Country in good condition is in acceptable order and its use for grazing can be continued provided that sound management practices are adopted. Good range condition has pastures in good to excellent condition and at worst, only minor wind and/or water erosion present, which can be readily reversed with appropriate management.
- Country in fair range condition may still be used for grazing, but changes in management practices may be necessary if further deterioration is to be prevented. Fair range condition has pastures in poor to fair condition (i.e. undesirable or intermediate value pasture species predominate respectively) relative to undisturbed parts of the same soil-land unit with at worst, only minor wind and/or water erosion present.
- Country in poor range condition is in unacceptable order. It is frequently unstable, as pastures are badly degraded and/or moderate to severe wind and/or water erosion is present (Figure 5). In many cases it should be removed from use for such time as is necessary for recovery.

Table 3. Criteria for pasture condition ratings.

Rating	Condition description
Excellent or very good	For the land unit-vegetation type, the site's cover and composition of shrubs, perennial herbs and grasses is near optimal, free of obvious reductions in palatable species or increases in unpalatable species liable to reduce production potential.
Good	Perennials present include all or most of the palatable species expected; some less palatable or unpalatable species may have increased, but total perennial cover is not very different from the optimal.
Fair	Moderate losses of palatable perennials and / or increases in unpalatable species or grasses, but most palatable species and desirables still present; foliar cover is less than on comparative sites rated 1 or 2 unless unpalatable species have increased.
Poor	Conspicuous losses of palatable perennials; foliar cover is either decreased through a general loss of perennials or is increased by invasion of unpalatable species.
Very poor	Few palatable perennials remain; cover is either greatly reduced, with much bare ground arising from loss of desirable plants, or has become dominated by a proliferation if unpalatable species.

Source, Payne *et al.* 1987

These data indicate that the majority of the areas surveyed have undergone change to a lesser or greater degree as a result of the combined impacts of grazing by domestic stock, feral herbivores and native animals over a relatively short time. If the vegetation classes are seen as indicative of these changes, then all condition ratings other than 1. (Excellent or very good) indicate some degree of change in vegetation cover or composition. From a broader environmental management perspective, there is no information about the significance of those changes and how the vegetation may be changed in the long term, if at all.

The overall values for the areas surveyed indicate that most of the rangelands have been altered to some extent, with 24% (20.2 million hectares) considered to be in poor rangeland condition and 30% (25.3 million hectares) in fair condition (see Table 4).

Where country has become eroded to some degree the opportunity for recovery may be quite limited at least within short to medium term timeframes. Country that is severely degraded and eroded is unlikely to recover as topsoils, and in many

Table 4. Range condition summaries for regional rangeland surveys.

Survey Region	Total area km²	Severely degraded km²	Range Condition class (% of traverse)		
			Good	Fair	Poor
Gascoyne	63400	1,205*	32	53	15
West Kimberley	89600	2,000*	20	50	30
East Nullarbor	47400	0	50	10	40
Ashburton	93600	534	50	34	16
Carnarvon Basin	74500	647	45	32	23
Murchison	88360	1560	21	37	42
Roebourne Plains	10216	233	51	37	22
North East Goldfields	100570	452	39	32	29
Sandstone Yalgoo	94710	145	45	32	23
Pilbara	181736	322	77	11	12
All areas	**844092**	**7098**	**46**	**30**	**24**

Source, van Vreeswyk *et al.* in preparation; *estimates only

cases subsoils, are no longer intact, suggesting that a very long period of time will elapse before soil conditions are such that vegetation may again be supported (see Figure 6).

The impacts of pastoral activities have not impacted uniformly over the landscape and there are obvious differences within survey areas as indicated in Table 4. The large area of country in poor condition within the Murchison (3.7 million hectares), Nullarbor (1.9 million hectares), north – east Goldfields (2.9 million hectares) and west Kimberley (2.7 million hectares) indicate the historically unsustainable nature of the industry – that is, the country is in such poor range condition with badly degraded pasture, wind and water erosion that it should be removed from grazing to allow recovery. Research into the recovery of degraded country (Silcock and Beale 1986) found that the exclusion of grazing animals alone had negligible effect on the botanical composition of perennial species at most sites. On some scalded areas, perennial grasses had been unable to recolonize after a period of 20 years. However, studies by Gardiner (1986a, 1986b) in Western Australia showed that complete exclosure of native and feral

Figure 5: Rangeland in very poor condition

Overgrazing has removed most of the vegetation on this land system exposing soils to accelerated erosion. The shrubs showing signs of regeneration are unpalatable to stock. The loss of soil, nutrients and seed bank may result in a very long recovery period. The total exclusion of stock, feral and native herbivores from this site is necessary.

Figure 6. Severely degraded and eroded country.

The reduction in vegetative cover has resulted in erosion removing top soil exposing the saline hard pan. Recovery of this country could take hundreds of years. Indeed, the notion that country now in this condition can recover to its former state is unrealistic and it is more likely that it will change to some new state different to that which it was originally.

grazing was necessary for substantial increase in perennial plants. The recruitment of perennial plants requires: presence of seed; favourable climatic conditions; and surface soil conditions for infiltration and nutrient capture (Hodgkinson and Tongway 2000).

Country considered to be in fair condition (25.3 million hectares) has pastures in poor to fair condition with some degree of water and wind erosion. Thus at least some of this country may not recover to its climax state even if destocked.

Overall 46% of the areas surveyed are considered to be in good condition; however, only 20% of the west Kimberley and 21% of the Murchison remain in good condition (see Figure 7).

Figure 7. Country in good condition.

Rangeland showing good recovery after about 15 years total destocking.

Pastoral leases or regions are not uniformly grazed or degraded (Pringle 1998). The impacts of domestic stock and native herbivores occur mainly in areas where palatable plants occur and access to natural or artificial water points is available. Areas at a distance from either natural or artificial water points, that have a suite of plants less attractive for grazing, or which are inaccessible such as rocky uplands, are more likely to have less grazing impacts. Large tracts of land now degraded or severely degraded and eroded are associated with river systems that once supported good grazing country in combination with the availability of water.

The broader issues of the possible destruction of the natural ecosystems of arid and semi-arid pastoral country resulting from continuous grazing, and the inevitable

heavy damage caused in periods of drought, raises a concern which appears to be supported by the range condition survey information. The cumulative effect of grazing by domestic stock, feral herbivores and native animals (now in greater numbers as a result of the development of artificial water points) combined with soil loss resulting from wind and water erosion suggests that pastoral activities over the majority of the pastoral rangelands are self destructive. The recuperative capacity of the long-lived perennial vegetation may not be enough, particularly in areas already effected by sheeting, rilling and gully erosion, to bring areas of poor condition (and perhaps much of the landscape considered to be in fair condition) back to an optimum state.

These data clearly demonstrate that vegetation decline is an extensive problem that will be difficult to reverse.

4.7 Causes of range deterioration

The Western Australian government actively encouraged the development of the pastoral areas through legislation that established pastoral leases and incentives for running stock. Early settlement incentives included the waiving of rents for the first four years and low rentals for the next eight (Burnside 1979). Government policy before 1940 was aimed at the rapid settlement of the most productive and accessible land. Pastoralists were required to develop land to a set fiscal level per 1,000 acres of land and run stock to predetermined stock levels of 10, 20 or 30 sheep per 1,000 acres at 2, 5 and 7 years respectively (Burnside 1979). Failure to carry out these requirements left pastoralists open to forfeiture of their lease (prior to 1887) or to pay double rent (following 1887). Within the first 70 years of pastoral development the area of land alienated for this land use increased from less than 7 million acres to an all time high of 259.4 million acres. Sheep numbers steadily rose to their highest level ever, approaching 5.5 million (about half the state total) in 1934. Up to this point in time at least, the economic returns to the state from the pastoral areas appeared to support government policy, returning to the state about 10.7 million pounds or about 50% of the total agricultural return (Burnside 1979).

The early period of pastoral industry development was characterized by overstocking, lack of drought management and inadequate lease development, all of which contributed to extensive and severe vegetation decline (Burnside 1979). Sheep numbers increased rapidly in the period of good seasons of early settlement and wool prices reached record levels in 1922 that were maintained until 1928. The combination of good seasonal conditions and the tremendous profits made inspired pastoralists to increase the size of their flocks even further, and to take up more land.

This boom period came to an end with the arrival of a prolonged drought which affected most of the sheep pastoral zone from 1935 to 1942. Unfortunately, this drought period also created environmental disaster as pastoralists failed to adjust stock numbers appropriately. Although stock numbers fell sharply from 5.5 million sheep in 1934 to 3.05 million by 1939, damage to preferential grazing country was disastrous. Burnside (1979) using information from Fyfe (1940) states that sheep numbers in the Murchison river catchment fell from 840,000 in 1934 to 250,000 in 1940. In the Murchison-Meekatharra area, it has been estimated that " by 1940, around 75% of the saltbush (*Atriplex* spp.) and 25% of the Acacias had been destroyed" (Burnside 1979). The 1940 Royal Commission (Fyfe 1940) recognized that overstocking, inadequate lease development and lack of drought management, combined with poor financial management by pastoralists contributed to the financial collapse of the pastoral wool industry south of the Kimberleys in the late 1930s. The Royal Commissioner noted "In the areas of more frequent drought south of the Kimberley, some of the country suffered permanent reduction in carrying capacity and has therefore lost its drought resisting ability. Other parts have been less seriously affected but it will take some years to recover" (Fyfe 1940). The Commissioner also noted that good wool prices combined with a series of good seasons "caused optimism to outweigh sound judgment, with the inevitable result of heavy overcapitalization on a great number of stations".

Improvements on Kimberley cattle stations were few due to the heavy reliance on river frontage country and natural surface water points. The Royal Commission found that the turn-off rates for cattle were low at around 10% and that overstocking and dry years had considerably reduced carrying capacities. The Commissioner noted the need to limit stock numbers to the carrying capacity of the land.

Holmes (1983) raised the issue of desertification of Australia's rangelands resulting from the cumulative effects of vegetation loss and erosion. He raises some interesting questions: "In the semi-arid rangelands, is the grazing system self destructive? Are the pressures exerted on the ecosystems during drought periods leading inevitably to desertification? Is it already too late to halt or reverse this decline? Has the recuperative capacity of the ecosystems already been severely impaired?" Francis Ratcliffe (1953) also raised these concerns in the 1930s in his work investigating the causes of drifting sand in northern South Australia, northwestern New South Wales and southwestern Queensland. Ratcliffe, an Oxford graduate trained as a biologist, had been brought to Australia by the Council for Scientific and Industrial Research to investigate the problem of erosion and soil drift, "which had assumed threatening proportions in the more arid pastoral districts, especially in South Australia" (Ratcliffe 1953). Ratcliffe declared

that pastoral settlement could only be stable and permanent if it permitted the vegetation to recover from the damage that it would inevitably suffer in drought periods, and raised further questions: Could this ideal ever be achieved? Was there any system of stocking and management, workable and economic in practice, which would preserve the vegetation of the semi-desert country, and thus ensure the survival of human settlement?

Following four years of observation in the semi-arid pastoral zone, Ratcliffe was able to reduce the problems behind the causes of increasing soil drift to a number of elements, which he succinctly described. It is worth noting these as they are as important today as when Ratcliffe wrote them in 1937.

1. The number of sheep carried on a station is determined by local custom, tempered by experience and financial considerations. Financial considerations (debt repayment, management costs, and returns to investors) set a lower limit to the stock numbers.
2. Variation of stock numbers to suit varying seasonal conditions is only practiced to a limited extent. Many pastoralists are unwilling to break up the genetic or blood-lines that they may have spent considerable time developing.
3. The effect of grazing on different components of the pasture is a key factor. While many of the perennial plants will defoliate, even die, in a period of drought, those plants retaining leaves, will be set upon by herbivores. If they are stripped of their foliage and rainfall is minimal, they too may succumb and die. Stock that are able to eat these plants to the ground will remove many juvenile plants altogether.
4. The rate of regeneration of the long-lived plants is slow and it may require more than a couple of good seasons for plants to recover and replace what had been killed off, in the face of grazing pressure from native and introduced herbivores, such as the rabbit, as well as introduced stock. As Ratcliffe so eloquently states, "if this age old balance is shattered it cannot be mended, historically speaking, overnight".
5. The frequency of droughts determines the length of the recuperative period.

Ratcliffe concludes that the fodder reserve of the semi-arid country is nowhere sufficient to stand up indefinitely to the strain that must be placed on it by pastoral settlement. He goes on to say that, in his opinion, only the wholesale evacuation of stock from country threatened with drought could preserve the key plants of the vegetation. Similar conclusions have been made (see Wilcox 1964 for example) since this time although actions by pastoralists indicate either the wider non-acceptance of these principles, or the inability to make the necessary changes in time of drought to make a difference in the condition of the vegetation or soils.

4.8 Contemporary range deterioration

Pastoral activities have continued to degrade the land despite the wisdom of many who have been involved in investigations into the causes of, and in the promotion

Figure 8. Contemporary land degradation

Relatively recent grazing activity on a fragile land system supporting bluebush (*Maireana* spp.) resulting in active erosion

Figure 9. Buffel grass invasion.

Buffel grass invasion on alkaline coastal soils has resulted in a reduction in native plant diversity.

of management strategies to overcome, land degradation (Wilcox 1964; Milton *et al*. 1994; McKeon *et al*. 2004). The impact of sheep, cattle and goats is considered the major driving force of changes in the vegetation of the rangelands in Australia (Harrington *et al.* 1984).

The causes of continued deterioration include: unsustainable management systems evidenced as inappropriate stock management (inluding overstocking), lack of drought management and inadequate development of leases (Select Committee Inquiry into Land Conservation 1991). Overgrazing is taken to include the cumulative impact of increased numbers of native and feral herbivores as well as sheep and cattle (see Figure 8). Freudenberger *et al*. (1997) maintain that herbivore (consumer) demand is most often greater than the available supply of digestible material. Wilson (1991) has shown that over a seven year period the feed supply required to maintain near-maximum live weight gain in young wether sheep is greater than that available due to long periods between optimal seasonal conditions (rainfall) for feed production (over the seven years). The lack of recognition of the consequences of constant consumer demand has lead to an unsustainable level of off-take. Kangaroos, sheep, goats, cattle, camels and donkeys are now the dominant rangeland consumers. An overlap in the dietary preferences is the norm rather than the exception, although sheep concentrate more on broad-leaved plants when available than do Kangaroos, which concentrate on grasses. However, both animals concentrate on grasses during prolonged drought and shortly after rain, when perennial grasses are the first to produce green leaf (Freudenberger *et al*. 1997).

The review of causes of continued pastoral land degradation as set out in Discussion Paper no. 3 (Select Committee into Land Conservation 1991) clearly identifies a range of issues which closely reflect those proffered by Ratcliffe (1953) in 1936 as the key causes of erosion and soil drift. The Discussion Paper refers to overstocking, lack of adequate stock management, poor pasture management, lack of drought management and lack of understanding of the rangeland ecosystems – all perceived as important factors in land degradation by Ratcliffe. Little has changed in land use practices in this period.

Although the predominant cause of rangeland deterioration is the result of pastoral grazing practices including the development of an extensive artificial stockwater network, deterioration can also result from other causes such as wildfires and the introduction of exotic plant species. It is interesting to note that exotic plant species were still being recommended as an appropriate measure for degraded land rehabilitation in Discussion Paper no. 3 (Select Committee into Land Conservation 1991). Exotic plants such as buffel (*Cenchrus ciliaris*) and birdwood (*Cenchrus setiger*) are both listed in the Environmental Weed Strategy for Western Australia (Anon. 1999), and are considered to be a high priority

for control and/or further research into control measures. These plants are listed in Discussion Paper no. 3 as suitable plants for consideration in areas requiring rehabilitation. Both plants are recognized as being highly invasive, have a wide current or potential distribution, and have the ability to change the structure, composition and function of ecosystems (in particular they have the ability to form a monoculture).

In some regions of the state, buffel and birdwood grasses are established over extensive areas, and have reduced plant diversity in many vegetation associations (see Figure 9). Buffel and birdwood grasses provide improved pasture for stock while green, but have little fodder value when dry. In dry periods these grasses may in fact limit carrying capacity, in that stock will have fewer native perennials to graze on as these have been reduced in distribution and abundance by the presence of buffel grass. A number of submissions to the Select Committee into Land Conservation (1991) claimed that the condition of the vegetation (and hence the carrying capacity) of the rangelands was improving due to the invasion of buffel and birdwood grasses. There is no doubt, however, that buffel grass has played an important role in stabilizing degraded landscapes (Pringle 1995; Payne *et al.* 2004).

Due to the open range method of managing pastoral cattle properties, particularly in the Kimberleys, it is difficult to establish with any precision, the number of cattle carried on leases. At the time of the 1979 Inquiry into the Pastoral Industry (Jennings *et al.*) there were about 800,000 cattle units in the Kimberley. The carrying capacity for this part of the state (at that time) determined by the Department of Agriculture was 600,000 cattle units. Since this time cattle numbers have been reduced, although the same problems exist in determining actual numbers, which may have led to some reduction in grazing pressure on the native vegetation. However, further reductions may be necessary. Unfortunately, most of the grazing pressure occurs in the more productive river systems, with the result that these highly productive areas are preferentially grazed while other parts of leases are hardly grazed at all.

Thus pastures of the river systems are subjected to unrelenting grazing pressure resulting in their deterioration. The issue of uncontrolled distribution of stock (grazing pressure) was raised in submissions to the Select Committee Inquiry into Land Conservation (House 1991) in which it was pointed out that the lack of adequate infrastructure (fencing, developed water points) has led to overgrazing and land degradation around permanent water. This situation has changed little from the time of these submissions and overgrazing in parts (preferential areas) of leases continues today.

Although stock management on sheep properties south of the Kimberleys is much more controlled, stock numbers are high and exceed the recommended carrying capacity in good seasons but fall back during poor seasons. Stock numbers fluctuate

due to seasonal conditions rather than the intentional manipulation of flocks by lessees. Some sheep properties are inadequately watered resulting in areas of the lease not being used or used only in good seasons when surface water is abundant. Sheep flocks are not distributed evenly over the land resulting in excessive grazing pressures in localized areas around watering points (Lange 1969; Pringle 1998).

Declining profits also result in a build up of stock numbers as a means of maintaining a reasonable income. Pastoralists are reluctant to sell off stock even when seasonal conditions indicate that this should occur, resulting in high stock losses during poor seasons (Faithfull 1994). In fact, Government sponsored drought subsidies may exacerbate this situation by allowing the maintenance of stock numbers in drought periods through the provision of fodder, with sheep maintained in localized parts of the landscape.

In a summary of forty years of rangeland research in the Meekatharra and Wiluna districts of Western Australia (both districts are within the Gascoyne-Murchison Rangeland Strategy region) the Department of Agriculture outlines the results of the study of exclosures in relation to areas where grazing has been practiced, and the results of grazing trials on pastoral properties (Thomson and Morisey 1996). This research shows clearly that grazing of annual plants encourages the establishment of more durable perennial plants, a goal of rangeland management promoted by the Department of Agriculture. The study of plants within exclosures has also established that recruitment and mortality of the major species is closely associated with seasonal conditions, and that grazing further exacerbates seasonal climatic influences in relation to these factors, particularly in dry seasons.

Grazing trial results at Coodardy and Booloothana indicated that moderate grazing levels did not have an adverse impact on the major scrub species – including species composition and population size when compared to plants within exclosures. One of the conclusions from this result is that conservative pastoralism can be compatible with nature conservation goals in the rangelands, although one of the trials indicated that it is possible to maintain high stocking levels over ten years despite adverse changes in the soil and vegetation. This result emphasizes the requirement for pastoralists to monitor vegetation condition as a means to adjusting stocking levels, rather than monitoring animal condition.

Grazing trials on Belele have shown that stock management should allow palatable plants to become established and set seed prior to re-introducing grazing as this allows the build up of seed reserves. Thus the concept of rotational grazing could be modified to cater for many of the useful perennial plants. Similar grazing trials on another station indicated that there was no advantage to be gained from a rotational grazing over continuous grazing. It is believed that this result is due to the inflexibility of the rotation, and that seasonal conditions are important to the restocking of a paddock.

Rotational grazing has been criticized by the industry as the view is held that Kangaroo numbers increase in the paddock if spelled from sheep grazing. To test this view Department of Agriculture officers conducted a number of trials which indicated that:

- kangaroos are selective grazers, preferring grasses and only move onto perennial plants if seasonal conditions are poor;
- indications from some of the trials are that kangaroos were attracted to the paddocks being spelled, but that movements were localized, and that mass build up of numbers did not occur; and
- kangaroo grazing reduced the accumulation of both annual and perennial grass biomass while at one of the trial sites there was an increase in perennial species over a three-year period of above average rainfall. This indicates that Kangaroos can impact on vegetation recovery in spelled paddocks, but that their impact is much reduced in good seasons, and that rotational grazing practices can produce improved pasture.

The research results also indicate that attempts over many years to rehabilitate degraded land using mechanical means have mostly been unsuccessful (Thomson and Morisey 1996). Furthermore, degraded systems require very large expenditure for perhaps little return, and it is concluded that such systems are unlikely to ever support productive perennial pasture unless topsoil is imported to the area. Trials into the effect of destocking and exclusion fencing indicate that slow recovery is possible, that kangaroos have not impeded the recovery of the rehabilitation area, and that this is the most cost effective method for repairing degraded country.

Feral goats have been recognized as a threat to the ecological status of much of the Western Australian rangelands, and although persistent effort has been made to control their numbers, they continue to thrive and increase in number (Woolnough *et al*. unpublished). Goats are currently prohibited stock unless held with a permit, are tagged and held within goat-proof fences. A number of studies into the long-term impact of feral goats on rangeland condition when compared to that of sheep have been conducted (see Fletcher 1995; Pearce *et al*. 1998). Fletcher (1995) showed that goats have less impact on native vegetation than sheep when grazed at conservative stocking levels of about 15 ha/stock unit. Although there are differences in plants grazed by sheep and goats, there are also overlapping fodder requirements. Studies have shown that plants often most favoured by sheep are also most favoured by goats, so are browsed by both. Goats browse a greater range of plant species than sheep (Fletcher 1995). Fletcher (1995) concludes that the overlap in diets of the sheep and goats indicates that competition for forage occurs and that pasture productivity is reduced by the presence of feral goats, particularly in poor seasons when pasture production is low. The presence of goats is considered detrimental to the region's ecology and economy.

4.9 Stewardship of the land – who takes responsibility?

Greater awareness of the state of pastoral lands after 150 years has led to the call for greater accountability from the community. Members of the broader community, including environmental and conservation groups, are demanding pastoralists take better care of the land they lease for their economic enterprises. They insist on better stewardship of this land (Ludwig *et al.* 1997).

Given the doubtful viability of many of the pastoral enterprises within the rangelands, it is unlikely that adequate long-term economic surplus can be generated for realistic management practices that address the conservation of biological diversity. In many instances landscape function has declined as a result of both historic and contemporary management practices aimed at making ends meet. The unpredictable nature of climate and economic returns has led to many pastoralists holding stock numbers to near maximum even when conditions should dictate a reduction. Smaller leases, particularly within less productive areas, are often not able to generate sufficient income from pastoral activities alone (Jennings *et al.* 1979; Holm *et al.* 1995).

Sustainable pastoralism has been defined as the maintenance of the long-term capacity of the natural resources on which the industry is based to continue to produce forage enough to sustain financial and social returns (Pickup and Stafford-Smith 1993).

Morton *et al.* (1995) consider sustainable land use as an enterprise objective leading to the long-term security of a business even at the expense, in many instances, of the maintenance of ecological functions. Ecologically sustainable land management is related to the management of the rangelands so that ecological functions are maintained resulting in the persistence of biological diversity. The achievement of ecologically sustainable land management relies on the maintenance of ecological functions in all parts of the landscape including resource rich areas. Resource rich areas were often the most highly sought after components of the landscape in the early phase of pastoral development, and as a result many, perhaps most, of these areas are now suffering from extensive land degradation. Finding ways to maintain ecological functions and biological diversity particularly in resource rich areas of the landscape is a challenge for land managers who are charged with managing for both the long-term sustainability of the business enterprise and ecosystems. If the development of the pastoral industry could begin today there would be a different approach to the way land was allocated for production and would most likely include resource-rich areas being managed for the conservation of biological diversity as well as for economic returns. There would be a much more systematic approach to land use planning with land allocated following an assessment of the potential impacts of the various land uses and the compatibility of these with land use goals (Morton *et al.* 1995).

The reality of land management today is that pastoralists are operating in a landscape suffering historic degradation that has impacted on the sustainability of the pastoral industry as well as biodiversity. Australian society none-the-less embraces the notion that land use involves the concept of stewardship. For example, section 95(c) of the Land Administration Act 1997, states "…pastoral leases are managed on an ecologically sustainable basis" and (d) to "develop policies to prevent the degradation of rangelands" (p.91). This legislation is a reflection of the community's desire to have land managed on a sustainable basis and to protect biological diversity.

Pastoralists are acting as land stewards in that they are engaged in long-term planning of their business enterprises at a landscape scale in order to obtain a range of sustainable benefits from the natural resources they manage. Where changes to lease size are envisaged as a reaction to the viability issue, then future land allocation should incorporate ecological sustainability goals as a requirement for the continued use of the land for pastoral production (ANZEEC and ARMCANZ 1999).

As governments have the overall responsibility for the management of pastoral land through a range of legislative and policy measures, it could also be argued that the stewardship of the land is their responsibility. In this light, any assessment of the outcomes of 150 years of land management aimed at the maintenance of biological diversity and the sustainability of the pastoral industry, must surely show that government has failed in its responsibilities to do so. When the number of business enterprises now considered to be unviable is viewed against the published results of rangeland condition surveys, this conclusion is inescapable.

4.10 Costs of range deterioration

The economic costs of rangeland deterioration are ultimately passed on to the wider community through declining production (input into State's economy), costs of rehabilitation, drought relief, taxation relief and income-smoothing, as well as the loss of biological diversity.

In 1989 the Department of Agriculture estimated the gross value of losses due to vegetation decline (see Table 5, House 1991). These figures are likely to be conservative as they are based on lost production from country considered to be in poor condition. The figures do not take account of country considered to be in fair condition that also has a decreased carrying capacity. The loss of carrying capacity has been determined as 31% of the Ashburton catchment, 26% of the Carnarvon basin and 45% of the West Kimberley (Jennings *et al*. 1979). The loss of production due to the decline in the natural pastures impact on local, regional and state economies and has the effect of inducing non-viability of many leases. The viability of others may come into focus as the need to reduce stock numbers in order to address regeneration of perennial plants affects the income of pastoral

enterprises, both from a reduction in income, and an increase in costs associated with rehabilitation or redevelopment works.

4.11 Addressing the problem

As a result of the Collaborative Soil Conservation Study (Anon. 1978), a number of management approaches aimed at addressing range deterioration were put forward (see Table 6). Issues of range deterioration include vegetation decline, soil erosion, and woody weed invasion.

Quite clearly, only a small proportion of the pastoral rangelands require no special treatment, while about one third of the area utilized for grazing requires

Table 5. Value of lost production.

Zone	Estimated gross value of lost production ($m) (1989 prices) *		Gross value of production ($m) (1989 prices)	Gross value of lost production as % of gross production
	Cattle	Wool & sheep		Sheep
Kimberley Non-Arid	0.05	-	32.56	-
Kimberley Arid	8.00	-		24.7
Spinifex– mulga		22.85	101.21	22.6
Goldfields		4.05	16.00	25.3
Nullarbor		2.05	6.00	34.2
Total	**8.05**	**28.95**		

*Estimates by the Dept. Agriculture based on loss of carrying capacity from land subject to vegetation decline.

Table 6. Areas of the pastoral region requiring treatment for range deterioration.

Treatment	Area	
	Km²	%
Number of Special Treatments	86000	9
Range Management Only	547000	58
Range Management and Stock Reduction	127000	13
Range Management, Stock Reduction and works	190000	20
Total	951000	100

Source: Anon, 1978. Collaborative Soil Conservation Study 1975-77.

a reduction in stock numbers. Given the degree of historic degradation of the vegetation and soils, the Department of Agriculture Western Australia considers that the primary aim of all pastoralists should be to improve the condition of the perennial vegetation. Achieving this aim requires pastoralists to recognize that natural ecosystems have been altered, accept that changed management is necessary, and be willing to do things differently to achieve the desired outcome. The use of legislative powers may be effective where rangeland management practices continue to degrade land.

The level of understanding of rangeland ecosystems, their structure and function, is far from complete, and considerable research effort is required to improve the level of understanding of the interaction of grazing stock with native plants and animals. While there has been good progress in understanding rangeland ecology at the landscape scale (see for example, Harrington *et al*, 1984, Ludwig *et al*. 1997), much more needs to be done at the ecosystem level.

4.12 Ecosystem resilience

The organization of natural communities is referred to as the equilibrium hypothesis or, in more modern terminology, the balance of nature, where populations have developed and are held in check by competition, predation, and other mutualistic interactions (Krebs 2001). Changes to this balance may occur through natural events such as wildfire, flood, earthquake or the introduction of exotic plants and animals. Change is continual, but it is the rate of change that is of concern in the rangelands of Western Australia. Understanding the impacts of the introduction of a range of exotic herbivores and predators in the pastoral rangelands is important to the sustainable development of the pastoral industry, or in some instances, in rehabilitating degraded country. The concept of resilience is an important issue that must be more clearly understood in terms of understanding pastoral industry impacts and conservation biology.

Resilience is a measure of the ability of an ecosystem to respond to perturbation, such as continued grazing pressure, and is concerned with the strong tendency to return to its original state once the disturbance is lifted (Harrington *et al* 1984).

As discussed earlier, there is considerable evidence of continual decline of the pastoral rangelands as indicated by the decline in biomass, soil thickness (erosion), species diversity and vegetative cover. This process is referred to as retrogression and has been induced by low level, but persistent, grazing over a relatively short period of time in the Western Australian rangelands. Retrogression refers to changes in biotic composition over time (Westman 1985). Tracking retrogressive changes such as soil degradation, changes in biomass, nutrient stocks, and abundance of long-lived species is difficult to accomplish (Woodwell 1967, 1970, Woodwell

and Whittaker 1968). Changes to species composition are therefore favoured as indicators of retrogressive change (Whittaker and Woodwell 1978).

The study of grazing impacts on rangelands in varying condition, carried out by Dyksterhuis (1949), resulted in a means of viewing changes to vegetation. Dyksterhuis found that it is possible to classify the species found in the rangelands utilized for grazing into three groups viz. (1) plants that decreased in abundance even under moderate grazing; (2) plants that increased in abundance – those plants that are not palatable or less palatable to grazing animals; (3) those plants considered to be invaders – those introduced or which were somehow restricted in distribution prior to the introduction of grazing animals. Patterns of retrogression will differ between different ecosystems and the level of stress applied by grazing animals.

The understanding of ecosystem structure and function prior to the introduction of grazing animals is essential in understanding retrogressive changes and predicting the resilience or rehabilitation of particular degraded portions of the landscape. In general, little is known of structure and function of ecosystems, prior to the introduction of grazing animals. However, there are some important reference areas that have been identified that have remained undeveloped and show little sign of gross change (Blood 1995). These areas provide the key to understanding the level of change and resilience of the ecosystems.

Westman (1985) uses a number of terms to describe the dynamics of ecosystem change. These include – inertia, amplitude, elasticity, hysteresis and malleability. While ecosystem inertia refers to resistance to change, the remaining terms refer to various components of resilience. Holling (1973) referred to inertia as resilience, but Westman (1978) draws the distinction between the two terms by limiting resilience to the "degree, manner, and pace of restoration of initial structure and function of an ecosystem" (p. 499).

The time taken for an altered ecosystem to return to a steady state resembling its original characteristics is described as the elasticity of the system. It is unlikely that any ecosystem will recover to having exactly the same characteristics pre-disturbance, as succession processes are the result of stochastic and deterministic processes (Bray and Curtis 1957). Thus the recovery of an ecosystem to its original structure following artificial stress such as grazing will rarely be achieved.

The amplitude of an ecosystem is the threshold beyond which the recovery to the original state will no longer occur. Pastoralists need to know the maximum stocking levels within native vegetation in the rangelands that will maintain this resource indefinitely. Within any ecosystem there may be particular species of plants or animals which reach a threshold level, even though the ecosystem as a whole may not have reached this level, with the result that these species may be under threat of extinction (Woodwell 1975).

The measurement of ecosystem change induced by stresses, such as grazing by sheep or cattle, to those which occur during recovery following the removal of the stress, forms the basis of hysteresis – the differences that occur between retrogression and succession. An understanding of the extent to which hysteresis exists is important in understanding rehabilitation requirements. For example, if the retrogressive sequence of rangelands is towards a suite of unpalatable plants following excessive grazing pressure over time, then this would not necessarily indicate that these same unpalatable plants should be planted as part of a rehabilitation program, if the aim is to return the ecosystem to its original status. The general lack of understanding of ecosystem response to artificial stresses in the Western Australian rangelands is a limiting factor in determining both the level of stock grazing pressure and of rehabilitation programs where adverse impacts are observed.

Malleability refers to the degree to which the steady state established after the disturbance factors have been removed differs from the original state (Westman 1985). The main difficulties in measuring the malleability of a system is knowing what the original state was, and understanding when the steady state has been achieved following the removal of the artificial stress. Westman (1978) has suggested that it may be possible to determine the steady state when the mean difference in PS (Percentage Similarity index; used to compare sites using qualitative data – this is a resemblance function) from one year to the next is less than five percent over a period of years and no greater than 10% between the first and last years of the sequence. It is suggested that historical records such as aerial photographs may be used to estimate the degree of change in a system that may have reached a steady state following disturbance.

4.13 Conclusion

Most of the rangelands in Western Australia have now been surveyed by the Department of Agriculture. The results indicate that 24% is in poor condition; 30% is in fair condition, and 46% is in good condition. All the country surveyed as being in poor condition (approx. 20 million hectares) has evidence of erosion, caused by both wind and water, to some degree. Rangeland in poor condition has a conspicuous loss of palatable perennial plants, with a reduction in foliar cover and, in many instances, the invasion of increaser species including woody weeds. Payne *et al.* (1979) suggest that country in poor range condition should be removed from use for such time necessary for recovery. The loss of perennial vegetation in the pastoral zone has reduced the productivity of land in periods of drought, placing significant pressure on pastoral enterprises. The use of legislative powers to enforce stock reduction, or withdrawal, from country in poor condition is appropriate if this country is ever to recover.

Rangeland monitoring provides feedback to pastoralists about the effect, over a period of time, of their management effectiveness in terms of environmental sustainability. Pastoralists should be able to determine if their stock management practices have been successful or otherwise and make effective decisions to maintain vegetation and soils in the long term. The results of the most recent measurement of monitoring sites throughout the southern rangelands indicate an overall improvement in foliar cover, recruitment and diversity, providing a degree of confidence that rangelands modified by 150 years of grazing can still recover given favourable climatic conditions and appropriate grazing management regimes; that is, rangeland ecosystems are resilient even though they may not return to their original state.

Chapter 5: The Gascoyne-Murchison Rangeland Strategy[1]

5.1 Introduction

Pastoralists in the Gascoyne-Murchison region of Western Australia concerned about their future following a period of seasonal and economic difficulty, proposed the need for the development of a regional strategy aimed at providing real long-term solutions. The outcome of this proposal saw the establishment of a steering committee to begin the identification of the range of issues that needed addressing if the industry in the region was to recover. So began the formulation of the strategy that eventually gained support from both State and Commonwealth governments. This Strategy is the result of a great deal of enthusiasm and commitment on the part of pastoralists and government agency personnel working in support of the industry. This chapter reviews the development of the Strategy and some of the key issues that have arisen, particularly in the area of conservation of biodiversity across the region.

5.2 Background

The Gascoyne-Murchison area is central to the southern rangelands (Figure 10). The area had suffered a serious economic downturn since the late 1980s due to a number of factors including the collapse of the reserve price scheme for wool in 1989; the serious drought conditions in the Upper Gascoyne and Meekatharra areas in 1993 and 1994; and the depressed beef prices in 1995 and 1996. The area comprises the shires of Exmouth, Carnarvon, Shark Bay, Upper Gascoyne, Murchison, Yalgoo, Meekatharra, Cue, Mt. Magnet, Sandstone and Wiluna, and covers approximately 59 million hectares. There are 253 pastoral leases within the region.

Wool and sheep production is the primary pastoral activity in the Strategy region. The pastoral wool industry had been the subject of a number of searching investigations into its economic viability beginning with the 1940 Royal Commission. Little or no action has been taken to rectify some of the most pressing issues facing the industry due to lack of political will and financial support, the non-acceptance by the industry of the conclusions drawn from the reports of these investigations, or the negative reaction of sections of the broader community not involved in the investigations.

1. The Gascoyne-Murchison Rangeland Strategy became known as the Gascoyne-Murchison Strategy following the acceptance of the Strategy action plan in 1998. Hereafter, reference is made to the Gascoyne-Murchison Strategy.

Figure 10. Map of Western Australia showing the Gascoyne-Murchison Strategy region.

5.2.1 Climate

The region has an arid tropical continental climate with a west coastal zone having a marine influence (Australian Bureau of Meteorology 1998). The Leeuwin current flowing southwards from warmer tropical areas influences the coastal climatic zone.

The regional climate is controlled by the seasonal shift of the mid latitude anti-cyclonic systems. The systems interact with tropical and temperate cyclonic systems that develop either side of them. In summer, the tropical monsoon and convection systems are to the north, and in winter the southern frontal systems are the key influence. In winter dry easterly winds off the anti-cyclone belt dominate the dry season of the northern tropics while in summer, the pressure belts bring the dry easterly winds across the southern half of the region.

Tropical cyclones are generated between January to March each year. Many of these cross the north-west coast and track south-east across the Gascoyne-Murchison region bringing flood rains at times.

The prevalence of a low, broadly undulating landscape results in a broad overlap of climatic regimes: the south temperate winter rains and the north tropical summer rain. A broad central band of bimodal climate exists across the region (Tinley 2003 unpublished). Within this band, both summer and winter rain is experienced. This is due to the overlap of the two major cyclonic systems, either of which source may result in little or no rain falling with resulting drought conditions.

In mid summer to early autumn, tropical low-pressure systems and cyclones are the primary causes of heavy rainfall and flooding. Thunderstorm rains are most frequent in the north and inland parts of the region and a single storm event can generate from 30 percent to 160 percent of the mean annual total rainfall. Large variation in summer thunderstorm rain over short distances can lead to prolonged drought conditions at a local or regional level. The dry times of the year are spring and early summer when less than 10mm of rain falls in at least 50 percent of years. The worst droughts recorded in the region were in 1935-41, 1943-45, and again in 1976-79 (Australian Bureau of Meteorology 1998).

In summary, the region receives an average 200mm of rain falling in mid winter along the coast and southern Murchison, with bimodal conditions in the central band, and mainly summer and early autumn rains in the north and towards the interior in the north east (Tinley 2003 unpublished).

5.2.2 Vegetation

Despite the apparent homogeneity of the region's vegetative cover the Gascoyne-Murchison Strategy region contains an extraordinary biodiversity. This is the result of the location of the region at the junction of three major biomes and the western

limit of the central arid zone. The vegetation of the region is dominated by:

- *Acacia* dominated scrublands 2 – 6 metres in height in savanna, woodland and thicket form;
- halophytic shrublands;
- sandplain mallee, cypress pine and heaths over wanderrie or spinifex grasses;
- alluvial grasslands; and
- *Eucalypt* tall woodlands along major drainage lines and low *Melaleuca* spp. woodlands around depressions.

5.2.3 Geomorphology

The Gascoyne-Murchison Strategy region contains the entire drainage basin of three rivers: the Gascoyne, Wooramel and Murchison Rivers. It also contains the headwaters of the Ashburton River in the north and the Greenough River in the southwest.

A large number of creeks flow episodically towards chains of salt lakes within broad valleys of paleo-drainage systems (Van de Graaff *et al*. 1977; Beard 1998).

The Strategy region is comprised of five major natural geological regions:

- Carnarvon coastal plain extending about 600 kilometres from the Ashburton delta in the north to the Wooramel delta in the south, is between 50 and 200 kilometres wide and rises to around 200 metres;
- crystaline shield forms the major body of the interior continental plateau in the Strategy region. The shield is a broadly undulating plain composed of two duricrusted planation surfaces of different age and composition. It has an elevation of between 200 and 600 metres over Archean granite-gniess, with deeply folded rocky outcrops of greenstones;
- sedimentary fold ranges occur between the northern edge of the Yilgarn block and the Pilbara ironstone ranges consisting of sedimentary and metasedimentary rocks. The ranges include Mount Augustus, the Collier Ranges, Mount Edgerton, Mount Kenneth, the Teano Ranges and Mount Waldberg. Mount Augustus is the highest massif in the region and rises to 1105 metres;
- Little sandy desert dunefields are closely spaced rising up to 20 metres above the interdune troughs and flats. The dunes trend north westwards in the eastern sector, curving anticlockwise over a distance of 200 kilometres to the southwest and west. Outcrops of folded sedimentary rocks occur near Lake Disappointment, the McKay Ranges, the Durba Ranges and the Essendon-Carnarvon Ranges on the southwest edge of the Little Sandy Desert; and
- interior desert margin of the far eastern part of the region from the Little Sandy Desert through Lake Carnegie and Prenti Downs Station to the de la Poer Ranges on Lake Wells Station.

5.3 Strategy development

The development of the Gascoyne-Murchison Strategy began with the view that the outcome would avoid the pitfalls of previous investigations. From the outset development was dependent on community consultation involving all groups with an interest in land use management within the region, was based on a whole of Government approach, and was established by a Ministerial Committee.

A steering group comprising residents from the region was established, and its terms of reference directed the group to develop a strategy in line with government policy and in consultation with the community, which would meet the long term needs of all sectors of the community. Finally, the group was to oversee implementation of the Strategy once agreed by Government. The Strategy was required to include proposals for restructuring directed at achieving sustainable pastoral use including opportunities for diversification, adequate conservation reserves, Aboriginal requirements and mining interests (Gascoyne-Murchison Rangeland Strategy Newsletter No. 1 Jan 1996). This group included seven pastoralists from the region, a representative from the conservation movement, and a representative of the Murchison Region Aboriginal Corporation. A support team of Government officers from the Department of Agriculture, Regional Development, Conservation and Land Management, Department of Environment, Aboriginal Affairs and the Ministry of Planning assisted the group. Senior officers from the Commonwealth Department of Primary Industry and Energy also assisted with the development of the Strategy.

A discussion paper addressing the formation of the group and the process by which it would achieve the terms of reference was prepared and distributed within the community and public meetings were held to promulgate information.

The steering group sought input into the identification of the key issues from the community by asking all stakeholders for their response to the question: "What issues must be addressed for the Gascoyne-Murchison rangelands to have a socially and economically viable community involved in a diverse range of industries, based on the use of the varied resources in an environmentally sustainable way?" (Gascoyne-Murchison Rangeland Strategy, Newsletter No.1). It was expected that the collection of responses in this way would ensure no issue was overlooked, and further discussions would sort out priorities. Nearly one thousand issues were identified in one hundred and seventy responses. Issues were later sorted into themes, providing the foundation upon which the preparation of the draft strategy document could begin, and later circulated to all stakeholders for further comment.

The final report of the steering group was made to the Ministerial Committee and Government in March 1997. This report contained 43 recommendations and required the commitment of both Federal and State Government funding over

a five-year period totaling about 43 million dollars. The report claimed strong support from the regional community, which had high expectations for action and positive results, as a result of the development of the Strategy. The report outlined four main areas of activity over the life of the Strategy including:

- business and development grants which would allow people to develop their business's full potential;
- industry research and development projects aimed at expanding and diversifying industries in the region;
- voluntary lease adjustment to allow leases to restructure for modern land use needs; and,
- better regional environmental management to create development that builds the region's environmental and economic base.

5.4 Attitudes, values and behaviour of pastoralists in the region

A survey of land managers in the region was undertaken by a firm of consultants with experience in this area to determine the attitudes, values and behaviour of land managers as a means of providing a baseline from which to monitor changes over the life of the Strategy and beyond (Dames and Moore – NRM 1999). The objectives of the study included the provision of information allowing the assessment and evaluation of progress towards the regional goals set out in the Strategy. As a result it would be possible to:

- ensure funds were being used in the most efficient and effective manner;
- adjust programs in response to new information;
- identify further options for intervention and change; and
- allow formal reporting to Government.

A telephone survey was conducted with a target population of 130 pastoralists in the region. Relevant information was also gathered from other sources such as financial performance of individual leases from the Department of Agriculture, the amount of land within the conservation reserve system from the State of the Environment Reports, and rangeland condition and trends from the Department of Agriculture. A very high response rate was achieved with 91, or 59% of all pastoral enterprises in the region (Dames and Moore – NRM 1999). Both qualitative and quantitative information was gathered.

Individuals were asked to nominate three key issues facing those in the region. Most of the responses to this question were related to socio-economic issues in the context of Commonwealth and State government policy. No responses addressed environmental sustainability or responsible land management issues, and most of the issues raised are influenced by factors outside the region and

beyond the influence of individuals. The solutions to these issues most often were general and involved expenditure of more money by Government or changes to Government policy. On the question of what the respondents wished the strategy to address, people generally found the answers quite difficult. Amongst a selection of comments in relation to this question is reference to the establishment of the conservation reserve system by the Department of Conservation and Land Management. However, one of these responses mentions the potential gains to pastoralists by having the agency acquiring non viable or "areas that may be a burden" (Dames and Moore – NRM 1999, p. 180) – pastoralists would gain financially and the country of low grazing value would be taken up as part of the reserve system. In another comment a pastoralist clearly expressed dissatisfaction with the substantial funds being expended on the establishment of the conservation reserve system – money that could be better expended by people wishing to diversify their enterprise. Many pastoralists have indicated that they would like to see the country managed well and that future generations would be able to enjoy the values of the country if it remained in good condition, even improved in condition to what it was say 30 years ago.

5.5 Policy setting – sustainable environmental outcomes

The development of the National Strategy for Ecologically Sustainable Development (ESD) occurred over a considerable period of time and followed extensive consultation with all levels of government, industry bodies, conservation groups and individuals. The origins of the Strategy are to be found in a number of pivotal developments including the World Conservation Strategy of 1980, the National Conservation Strategy for Australia – 1984, and the 1987 report of the World Commission on Environment and Development - Our Common Future, more commonly known as the Brundtland Report. This latter report recognized that the pattern of development throughout the world was unsustainable and that new thinking about the way development occurred was required if sustainability was to be achieved.

The Prime Minister of Australia, in his One Nation Statement in February 1992, announced that consensus had been reached on an Intergovernmental Agreement on the Environment, which set out an approach by which Commonwealth, State and Territory, and local governments would cooperate in their dealings on the environment. This Agreement was developed as part of the Government's commitment to reform intergovernmental interaction and cooperation on the management of the environment. The intention to develop this Agreement was indicated in the communiqué issued by the first special Premiers Conference in October 1990.

Following the release of a Commonwealth Government discussion paper on ESD, a number of working groups were established to examine sustainability issues

and provide advice on future directions, leading towards the achievement of ESD. These working groups produced many recommendations for action, which had a broad level of support from all interests represented. The development of the ESD Strategy was based on these recommendations and reports, which were assessed by the intergovernmental ESD steering committee. A draft of the Strategy was released in June 1992 for a period of two months during which community views were obtained. This feedback was to provide a valuable foundation upon which to base the finalization of the Strategy. The Strategy was endorsed in December 1992.

Agenda 21 was adopted at the United Nations Conference on Environment and Development held in Brazil in June 1992. It recognizes international consensus at that time on the necessary actions that would move the world towards sustainable environmental and development outcomes. As there had already been considerable progress in developing a coordinated approach to ESD through the preparation of the National Strategy for Ecologically Sustainable Development, it was not a large step for the Commonwealth Government to take in accepting this Agenda, and Australia ratified the Convention in June 1993.

The National Strategy for the Conservation of Australia's Biological Diversity was prepared following the ratification of the Convention on Biological Diversity in June 1993. This important document aims to "bridge the gap between current activities and the effective identification, conservation and management of Australia's biological diversity" (DEST 1996). There is also the need for additional resources, coordination, and more detailed knowledge by which we make decisions about the conservation of biological diversity. The inadequacy of the existing conservation reserve system is acknowledged.

This Strategy is the product of a cooperative effort engendered by the Intergovernmental Agreement on the Environment in which all States and Territories have formally agreed to the importance of the issue and the need to take concerted action.

While this Strategy recognizes that there are many benefits from conserving biological diversity, there is clear recognition that locking up nature in conservation reserves is not the only way to protect wildlife. The sustainable use and management of our natural resources across all sectors of society is required if we are to make progress towards ESD. The Strategy also recognizes that large parts of Australia are not managed sustainably and that past economic, social, political and institutional factors have often prevented appropriate management practices being adopted. The acceptance of the need to incorporate ESD principles into future resource allocation and management is of paramount importance to all Australians. The goal of protecting biological diversity and maintaining ecological processes and systems provides the foundation for the conservation of biological diversity throughout Australia.

Identified in the first section of this Strategy are a number of important objectives which include: identification of ecosystems and threatening processes; bioregional planning and management; encouraging integrated management and protection; establishing and managing a comprehensive, adequate and representative conservation reserve system, and improving off-reserve conservation management.

The National Strategy for Ecologically Sustainable Development (Anon. 1992) and the National Strategy for the Conservation of Australia's Biological Diversity (DEST 1996) provide a relevant framework within which all levels of government, industry and community stakeholders are able to work together. These Strategies have provided the foundation for a number of other important policy documents including the National Principles and Guidelines for Rangeland Management (ANZECC and ARMCANZ 1999) and the Western Australian government's policy Managing the Rangelands (Anon. 1998). Contained in the latter two documents is a clear articulation of the need for the development and management of industry in an ecologically sustainable way and the need for the establishment of a comprehensive, adequate and representative conservation reserve system. In both of these documents the conservation and management of the natural environment, including the establishment of a conservation reserve system, heads the list of policy objectives.

The Gascoyne-Murchison Strategy recognizes the need for industry development, which addresses the principles of ESD within the context of the guiding principles, set out in these national documents and relevant state government legislation.

Within the section addressing environmental protection the Gascoyne-Murchison Strategy sets out the regional vision which is the "management of the Gascoyne-Murchison rangelands so as to preserve biodiversity and ecological sustainability through the development and implementation of sound environmental objectives and the creation of comprehensive, adequate and representative conservation reserves" (Gascoyne-Murchison Rangeland Strategy 1997, p. 39). The important guidance of the National Strategies is acknowledged. The Gascoyne-Murchison Strategy puts forward three recommendations addressing ecologically sustainable development: the establishment of a comprehensive, adequate and representative reserve system; the development of off-reserve conservation management agreements with pastoralists; and the need to address broader biodiversity conservation issues on pastoral land.

5.6 Conclusion

Development of the Strategy has required pastoralists in the region to think about the range of problems they are facing from a broad perspective and to consider

strategic land management actions by individuals, the industry and government, aimed at ameliorating these issues. The region was faced with the continued decline of economic returns, a range of environmental issues including the need for the efficient reticulation of a large number of artesian bores, feral animal control, infrastructure replacement and the continued decline of the natural resources of the area on which their grazing practices are maintained.

The Strategy provides a strategic view of the provision of solutions to the problems faced and how assistance, including the need for significant financial support from government, can be provided. This approach to addressing issues facing the industry today will have a long-term affect on individual pastoral enterprises, the industry, and environment.

Chapter 6: Why Conserve?

6.1 Introduction

The need to conserve Australia's biodiversity is seen as a pressing issue due to the recognition that much of our environment has been modified with a resultant loss of biodiversity (DEST 1996) and that the existing conservation reserve system does not represent the full range of habitats (Pringle 1995; Thackway and Cresswell 1995). Information about species – their distribution and abundance, and threats to their continued existence is lacking, making informed decisions about management of biodiversity difficult.

This chapter reviews the utilitarian and ethical issues that define the discussion about the need for conservation and the best means to achieve this objective.

6.2 Defining terms

Biodiversity is defined as the variety of all life forms, the genes they contain and the ecosystems of which they form part (DEST 1996). Biodiversity is not static – it changes as a result of evolutionary pressures or habitat modification, which in some instances results in population decline and extinction. Australia's National Strategy for the Conservation of Biological Diversity (DEST 1996) considers biodiversity at three levels including genetic diversity, species diversity, and ecosystem diversity. It is recognised that Australia's ecosystems have been extensively altered, often degraded, since European settlement about 200 years ago.

With the arrival of Europeans came some significant introductions of exotic plants and animals which, once established, had a tremendously adverse impact on indigenous plants and animals (DEST 1996). The loss of biodiversity is partly determined by the extinction or extirpation of species at a local or regional level, but also by the reduction in the gene pool, or ecosystems (Burgman and Lindenmayer, 1998). Reductions may result from the impacts of introduced plants such as buffel grass (*Cenchrus ciliaris*) which out-compete native species (Best 1998; Franks 2002), or predators such as the European fox, with a resultant change in relative abundance of both plants and animals. Changes in relative abundance and distribution of species is also the result of grazing practices in the pastoral rangeland (Landsberg *et al.* 1997). Burgman and Lindenmayer (1998) consider that the rate at which biodiversity is lost relates to the magnitude of impacts resulting from human activities in the natural environment and the number of species affected.

Conservation is defined by the World Conservation Strategy (IUCN 1980) as "the management of human use of the biosphere so that it may yield the greatest sustainable benefit to present generations while maintaining its potential to meet the needs and aspirations of future generations".

The dramatic decline in the distribution and abundance of many of the native plants and animals in Australia as well as world wide is acknowledged, with many of the small mammal species in this country extinct after a relatively short period (Burbidge and McKenzie 1989; SEAC 1996). Perhaps our greatest challenge now is to ensure that there is no further decline in biodiversity, but this must be set amongst other social and economic aspirations of society.

The issue of repairing ecosystems that have been degraded is also important although in many instances, for example extensive land clearing for agricultural production purposes, it will not be possible to return the land to its former natural state. Conserving biodiversity could be seen as requiring a multifaceted approach to land management including the notion of ensuring the survival of plants and animals in the long term so that future generations have the same options available to them as are available to current generations. Ensuring the maintenance of interactions between species of plants and animals continues to function is a major challenge. Finding ways to protect and manage the rangeland environment will continue to challenge industry, the community and relevant government agencies.

6.3 Biodiversity conservation

Conserving biodiversity is important for many reasons (Brown *et al.* 1993; DEST 1996; SEAC 1996; Burgman and Lindenmayer 1998) including the provision of both utilitarian and intrinsic values. In considering the provision of utilitarian values it is important to recognize that this service can be viewed as having an economic value that may result in adverse impacts on the environment as a result of certain human activities. It is only within the last few decades that the concern for how human actions affect our natural environment has become important (Ortolano 1984). Prior to this period, the focus was clearly the converse with politicians and scholars mainly interested in the ways the environment influenced people.

Plants and animals, directly or indirectly, provide a food source for humans. In many developing countries, and to some extent in Australia, populations of indigenous people living in traditional ways are directly dependent on the spectrum of biota for the provision of food, medicine, building materials and fuel. For example firewood and dung provide 90 per cent of the primary fuel needs of Nepal; natural sources of food from fish, snails and insects provide protein for

about 75 per cent of the population of Ghana; and up to 80 per cent of people in developing countries rely on traditional medicine derived from native plants and animals (McNeely *et al.* 1990; WCMC 1992).

Biological resources may be commercially harvested to provide timber, food, minerals, medicines, or useful chemicals. It has been estimated that wild species taken from natural ecosystems contributed 4.5 per cent to the gross domestic product of the United States of America (Prescott-Allen and Prescott-Allen 1986, cited in McNeely *et al.* 1990). The commercial use of natural resources derived from native forests, for example, makes a significant contribution to the economies of many countries such as Australia. In the rangelands, plants provide the pasture on which domesticated (and native) animals graze and which therefore provide the foundation of the pastoral industry. The value of this resource does not appear in the economic accounting systems of industry – it is taken for granted in most countries.

Natural ecosystems provide services such as photosynthetic fixation, maintenance of the hydrological cycle, nursery sites for fish and other animals, regulation of climate, cycling of nutrients, soil production and the absorption of pollutants (Burgman and Lindenmayer 1998). The provision of services becomes much more readily identifiable when ecosystems are degraded and the costs of attempting to reverse such degradation become important. The impact on agriculture in Australia resulting from increasing levels of salt-affected land, rising water tables, water-repellant soils, erosion of soils and compaction become important as these processes begin to have a significant effect on economic returns. The cost of treating land degradation in Australia has been estimated at $400 million (LWRRDC 1997), not including the cost of lost production. Similarly, vegetation and soil degradation in the rangelands has resulted in a reduction in carrying capacity and production.

The natural environment also contains areas such as wilderness, which often have values important to both indigenous people and others in a spiritual, religious or cultural way.

Wilderness areas or vast relatively undisturbed areas remote from civilization, have aesthetic and recreational values attracting many people with a wide range of recreational pursuits including bush walking, camping, art, observing birds and other animals, and wildflower enthusiasts (Burgman and Lindenmayer 1998). The tourism industry, which is based on the natural environment, contributes significantly to the nation's gross domestic product and contributes more than the income derived from the export of coal (Commonwealth Department of Tourism 1992). Driml and Common (1995) consider that government agencies are under-resourced to cope with the rapidly increasing numbers of tourists given the contribution to local, regional, State and national economies. This lack of

resources could result in lack of management of the tourism industry, resulting in the degradation of the values sought by tourists.

There is also an intrinsic value of conserving biodiversity which relates to the consideration of the value of conservation and the welfare of the environment simply because animals, plants and the environment have a right to exist (Maley 1994). This raises the issue of the way human actions that impact on the environment are viewed, and whether this is judged to be right or wrong.

6.4 Ethics and the environment

Consideration of moral and utilitarian reasons for conserving biodiversity requires resolution of our philosophical position on how we might judge what is good or bad, or right or wrong. Maley (1994) suggests that discussion of the intrinsic value of nature exposes a contradiction which, if resolved, would test the validity of the argument that all natural things have an equal moral standing with humans. The problem with such thinking is that the intrinsic value of natural things cannot be independently referenced without a subjective or conscious human view. To consider that natural things can have an objective, intrinsic value without human thought or action is to enter the realm of metaphysics (Callicott 1985). Moral judgments about what is right and just reflect cultural desires which are plainly human; they are subjective responses to things that are important to us due to their utilitarian benefit (Maley 1994). Objective values are an impossibility, which suggests that the concept of a non-anthropocentric ethic is untenable because the subject matter of ethics is human conduct.

Policies directed at utilization of the environment, including the drastic alteration of ecosystems, landscapes or wildlife populations are not necessarily wrong or irrational, and may be legitimate on the grounds that such policies serve human interests and values. However, policy development must increasingly take into account the appreciation by more people of the need to manage our environment in a sustainable way (Anon. 1998). The way we handle development of policies aimed at economic development in the context of the growing concern for the global, as well as local, environment has become an ethical and institutional issue of extreme complexity. A land 'ethic' which provided for the preservation of the integrity, stability and beauty of the biotic community was seen as the right thing to be doing in terms of land development (Leopold 1949). Although the conservation sentiment of stewardship of the land is very old, the development of the environmentalist movement over the last thirty years or so has seen the rise of a powerful, scientifically informed and sophisticated movement which has been successful in arousing strong moral commitment and support in many parts of the world. This is exemplified, particularly in developed countries

such as Australia, by the concern over environmental degradation and the level of publicity relating to activities which appear to be in conflict with the moral values of conservation and sustainability. Such treatment of important environmental issues can often lead to the marshalling of powerful forces exerting considerable political influence, as Governments in Australia are well aware. Contentious environmental issues are best dealt with in the context of attempting to balance environmental well-being and economic development. This would require the development of a framework of law aimed at arriving at the best compromise. Maley (1994) maintains that the preservation of the best features of the capitalist free market, political liberalism and environmental amenity, will require the clear delineation, and finally separation, of environmentalism from an idealistic attack on capitalism – any defense of capitalism that somehow devalues environmental amenity will surely fail.

The Christian outlook of the world is that it is appropriate to use nature for man's benefit, and it follows that the western traditions of stewardship, responsible use, working with nature, conservation and understanding how nature serves the needs of humans, are key ethical issues influenced by Judeo-Christian religion (Elder 1994; Maley 1994). The challenge is to find the best ways of accommodating a balance between the need to serve human needs in both economic and environmental senses. While both are important to the way we live, neither is supreme. There is abundant evidence that this balance has not been achieved with many examples of pollution (air, water and soil), erosion, saline soils, ecosystem destruction and loss of species which test the honour of this ethic.

The current focus on threats to species, particularly the more charismatic ones, is a reflection of more people placing increasing value on environmental amenities. Powerful arguments are often articulated by sections of society to emphasize the negative value of many economic development proposals, or even ongoing land uses which threaten habitats and the continued existence of ecosystems of species. It is interesting that developed countries keen to follow a free-market economy are being driven along an environmentally destructive path with ongoing degradation now institutionalized.

Loss of species is of considerable concern in Australia. Maley (1994) concludes that there is much evidence to suggest that the impact of the European fox and the cat have had, and will continue to have, a far greater impact on native animals than all economic activities combined, and that elimination of these two introduced predators would have a far greater impact on the protection of species than any other action; this goal should be the primary objective for the protection of our native species (see also Giles, in Cohen 1992; Wamsley 1993). There is, however, a cat loving and cruelty to animals group of people who resist moves to eliminate these animals.

The equity principle is relevant to decisions about the way we use our natural assets as the individuals benefiting from the utilization of these resources are often quite different from those who pay the costs (Ortolano 1984). For example, utilization of the Western Australian rangelands, which returns a very modest economic benefit to the state, and has a very low employment base, has resulted in widespread degradation of native vegetation and native fauna dependent upon it. The beneficiaries have been, and in the main still continue to be, pastoralists. Yet the costs of the extensive land degradation in terms of lost production, loss of habitat and wildlife, and remedial action are passed onto the taxpayer. Other costs relate to the provision of an extensive road system, provision of health care and education, communications networks, fuel subsidies, tax relief during droughts and remedial works.

The principle of equity in making decisions about land uses affecting environmental quality has widespread support, yet the issue is not easily analyzed (Ortolano 1984). One of the questions arising from the consideration of the allocation of pastoral leasehold land is: if a decision leads to unfair distribution of benefits and costs, should the inequity be tolerated if the individual gains outweigh the social costs? In attempting to answer the question, difficulties arise related to estimations of how much is gained or lost by particular individuals or industries, and how is a cost ascribed to the loss of biodiversity ?

There are no easy answers to the problems associated with the ethical utilization of our natural resources. The challenge for those involved in developing public policy on matters relating to ethical considerations about land uses which may have adverse impacts on the environment, equity in the distribution of resources and sustainable management, is to encourage widespread, informed consideration of all relevant issues and to be willing to provide adequate support for this process. It must be understood that those interested in considering land-use issues will bring to bear a range of political, social, economic and social perspectives, all which need to be assessed and evaluated in determining the best outcome for society. In the end decisions will be made by those charged with doing so using their best judgment of facts and inputs, using the best information available at the time (McNeely *et al.* 1990).

6.4.1 Biodiversity in Western Australia's rangelands

It is difficult to establish the status of biodiversity in Western Australia, given the immense area and remoteness of the State, and limitation of knowledge about many species yet to be discovered and identified. The best known groups of species are the birds and mammals, but insects, which are amongst the least described species, make up about 65 per cent of all species (Hammond 1992). It has been suggested by Hammond (1992) that systematic survey work aimed at

describing new species is based on a biased approach that continues to consider animal or plant groups that have economic value or are attractive to humans. This is reflected in the relative knowledge about plants and animals where there is far greater knowledge about vascular plants and vertebrates, while there is far less knowledge of other groups.

A prudent approach to the conservation of biodiversity is required. Recent changes to legislation (see the Land Administration Act 1997 for example) and policy (see Managing the Rangelands) directed at recognizing the need for the conservation of biodiversity, reflects the importance placed on this issue by society. These policy documents recognise that efforts aimed at conserving biodiversity should be increased in the light of improved understanding of the significance of species loss and the alteration of ecosystems (Bennett *et al.* 1995).

The conservation of biodiversity is unlikely to succeed without consideration of the full range of actions likely to provide the outcomes sought by society. The options available include:

- protecting biodiversity in parks, reserves and sanctuaries and off-reserve land (most biodiversity within the Gascoyne-Murchison Strategy region occurs outside the conservation reserve system);
- sustainable use of biodiversity – such as native forests, rangelands, kangaroos;
- restoration of degraded landscapes or depleted plant and animal populations; and
- managing biodiversity in ways that ensure there is no further loss – undertaking threat-abatement programs and altering current land-management practices.

An over-reliance on conservation reserve systems may indeed place biodiversity at further risk if this results in any reduction in the recognition for the need to address biodiversity within our overall use of the environment (Wilson *et al.* 1984; Pringle 1995). Clearly some species or ecosystems require protection where they are threatened by a continuation of certain land uses, inappropriate fire regimes, feral predators or grazers, particularly if known populations are rare or restricted in distribution. This raises questions related to the identification of the components of biodiversity that must be carefully protected, areas which should be included in a representative reserve system and finally, those areas that cannot be included in a reserve system for whatever reason, and the mechanisms available to ensure there is no further loss of biodiversity.

6.5 Conclusion

The ethical and utilitarian arguments for the conservation of biodiversity are both forwarded as justification for action by governments, industry and individuals. Belief systems underpinning the range of views about conservation of biodiversity are diverse, putting pressure on decision makers to make concessions to various

interest groups. However, it is likely that a consensus amongst interest groups can be reached given the common goal of conserving biodiversity. A balance between environmental, economic and socio-political issues will be necessary to achieve this goal.

An ongoing commitment for the continued effort into conducting biological surveys and ecological studies is important to the knowledge about species and their habitats. Improved decisions in conservation reserve system design and the conservation of biodiversity on land utilized for pastoral production will result from improved knowledge. While recognizing the need for more knowledge and understanding, there is sufficient understanding to begin the design of a comprehensive conservation reserve system and to pursue adaptive management of pastoral land aimed at conserving biodiversity.

Chapter 7: The Conservation of Biodiversity

7.1 Introduction

The National Strategy for the Conservation of Australia's Biological Diversity (DEST 1996) provides the context for discussion in this chapter. Biological diversity is the variety of all life forms and contains all the different plants, animals, microorganisms, the genes they contain and the ecosystems within which they occur (Noss 1990; Dovers and Norton 1994; DEST 1996). Biodiversity is constantly changing due to genetic change and evolutionary processes on the one hand and habitat degradation, reduction in population distribution and abundance, changes in climate and landscapes, and extinction on the other. Biological diversity can be considered at three levels: genetic, species and ecosystems. As a result of millions of years of isolation from other continents, Australia's plants and animals have evolved to a point where many species occur nowhere else. At the species level, about 82 per cent of mammals, 45 per cent of land birds, 85 per cent of flowering plants, 89 per cent of reptiles and 93 per cent of frogs in Australia are endemic.

In recognition of the extensive alteration of many of the rangeland ecosystems (Wilcox 1964; Wilcox and McKinnon 1972; Pringle 1994; DEST 1996; ANZEEC and ARMCANZ. 1999) resulting in the rapid decline in the distribution and abundance of many species, and the need to safeguard life support systems, the Commonwealth Government has embarked on a program aimed at protecting biological diversity and maintaining ecological processes. It is clear that most ecosystems, species and communities are outside the conservation reserve system, and that most of Australia is not managed sustainably.

The determination of what should be conserved within the conservation reserve system requires an understanding of the foundations of biodiversity and what the primary goals for conservation might be (Wilson *et al.* 1984). This chapter is primarily concerned with the conservation of biological diversity in the pastoral rangelands of Western Australia. It is recognized that the conservation of biodiversity cannot be achieved in protected areas alone and that land outside the conservation reserve system will contain ecosystems and species requiring conservation. Therefore the management of this land is of great importance to the overall aim of conserving biodiversity (Wilson *et al.* 1984; Pringle 1995; DEST 1996).

7.2 Genetic diversity

Genetic diversity refers to the heritable variation – the resemblances and differences between individuals within a population, between populations within species and between species (Abercrombie *et al.* 1975; Burgman and Lindenmayer 1998).

The retention of genetic diversity is important if populations are to adapt to new environmental conditions therefore ensuring their long-term persistence. The rate at which evolution proceeds is directly proportional to the heritable genetic variation in a population (Fisher 1930). Any reduction in genetic diversity is likely to reduce the rate of evolutionary change.

The greatest difficulty in utilizing genetic criteria as a basis for determining what should be conserved is the lack of information about genetic variation. Therefore conservation planning is reliant on the use of indicators of genetic variation based on reliable measures of variation in species (Burgman and Lindenmayer 1998).

Given the dearth of information available about the genetic diversity of the range of organisms in the pastoral rangelands of Western Australia, this attribute has not been considered in conservation planning. Instead, the aim of conservation reserve system planners has been to identify different parcels of land, having conservation values, from an extensive geographic and climatic range. While there is recognition of the need to ensure the conservation of genetic diversity (DEST 1996), it is not possible given the current level of knowledge in this area to apply selection criteria which recognize this important factor. By selecting land for inclusion in the conservation reserve system from geographically, geomorphically and climatically diverse areas, it is assumed that the issue of retaining genetic diversity will be addressed.

7.3 Populations

A population is defined as a group of organisms of the same species occupying a particular space at a particular time. The key constituents of a population are individual organisms that have the capacity to interbreed (Krebs 2001). As a result, individuals in a local population share a common gene pool.

Determining what constitutes a population for any given species is difficult, particularly given the area of the Western Australian rangelands and the number of species residing there. In fact organisms may exist in a continuum with non-existent boundaries (Krebs 2001). Krebs suggests that part of the definition of a population should involve the probability of genetic exchange between members of the same population.

An important cause of genetic differentiation within a species is the spatial segregation of populations that may result in restricted gene flow or complete isolation (Magurran 1988; Burgman and Lindenmayer 1998; Krebs 2001). Isolated populations may experience some degree of genetic drift, and unique environmental conditions may result in selective pressures resulting in genetic differentiation. The frequencies of genes in a population may occur in gradients (clines) or patterns resulting from genetic drift. Genetic neighbourhoods are the largest panmictic unit within a species. Neighbourhoods are important as they

define the provenance of an individual (Burgman and Lindenmayer 1998). A provenance represents a sample of genetic material from a relatively cohesive genetic unit, and variation between provenances is an expression of genetic differences between populations.

Burgman and Lindenmayer (1998) suggest that the extent of differentiation amongst populations should determine conservation strategies. However, it is recognized that it is impractical to identify evolutionarily significant units given current genetic analysis technology and limits to the necessary resources. As a result, it is unlikely that we can measure and characterize genetic variations of populations.

7.4 Species and ecosystems

Many species have restricted distributions due to natural causes. Species do not exist alone in nature but occur in a matrix of many other species (Krebs 2001). The simplest measure of species diversity would be to count the number of species (using suitable sampling techniques) within an area to determine the species richness. Typically, areas of high species richness are targeted for inclusion in conservation reserve systems (Burgman and Lindenmayer 1998). Species diversity can also be taken to mean a function of relative abundance of a number of different species (Margules and Usher 1981). Williamson (1973) has criticized the use of single statistics to measure diversity and casts doubt on the value of diversity studies as a result of the difficulty of separating historical and evolutionary effects on diversity from purely ecological ones. Usher (1979) has shown that diversity may depend on successional stage with sites containing more diversity being usually more mature, so that sites at an early successional stage may not be rated highly on a diversity scale.

Organisms restricted to small areas may be vulnerable to extinction as a result of chance catastrophic events, such as fire or flood, and their identification and description is important in preventing inadvertent or deliberate damage from development or production activities. Wilson *et al.* (1984) point out that it is generally the common species that are important to the functioning of ecosystems, hence to the overall survival of most other organisms. They put forward the idea that conservation concerns should not be dominated by the consideration of species determined to be at risk, and that conservation of ecosystems is the key to the long-term conservation of species. Understanding the structure and function of ecosystems is central to this proposition. Conservation management should then recognize that there will be natural changes to ecosystems in time as a result of natural perturbations, and the recognition of these changes should not cause alarm. However, unwanted and perhaps irreversible changes resulting from human actions must not be allowed to continue unchecked (Wilson *et al.* 1984).

Within the conservation reserve system, natural events such as fire may cause intense changes to some ecosystems, and in particular to long-lived plant species, and the animals living there. In such situations management actions must recognize the need to minimize the impact of catastrophic events.

7.5 Diversity

Ecosystem diversity at the landscape scale refers to the variety of different assemblages and communities of organisms existing in different parts of the landscape. However, there is no consensus on the definition of ecosystem diversity and how to measure the properties of ecosystems (Burgman and Lindenmayer 1998; Krebs 2001).

Ecosystems are subjected to disturbance from grazing, fire, drought, flood, and disease. Species within ecosystems will respond to these disturbances and their degree of resilience will be determined by the diversity of the genotypes (within these species). The resilience of ecosystems will be greater if they contain a large variety of species and habitats that provide protection from disturbance (Wilson *et al.* 1984). Frankel and Soule (1981) maintain that the number of individuals and their distribution are critical factors in the survival potential of species.

Edge effects resulting from disturbance events such as fire may result in changes to microclimate (Chen *et al.* 1990; Esseen 1994) and associated fire ignition probabilities (Uhl and Kauffman 1990). Precipitation, frost, and fire behaviour (Roberts 1973) are likely to influence species that inhabit disturbed sites. For example these areas are subjected to the influence of environmental weeds and other introduced plants which are often better able to adapt to the disturbed environment than native plant species (Janzen 1983).

Edges are the modified margin of a patch which have different ecological conditions to the interior of the patch (Matlack 1993). Ecological edges are referred to as ecotones which are often species rich because mobile organisms – birds in particular, but also lizards - need to utilize more than one habitat to fulfill their needs (Wilson *et al.* 1984). Birds may require a wooded area for shelter and nesting sites but grasslands for their food source, while lizards require both exposed and sheltered sites in close proximity.

7.6 Endemism

A species or taxon is considered as endemic to an area when it occurs uniquely in that area – the specification of the area is important as geographic ranges of taxa may change (Anderson 1994). Anderson (1994) suggests that the specification of time is also important as changes are temporal as well as spatial. Endemism is a

term used by biologists to refer to species with restricted distribution (Burgman and Lindenmayer 1998).

Intuitively, it is expected that more endemic species will occur in larger habitats that have been isolated for long periods of evolutionary time (Nelson and Platnick 1981; Anderson 1994). For example, about 5% of Australia's flora is contained within the Stirling Ranges of south-west Australia which has unique ecological characteristics.

7.7 Rarity

The term rare generally refers to species having low abundance, or limited distribution, or both (Main 1984; Burgman and Lindenmayer 1998). Conservation biologists tend to define rare species as those with small population size or restricted distribution. Rarity is a concept that is used in conservation management planning and in the evaluation of land for inclusion in the conservation estate. Drury (1974) specified three types of geographic distributions of rare species, viz.:

- species inhabiting stressed sites;
- widespread but locally infrequent species; and
- species in large numbers but in only a few locations.

Burgman and Lindenmayer (1998) maintain that rarity is a useful concept in assisting in developing priorities for the allocation of scarce conservation resources. They consider that species having narrow geographic distributions and restricted habitats but are abundant in at least one place would benefit from some level of conservation. Those species that are rare in all locations would have the highest priority for conservation. Species that have restricted geographic distributions are most susceptible to habitat loss, irrespective of their abundance.

7.7.1 Indices of rarity

Low densities of organisms may be related to physical size, scarce or dispersed resources, chance adverse environmental conditions, or disease. Specialized habitats may result from evolutionary processes that lead to adaptation to unusual environmental conditions and loss of habitat - for example due to human developmental activities such as land clearing for crop production – which may also create barriers for dispersal of species, or may cause restrictions to ranges of organisms.

The concept of niche is also an important element of rarity and is defined as that part of the environment within which a species can exist indefinitely (Abercrombie *et al.* 1975; Hutchinson 1959). The continued existence of particular species within a niche is determined by the abiotic and biotic factors

that impinge on the survival and reproduction of the species. The concept of rarity is based on a species' realized niche, thus the notion of habitat specificity. Where environmental niche factors are such that species occur only in isolated islands within the landscape, for example plant and animal species surviving in mound springs within arid landscapes, there is an overwhelming need for conservation management action to be undertaken if these sites are to survive in the long term. A lack of understanding of the environmental variables that limit distribution and abundance of species has resulted in habitat specificity being ignored in many studies (Burgman and Lindenmayer 1998). Attempts to match the distribution of species to edaphic or other environmental conditions may be confounded by biotic inter-relationships, and the difficulty of identifying the correlates influencing species distribution has led researchers to look more closely at the measurement of abundance and range.

Another important index of rarity is the relationship between abundance and frequency of species in samples (Preston 1962). There is a direct relationship between the frequency of species in samples and their relative abundance (Nachman 1981). Local abundance will depend upon a range of factors including seasonal conditions, competition, predation, chance disturbance events and ecosystem tolerance as species approach their limits.

The above concepts are not used with any consistency, and reliance on any one of them appears related to the way in which researchers determine sampling strategies. Rarity has been determined variously as species which occur only once in a sample (Bassett and Kitching 1991) or species occurring less than three times in a sample of 64 (Burgman 1989). Gaston (1994) listed 45 studies that dealt with rare species that showed abundance was frequently used to represent rarity; geographic range was used once and habitat specificity was not used in any of those reported.

Population range may often be expressed as a linear distance or it may be described as a map. In measuring range a number of factors including temporal differences (related to season or time of day), disturbance dynamics and the exclusion of vagrants need consideration (Gaston 1994). Gaston (1994) describes range as the extent of occurrence or the distance between the spatial limits of a species that may be described as a polygon on a map base even where the species measured does not uniformly occupy the area. Sample size will also affect the validity of range determination and insufficient sampling will likely result in an underestimate of geographical range, particularly in the case of rare species (Colwell and Coddington 1995). One of the great difficulties in determining the range of rare species is the effort that is required to obtain sufficient sample size with the result that many rare species remain undetected (McArdle 1990). However, although rarity does not necessarily result in an increased threat of imminent

extinction, small populations of species with narrow limits of environmental tolerance are more likely to become further threatened or even extinct than large populations (Diamond 1984). The degree of proneness to extinction of species or species assemblages will vary and is dependent on a range of factors including habitat types, disturbance history, susceptibility to hybridization, competition, predation and major perturbations from natural catastrophes such as fire, drought or flood (Soule 1983; Thomas 1990; Walter 1990; Gaston 1994). A thorough understanding of species biology and ecology is required to effectively conserve and manage rare species.

7.8 Conservation status

Estimates of population size and distribution are used to assess conservation status. The components of rarity are used to assign species or species assemblages to different categories of threat (Munton 1987; IUCN 1994).

Schedule one of the *Federal Endangered Species Protection Act (1992)* contains the definitive list of nationally threatened plants and animals (Male 1996). This schedule provides for the listing of species presumed extinct, endangered or vulnerable. The definitions of categories, as provided in the ESP Act, are listed below.

- *presumed extinct:* a species is presumed extinct at a particular time if it has not been definitely located in nature during the preceding 50 years; or it has not been definitely located in nature during the preceding ten years despite thorough searching in that period.
- *endangered:* a species is endangered if it is likely to become extinct unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate; or its numbers have been reduced to such a critical level, or its habitat so drastically reduced, that it is in immediate danger of extinction or it might already be extinct but it is not presumed extinct.
- *vulnerable:* a species is vulnerable at a particular time if, within the next 25 years, the species is likely to become endangered unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate.

The conservation status of species determines the degree of threat faced by that species and is useful in setting conservation priorities.

Species are extinct when there can be no doubt that any members of that species continue to survive. However, species presumed extinct are more difficult to assess and there are a number of species once presumed extinct that have more recently been found, some after more than 100 years since last collected. For example Gilbert's Potoroo was last recorded in 1879 only to be rediscovered in 1994 during the field sampling phase of a research program directed towards a

different species. Similarly, the noisy scrub bird was rediscovered in 1961 having been last recorded in 1889.

Local extinction, sometimes referred to as extirpation, refers to the extinction of a population in a spatially isolated patch of its habitat. For example, the Mallee Fowl (*Leipoa ocellata*) has not been recorded in parts of the north-eastern goldfields of Western Australia since 1969 (Moriarty 1972) and the grey honey eater since 1972.

7.9 Threatening processes

A threatening process detrimentally impacts on habitats, ecosystems or species. These processes may threaten the survival, abundance or evolutionary development of a species or ecological community (SoE 1998; Burgman and Lindenmayer 1998). The identification of threatening processes and the likely impact these processes may have on species or ecosystems, is important for prioritizing conservation planning and management activities.

Threatening processes may involve the impacts from one or more factors including competition from invasive species, modification or destruction of habitat, and loss of species from the introduction of diseases. The impacts from threatening processes may result in the decline of species distribution and abundance (Falk 1990). The adverse impacts of introduced predators such as the European fox (*Vulpes vulpes*) and the cat (*Felis catus*) may have had a greater effect on the status of native animals, particularly those mammals in the critical weight range (Burbidge and McKenzie 1989; Christensen and Burrows 1995), than the introduction of sheep and cattle. The rate of decline of mammal species following the introduction of the fox suggests that the fox has played a greater role than the cat (Abbott 2002). Effective control of these two feral predators in particular is necessary if further declines in native fauna are to be averted. The extensive area of the remote Western Australian rangelands requires a broad scale and pragmatic control method such as aerial baiting using sodium fluroacetate (1080) toxin in meat baits (Burrows *et al*. 2003). Burrows *et al*. (2003) have achieved encouraging results from recent aerial baiting trials in the Gibson desert using 40 – 60 g dried meat baits impregnated with 1080 and delivered at a density of 5 baits km^2. As a result of a single aerial baiting carried out during a period of below average rainfall, foxes and dingoes were all but eradicated from a core area for a period of 15 months, although feral cats appeared to increase in abundance (Burrows *et al*. 2003).

Foxes in semi-arid and arid zones of Western Australia appear to be highly susceptible to 1080 baiting. It is claimed that foxes were virtually eliminated from the Peron Peninsula in the Shark Bay Region following a single baiting (Algar and Smith 1998). The removal of *canids* (dingo) from the environment may result in higher cat numbers (Pettigrew 1993; Williams *et al.* 1995), and it is suggested

that cats may have a higher breeding success in an area from which both dingoes and foxes have been removed (Burrows et al. 2003).

Feral cat control is also reported by Risbey *et al*. (1997) at a site managed for the introduction of endangered mammal species on the Heirisson Prong in the Shark Bay region of Western Australia. Control measures included trapping and baiting using 1080 toxin, in a small reserve (1200 ha) where it was necessary to eliminate cats, and at the same time establish a buffer zone of low cat density. Short *et al*. (1997) achieved a substantial reduction in cat population numbers on Heirisson Prong following a baiting program using a range of baits distributed on the ground rather than using aerial distribution techniques.

Ongoing research into the most effective bait material, timing of baiting programs in relation to seasonal conditions and target species density, bait density, and follow up period after initial baiting is progressing. Investigations into the inter-relationships between feral predators is required to ensure that the control of one does not result in an increase in abundance of another.

The introduced herbivores such as the rabbit, donkey, goat, camel and horse, have also had a dramatic effect on native vegetation, soil erosion and habitat and remain a potent force in rangeland ecosystems (Wilson *et al*. 1984). It is quite evident that native fauna have been adversely affected by the introduction of feral predators and herbivores. For example, islands which have remained free of foxes and cats have retained higher numbers of mammal species than on the mainland . Fox control measures in parts of south-western Australia have resulted in an increase in abundance of a number of mammals such as the numbat, western quoll, brushed-tailed bettong, tammar wallaby and the common brush-tailed possum (Strahan 1995). This evidence suggests that the fox has been the primary cause of decline of these animals in this region.

Fire, particularly wild fire, is a major threat in areas containing fire sensitive plants or where conservation reserves are small in area. On the other hand the presence of fire seems to be implicated in the maintenance of suitable habitat for some animals such as the mallee fowl. Fire management requires an understanding of the ecology of plants and animals as a pre-requisite for developing prescriptions aimed at introducing fire into an area either to reduce fuels as a means of protecting life and property, or in the maintenance or regeneration of habitats (Leigh and Noble 1981; Allan and Southgate 2002). European man has modified fire regimes by suppressing wildfires allowing a build up of fuel which, when the inevitable fire occurs, results in larger and more intense fires. This may result in the alteration of the character of the vegetation (Wilson *et al*. 1984) and therefore impact on animal species existing in these habitats.

7.10 Wilderness values

As discussed earlier, there have been many changes to the Australian environment since the arrival of Europeans just over two hundred years ago. There has been not only marked changes to the landscape, but more recently, marked changes to the way we view our environment. A number of public recent opinion polls indicate that the majority people responding are concerned about the environment (see for example the Australian National Opinion Poll 1991). In relation to our concern for wilderness areas, there is perhaps a noted change in public opinion that results from its increasing scarcity.

Wilderness is defined (Robertson *et al.* 1992) as an area that is, or is capable of being restored to be:

- of sufficient size to enable long-term preservation of natural ecosystems and biological diversity;
- substantially undisturbed by the activities of people; and
- remote at its core from places of mechanized access or other evidence of modern society.

The essential values of wilderness are remoteness and naturalness. A number of activities are therefore incompatible including mechanized access, utilization of natural resources, or the use of exotic animals for transport or primary production (Robertson *et al.* 1992). Values that may be maximized in wilderness areas include:

- maintenance of ecological processes;
- opportunities for the preservation of biodiversity;
- mitigation of the impacts of climatic change;
- protection of landscapes that have played a significant part in shaping the values and culture of Australia's aboriginal and non-aboriginal communities;
- opportunities for aboriginal and islander traditional knowledge to assist with ecological research and protection of biodiversity;
- spiritual, aesthetic and psychological benefits;
- an insight into humanity's place in nature;
- opportunities for recreation and research; and
- tangible values such as provision of clean water and other economic benefits.

The Australian continent still contains many vast wilderness areas and the Commonwealth Government has established a National Wilderness Inventory to assist in recognizing and protecting such areas. The Commonwealth has provided significant support for wilderness preservation as seen in earlier statements on our environment. For example, in July 1989 the then Prime Minister of Australia, R J Hawke, stated:

> "Wilderness is one of the many legitimate land use options. Sustainability has special relevance in this case as wilderness is essentially pristine and especially vulnerable to developmental pressures." (Hawke 1989)

McClosky and Spalding (1989) calculated that wilderness areas in Australia are more than five times that of the United States, but that Australia has placed far less emphasis on designating wilderness areas. In the United States more than 500 wilderness areas containing 37,000,000 hectares of public land have been designated (Hendee *et al.* 1990). However, the protection of wilderness has always been an important consideration in the establishment of many national parks (CONCOM 1986). The protection of wilderness has a critical role to play in the construction of a representative reserve system (Robertson *et al.* 1992).

7.11 Conclusion

The lack of biological inventory information including taxonomic data over the majority of the Western Australian rangelands is a severe impediment to conservation planning and management. However, even recognizing the inadequacy of our knowledge and understanding of rangeland biodiversity, there is a pressing need to protect biodiversity and to maintain ecological processes (DEST 1996). Unfortunately, teaching, research and regulatory institutions are investing less resources on fundamental taxonomy and biological inventory as time goes on (Burgman and Lindenmayer 1998). Hopper (1997) considers that Australia runs the risk of losing significant undiscovered and undescribed components of its biota as a result of the reduction in resources directed towards fundamental taxonomy.

There are difficulties in the classification of rarity and the assessment of threat, a dearth of knowledge about species richness and diversity, and understanding of species interaction and ecology. Yet Commonwealth, State and Territory governments in Australia are charged with establishing a conservation reserve system of ecologically viable protected areas to ensure the long-term survival of species and ecosystems. The use of the criteria reviewed here will depend not only on biological theory but also on human value systems and the need to consider a range of pragmatic management issues.

Chapter 8: Conservation Reserve System – Principles

8.1 Introduction

Conservation reserve systems allow for the management of land to achieve an outcome that is otherwise not achievable under other land management systems (Wilson *et al.* 1984). The objectives of management range from the provision of tourism and recreation opportunities centred on attractive scenic values, to the protection of species and their habitats considered threatened by developmental activities.

The historic development of the conservation reserve system in Western Australia, like most other countries, has been undertaken on an *ad hoc*, unscientific basis, often focused on land that was not required for agricultural development due to its inherent low productivity or isolation (Pringle 1995). The existing system of conservation reserves in the Western Australian rangelands is far from being representative of the diversity of land surfaces, habitats and species. It is a national and state priority to address the inadequacy of the current conservation reserve system (DEST 1996).

Although there is sound reason for protecting the range of species and habitats in all the biogeographic regions of the rangelands in Western Australia, it is unlikely that any conservation reserve system can fully protect the full range of species in that region. Any conservation reserve system will only provide a sample of the ecosystems within a biogeographic region. The conservation status of the majority of plant and animal taxa in the rangelands of Western Australia is unknown (Burbidge and Wallace 1995).

The time taken to carry out detailed biological surveys of the rangelands of Western Australia would be so great that it would take decades or more to provide this basic information. The time necessary to establish valid outcomes from research may mean that there is further loss of our unique biodiversity, thus the time to take action and establish a better conservation reserve system is now. However, while such action will undoubtedly improve our conservation reserve system, it may not always provide the level of protection necessary for some species or the habitats they live in. The political settings at the national and state levels clearly establish the foundations for achieving a better reserve system in the Western Australian rangelands although there is still considerable resistance to doing so from those engaged in other land use activities such as pastoral grazing and mining (DEST 1996).

8.2 Biodiversity components

Given the lack of information about individual species, the level of bias in relation

to our knowledge about some taxa, but not others, and public perceptions of what land types, vegetation, or animals are important for conservation, the focus on the conservation of individual species as a means for identifying conservation areas is challenged (Burgman and Lindenmayer 1998). An alternative approach is to protect ecological communities containing high diversity, and which may contain large numbers of endemic or threatened species, or wilderness areas, or are representative, unique or associated with key evolutionary processes (Specht *et al.* 1995; DEST 1996). This approach has the secondary benefit of the potential for the protection of unknown as well as known biodiversity values.

When vegetation communities or ecosystems are contained within a conservation reserve system it is assumed that the species making up these communities are also protected. Reserve system selection processes which encompass the use of land surfaces or vegetation associations assumed to reflect a degree of diversity, are used extensively in the rangelands of Western Australia. These attributes are known as surrogates for other forms of biodiversity, even though the relationship between them and other forms of diversity are not entirely understood (Margules and Pressey 2000; Gaston *et al.* 2002). Ecosystems are most readily defined by their characteristic plant formations. Plants are also good indicators of ecosystem condition (Holmes 1983).

Some ecological communities are recognized as endangered. The Federal Endangered Species Protection Act, 1992, provides for the listing of ecological communities considered endangered. An endangered community is defined within this Act as:

> "likely to become extinct in nature unless the circumstances and factors threatening its abundance, survival or evolutionary development cease to operate; or it might already be extinct"

The conservation status of ecological communities is an important consideration in setting priorities for conservation (Thackway and Cresswell 1995; Pressey *et al.* 1995; Pressey and Taffs 2001; Margules and Pressey 2000; Gaston *et al.* 2002).

The evaluation criteria by which a community is assessed have been developed by the Australian Endangered Species Scientific Subcommittee (ESSS 1995) and are shown in Table 7.

The level of protection of Australia's flora compared to that in other countries indicates that more could be done in relation to threatened species alone (WCMC 1992; Briggs and Leigh 1996). In the Western Australian rangelands the problem of addressing the issue of identifying plants that are threatened and, secondly, in planning for their protection in the conservation reserve system is enormous. Pringle (1995) has shown that two of three declared rare flora are not known to occur on land within the conservation reserve system within the north eastern goldfields region of Western Australia, and 21 out of 23 priority species are also

Table 7. Criteria for an endangered ecological community.

Community may already be extinct
Community is subject to current and continuing threats likely to lead to extinction as demonstrated by one or more of:
• loss of taxa
• marked decrease in geographic distribution
• marked alteration of composition or structure
• community is approaching non-sustainability
• loss or decline of species that play a major role in community function
• small geographic range such that the community could be lost rapidly by the action of a known threatening process
• community processes being altered to the extent that interaction between the community components will be impeded

Source: ESSS, 1995.

not known to occur within the reserve system. Only two of eleven priority one species (poorly known taxa under threat) are known to occur on conservation lands. This indicates that the conservation status of these plant taxa has not been used as part of the conservation reserve selection (the two reserves in the area referred to by Pringle are the result of *ad hoc* selection).

The conservation reserve system is not uniformly distributed amongst the biogeographic regions of Australia, with some having less than one per cent of their total area contained within reserves (Thackway and Cresswell 1995). In many of these biogeographic regions there is a high level of bias towards them appearing in certain land types more than others. For example few conservation reserves occur along major river systems while those containing steep rocky areas or land containing vegetation of low pastoral value such as the spinifex sand plains, are numerous (Pringle 1995). The result of this historic bias in conservation reserve selection is that some ecological communities are relatively well represented while others are not represented at all.

On a continental scale, Specht *et al.* (1995) identified that while some community types are well represented in the reserve system, others, including large proportions of the grassy savannah, grassland, hummock grassland (spinifex dominated), and *Acacia* dominated desert communities, are very poorly represented or absent altogether (Hopkins *et al.* 1996).

The fact that in some bioregions there is little land within the conservation reserve system does not necessarily mean that biodiversity within these regions is not protected or is under some degree of threat to its continued existence. Within some of the biogeographic regions there is so little human activity that increasing

the reserve system is a low priority (Thackway and Cresswell 1995). In relation to the consideration of human land-use impacts, Amos *et al.* (1993) suggested conservation reserve planning should take into account the level of threat faced by species and communities, and that a higher proportion of an ecological community would need reservation if it were under a high level of threat.

The concepts of vulnerability and irreplaceability are also important to conservation reserve system planning (Pressey *et al*. 1995; Pressey and Taffs 2001; Margules and Pressey 2000; Gaston *et al*. 2002). Irreplaceability is used in the context of the optimal selection of an area of land in which all, or a large proportion of, biodiversity occurs (Gaston *et al*.2002). If for some reason this area of land is unable to be managed for conservation, either as part of the conservation reserve system, or under some other form of management agreement, then critical elements of biodiversity could potentially be lost. The identification of areas considered irreplaceable allows conservation planners to make informed decisions about targeting this land, and consider all options in relation to management units (pastoral leases or combinations of leases or parts thereof) including areas of land with lesser options for gaining high biodiversity representation useful in achieving conservation targets. Vulnerability of species, or other features, to disappearance as a result of competing land management activities is an important issue for consideration in conservation reserve system design (Gaston *et al*. 2002).

In the Western Australian rangelands the combination of total grazing pressure from stock, native fauna, and feral herbivores results in landscapes, particularly within close proximity to water, being subjected to sustained grazing pressure (Landsberg *et al*. 1997; James *et al*. in prep.). Recent studies indicate that grazing disadvantages a proportion of native vegetation and fauna, even where grazing levels are held at a moderate level necessary for economic viability (Landsberg *et al*. 2002; James 2003; Landsberg *et al*. 2003). Predicting grazing and water point impacts on plants and animals remain elusive (Landsberg *et al*. 1999; Vesk and Westoby 2001), although the increaser – decreaser model appears to have validity (Landsberg *et al*. 2002) and the alteration of the environmental "architecture" (James *et al*. 1997) particularly near watering points, also impacts on birds, small mammals and reptiles. Thus the conservation of plants and animals affected by pastoral activities requires the identification of areas that are lightly grazed or are not grazed at all (James *et al*. in prep.).

8.3 The use of surrogates

Given the major shortfall in even the most basic information about biodiversity within much of the rangelands of Western Australia, it is necessary to consider the use of surrogates as indicators for biodiversity (James and Saunders 2001). Without suitable surrogates we would be left with little information upon which to base

conservation reserve system planning and management, including establishing priorities. There are many examples where surrogates have been used to predict the distribution of biota (see Braithwaite *et al.*1984; Nix 1986; Margules and Stein 1989; Cork et al. 1990; Pressey and Taffs 2001). A range of surrogates is used to predict the distribution of biodiversity including environmental domains, vegetation associations and centres of diversity.

The vegetation of Western Australia has been mapped at scale 1:1 000 000 (Beard 1980) and digitized by Hopkins *et al.* (1996) to allow computer manipulation of this information as part of a program aimed at identifying the conservation status of vegetation types in Western Australia. The detailed, yet broad-scale maps produced by Beard (1980) are the result of photo interpretation, and extensive ground-truthing of the vegetation structure, floristic composition and description of map units. Vegetation types mapped by Beard are used as a surrogate for biodiversity in the establishment of the conservation reserve system in the Gascoyne-Murchison region of Western Australia. However, the validity of using surrogates as a reliable indicator of biodiversity has not been tested, and remains an important future research priority. The use of vegetation types assumes that the conservation of a proportion of them will also protect sufficient proportions of other species of plants and animals (James and Saunders 2001). Burgman and Lindenmayer (1998) point out that the use of vegetation maps may not be adequate where animal species are reliant on a successional stage within the plant community and reliance on vegetation mapping may result in potentially important areas for conservation being missed.

It is useful to discuss centres of diversity, as this approach has also been used to identify areas that are intrinsically species rich, and referred to as "hotspots" (Pringle 1995; Tinley unpublished). Myers (1988) defined biodiversity hotspots as areas with exceptional levels of endemism (irreplaceability) and facing exceptional levels of threat (vulnerability). The approach taken by Tinley does not consider the level of threat that is apparent, or likely to be so in the future.

8.4 Off-reserve conservation

The formal conservation reserve system will never be capable of conserving all of the State's biodiversity. Reserves alone will be inadequate for conserving biodiversity as they inevitably include only a small proportion of an area and thus a relatively small proportion of biological variation throughout the landscape (Margules *et al.* 1988) and landscape-scale ecological and evolutionary processes will remain inadequately protected (Rouget *et al.* 2003).

The recognition for the need to include from 10 – 15% of each ecosystem within the conservation reserve system (Rodrigues and Gaston 2001; Environment Australia 2001), is considered flawed as it does not account for the natural

ecological setting nor context of threat to species or habitat (Noss *et al.* 1999), and further study into the need for variable target areas will be necessary. The strict adherence to this static level of representation would mean that much of the variation in habitats could not be achieved, thus reinforcing the need for off-reserve conservation to be successful.

Biodiversity and the threats to its long-term survival, extend across many different tenure and administrative boundaries. The conservation of biodiversity therefore requires a consistent and cooperative approach to land management across many different land tenures (freehold, leasehold, unallocated Crown land) and administrative jurisdictions.

Many community groups have been attempting to come to terms with the need for conservation measures aimed at nature conservation outside the conservation reserve system, within the context of the need to maintain economic activities (Burbidge and Wallace 1995; Pringle 1995; Pringle and Tinley 2001; Pringle *et al.* 2003). The issue of biodiversity conservation on land outside the reserve system requires land use priorities to be developed and agreed upon by industry, communities and governments. Conservation management objectives must provide a high degree of certainty that these are achievable and financial resources are utilized efficiently and effectively (Krockenberger and McLean 1997). To ensure that these objectives are met, Krockenberger and McLean (1997) suggest a high level of financial and environmental accountability are built into systems aimed at the conservation of biodiversity and that outcomes are monitored carefully.

Off-reserve conservation management is a voluntary process requiring a high level of goodwill from land-holders. The problem with any voluntary approach to land management is that there will always be those who resist the opportunity to change ingrained land management practices, some of whom control land containing important conservation values. The challenge is to encourage all land managers to consider the benefits of changing land management practices (Pringle and Tinley 2001). Off-reserve conservation presents opportunities to have areas of high conservation value outside the formal conservation reserve system managed by pastoralists, in consultation with relevant agencies, for the benefit of all Australians. Given the area of the conservation reserve system and the limited resources of government agencies to manage this land, the opportunity to engage pastoralists in conservation activities offers the prospect of better management and the achievement of broader conservation goals.

Managing land for the conservation of biodiversity, or carrying out restoration activities on degraded land, is not a simple activity, and many land managers will not have the necessary resources to undertake these activities themselves (Krockenberger and McLean 1997). Leadership from government, communication and consultation, and encouragement for community groups to become involved

and take ownership of programs aimed at conservation will be necessary.

Indigenous people control activities on large areas of Australia and Western Australia, and have an important role to play in the conservation of biodiversity due to their unique knowledge of biodiversity. Initiatives such as the Indigenous Protected Areas program, which provides assistance to communities wishing to self-declare protected areas rather than have them imposed, can provide significant conservation benefit.

Within the Western Australian rangelands there have been many instances where pastoralists have assisted with the conservation of biodiversity, particularly where small isolated populations or threatened communities occur on their lease. Pringle (1995) concludes that this indicates a general interest and commitment to regional conservation management. However, this raises the issue of who should pay for biodiversity conservation on 'private' land? According to Binning (1997), a case can be made for governments to contribute to biodiversity conservation by reimbursing land-holders for some of the conservation work that they do. The reasoning used here is that private land-holders are meeting the costs of biodiversity conservation which is seen as a benefit to society as a whole.

Incentives or economic subsidies play a significant role in gaining commitment from land-holders undertaking biodiversity conservation activities on their land. There are a number of opportunities for such incentives or subsidies to be provided and include the development of management agreements, and conservation covenants providing a contract between land-holders and government or conservation organizations for conservation management on land under their control. Taxation measures and rate relief provide opportunities which may be utilized to provide an economic benefit to those engaged in conservation management on their properties. If society at large wishes to gain from the benefits of maintaining landscape values, or conserving remnant vegetation and the animals living there, on private land, then the need to recognize opportunities such as inducements and incentives for the conservation of our biodiversity is just and necessary (Wilson *et al.* 1984).

The Department of Conservation and Land Management has statutory responsibility for flora and fauna conservation outside the conservation reserve system and must become involved in working cooperatively with pastoralists in conserving the region's biodiversity. The Department must recognize the importance of working with people in the region with land management responsibilities and the need to develop goodwill with its neighbours, the pastoral and mining industries, and Aboriginal people. This will require a shift in policy direction from a strong focus on the management of formal conservation reserves to biodiversity conservation on the majority of land within the region that remains outside the formal reserve system. There are enormous financial and resource benefits to be gained from the establishment of goodwill with land managers

in the region. While the Department is struggling for resources to adequately address management requirements of the conservation reserve system, it could enlist, on a voluntary basis, pastoralists and others who would be willing to make contribution to routine issues such as maintaining tourism facilities and assisting with local knowledge, keeping a watch on feral animal numbers and wildfire occurrences, and undertaking regular inspections of boundary fences.

8.5 Comprehensive, adequate and representative conservation reserves

The National Strategy for the Conservation of Australia's Biological Diversity (DEST 1996) establishes as one of its key objectives the need for a comprehensive, adequate and representative reserve system. These terms are defined as:

- *Comprehensiveness*: The degree to which the full range of ecological communities and their biological diversity are incorporated within reserves;
- *Adequacy*: the system should include sufficient numbers of individuals, and sufficient area of habitat, to ensure that species remain viable (i.e. have a very high chance of persistence) in the long term. Note that the interactions between reserves and surrounding areas should be taken into account in determining the reserve's ability to meet ecological viability and integrity criteria. Complementary management of adjacent areas can play a significant role. In some instances, however, the ecological viability of the protected area itself will be paramount;
- *Representativeness*: the system should include areas from throughout the geographic range of species and ecological communities.

The design of a reserve system incorporating these attributes will depend on the reliability of the surrogates used predicting the range of characteristics of biodiversity such as diversity, rarity and endemism. The design of the conservation reserve system in the Gascoyne-Murchison region of Western Australia has relied heavily on vegetation mapping (Beard 1980) and the utilization of limited information about species richness and diversity available from a few recent biological surveys (McKenzie and Hall 1992; Burbidge *et al.* 2000).

8.6 Conclusion

The need to establish a reserve system to increase the level of representation of ecological communities is now well established in Australia (DEST 1996; ANSECC and ARMCANZ 1999). There is clear recognition of this in the Western Australian government policy, Managing the Rangelands (Anon. 1998), and progress has been made with the development of a comprehensive, adequate and representative conservation reserve system.

Given the lack of detailed biological and ecological information, a suitable

surrogate has been used to direct the establishment of the reserve system, in this case vegetation type maps covering the entire rangelands. There is a clear need to validate the use of this surrogate as a good predictor for biodiversity.

It is recognized that the conservation reserve system cannot be fully comprehensive and that off-reserve conservation management remains as an additional requirement for conserving biodiversity.

Broader sustainable environmental management on lands managed for the production of meat or wool is also a goal that recognizes wider international and national recognition for the need to sustainably manage our natural assets.

Chapter 9: Systematic Conservation Reserve System Design

9.1 Introduction

Population pressures, resource scarcity, economic imbalances and continued use of inappropriate technology combine to challenge the ongoing use of natural resources in a sustainable fashion (McNeely 1994). In this environment, conservation reserves and broader conservation management will have an even more important role to play in the provision of life support systems and in the conservation of biodiversity. Achieving these goals is becoming increasingly difficult in many places due to population and development pressures (Margules and Pressey 2000). Margules and Pressey (2000) argue that the attainment of these goals is dependent upon how well two objectives are addressed. The first relates to the degree to which reserves fulfill the need to fully represent biodiversity, and the second is related to how well the reserve system promotes and is successful in achieving the persistence of species and broader biodiversity, through the maintenance of natural processes, and viable populations, by removing the threats to their long term existence. To do this, conservation planning needs to account for the geographic location and design, including such variables as size, shape, replication, and the alignment of pragmatic boundaries.

Society has responded to some extent to these challenges resulting from the introduction of European land management, by establishing a conservation reserve system of National Parks (Morton *et al.* 1995; Margules and Pressey 2000). This reserve system in the rangelands is far from adequate and requires expansion (Saunders and Curry 1990; Margules and Austin 1991; Morton and Pickup 1992; Woinarski *et al.* 1992; Pringle 1995; Thackway and Cresswell 1995). The existing network of conservation reserves in the rangelands has failed to focus on the ecological processes permitting connectivity between reserves (Noss and Harris 1986) and is mostly the result of historic land selection rather than based on the analysis of carefully prepared scientific data.

There is considerable discussion in the literature about the degree of bias now apparent in our conservation reserve system as a result of expedient measures taken to reserve areas of land in response to availability, aesthetics, pressure from lobby groups, and lack of competition from competing land uses (McMichael 1973, 1975; Webb *et al.* 1973; Fenner 1975; Pringle 1995). This issue will be discussed further in this chapter.

The Convention on Biological Diversity (Biodiversity), signed by more than 150 countries, including Australia, at the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992, included strong support for the development of protected areas. Australia ratified this

convention in 1993 and developed the national framework for the conservation of biodiversity (DEST 1996).

Conservation reserves are often perceived as islands surrounded by land utilized for some form of productive activity likely to have some degree of negative influence on the reserve (McNeely 1994). McNeely (1994) claims that these 'islands' may have little chance of conserving biodiversity in the long term if the surrounding land is degraded such that gene flow is restricted, or surface water flow is interrupted. Rather than being islands as perceived by McNeely, conservation reserves in the pastoral rangelands are embedded within a "matrix of similar vegetation" in an environment where there are gradual gradients of human impact, climate and environmental change, extensive spacial scales, and poor biological inventories (James *et al*. in prep.). There can be no doubt that establishing conservation reserves is a difficult task requiring the expenditure of additional public funds and which faces considerable opposition from other land users.

The sympathetic management of land surrounding conservation reserves will be necessary to enhance the likelihood of achieving conservation outcomes, particularly in relation to the control of threatening processes such as fire, feral animals, weeds and the incursion of domestic grazers such as sheep. An approach is needed to ensure the conservation of biodiversity on all land, whether under pastoral management, traditional cultural use, public utility, or mineral production, and should be for broader goals of government rather than focusing on having a comprehensive conservation reserve system.

This chapter is concerned with the range of approaches, developed in Australia and elsewhere, aimed at achieving the best outcome for the establishment of a representative conservation reserve system.

9.2 Conservation planning process

The criteria used to evaluate conservation values have been reviewed by a number of biologists interested in developing a systematic and rigorous method that may be applied universally (Margules *et al.* 1988; Margules 1986; Usher 1986; Margules and Usher 1981; Diamond and May 1976; Purdie 1987). In seeking to identify areas containing high species diversity that are not within the existing reserve system, a systematic approach is required so that areas are selected which provide the best outcome for conservation. The identification of areas most likely to maximize diversity is an important goal of any selection process (Margules *et al.* 1988). Pressey (1992) maintains that sound decisions about reserve selection require two important factors: information about the indices of biodiversity; and procedures for utilizing this information.

It is useful to review a six phase stepwise planning process put forward by

Margules and Pressey (2000), and Gaston *et al*. (2002), as this provides a logical framework as a basis for starting out (see Figure 11).

Phase one relates to the collection of information about suitable surrogates given the complexity of, and limited knowledge about biodiversity. Planning units should also be considered in this phase of planning. In the Gascoyne-Murchison Strategy region, the planning unit is based on tenure, that is, whole or part pastoral leases. Using tenure as the planning unit has some advantages in that negotiations over land acquisition requires contact with one person or family; however, pastoral leases are often irregular in shape making decisions about management efficiency all the more important.

In phase two, the overall goals of systematic reserve planning – representativeness and persistence – need translating into more specific targets focusing on regional or sub-regional scale; deal with natural processes; reflect the relative needs of species and landscapes requiring protection; and identify options so that the targets can be readjusted as socio-political or economic conditions change (Margules and Pressey 2000).

In phases three and four it is desirable to identify vegetation types that are under-represented, or not represented at all in the conservation reserve network, as well as considering the degree of threat to their long term persistence if not afforded full protection (Gaston *et al*. 2002). The consideration of past land uses and resultant impacts; activities carried out on adjacent land and the likely impact of these on a potential reserve area; attitude of local residents to the creation of a conservation reserve; and the contribution of an area to the overall target and design rules, are necessary in phase four.

Implementing conservation actions (phase five), will be greatly influenced by the availability of resources, and conservation land managers need to set priorities once issues such as degree of threat to the persistence of biodiversity, and the irreplaceability of those areas are considered.

The maintenance of biodiversity in established conservation reserves depends on the range of actions implemented aimed at maximizing the persistence of the attributes identified in earlier planning phases. In much of the Gascoyne-Murchison Strategy region, it must be recognized that the majority of the area has been altered by a long history of grazing and that it will take considerable time to achieve climax associations once more. Preparation for managing a reserve includes recognition of the need for information on the biodiversity of each area; knowledge of the processes that underpin ecological functions; and an understanding of the way in which biodiversity responds to natural processes and disturbance. Periodic monitoring to assess the effectiveness of management activities must complement ongoing management, and an adaptive approach to management based on the results of the monitoring program, will be necessary (Margules and Pressey 2000).

Figure 11. Conservation planning process.

1. Compile data on the biodiversity of the planning region.
• Review existing data and decide which data sets are sufficiently consistent to serve as a surrogate for biodiversity across the planning region. • If time allows, collect new data to augment or replace some existing data sets. • Collect information on the localities of species considered to be rare and/or threatened in the region (these are likely to be missed or under-represented in conservation reserves based on land or vegetation classes).
2. Identify conservation goals for the planning region.
• Set quantitative conservation targets for species, vegetation types or other features (The explicit value of such goals provides clear targets). • Set quantitative targets for minimum size, connectivity or other design criteria. • Identify qualitative targets or preferences (e.g. new reserves should have minimal disturbance from grazing impacts, desirable shape and boundary to area ratio, boundary fencing in good order).
3. Review existing conservation areas.
• Measure the extent to which quantitative targets have been achieved in existing conservation reserves. • Assess the extent to which qualitative tarets or preferences have been achieved.
4. Select additional conservation reserve areas.
• Regard established conservation areas as "constraints" or focal points for the design of an expanded system of conservation areas. • Identify preliminary sets of new conservation areas for consideration as addition to established areas. Options for doing this include reserve selection algorithms or decision-support systems to allow stake-holders to design expanded systems that achieve regional conservation goals subject to constraints such as existing reserves, acquisition budgets, or limits on feasible opportunity costs for other land uses.
5. Implement conservation actions.
• Decide on the most appropriate or feasible form of management to be applied to individual areas (some management approaches will be fallbacks from the preferred option). • If one or more selected area prove to be unexpectedly degraded or difficult to protect, return to phase 4 and look for alternatives. • Decide on the relative timing of conservation management when resources are insufficient to implement the whole system in the short-term.
6. Maintain the required values of conservation areas.
• Set conservation goals at the level of individual conservation areas. Ideally these goals will acknowledge the particular values of the area in the context of the whole system. • Implement management actions and zonings in and around each to achieve the conservation goals. • Monitor key indicators that will reflect the success of management actions or zonings in achieving goals. Modify management as required.

Six phases of the conservation planning process (modified from Pressey and Cowling 2001). The process is not unidirectional and the need for feedbacks is recognized as difficulties arise in implementing a particular phase. Source. Gaston *et al.* 2002.

9.3 Data used in the design of reserves and their limitations

The features most often used in reserve selection are plant and animal species, and land surfaces or vegetation types (Pressey 1992, Margules and Pressey 2000; Gaston *et al*. 2002). Due to the limitation of our current knowledge about species, their distribution, richness, and diversity, land classes are generally used for conservation reserve planning at a regional scale. This information is most often used as a surrogate for biodiversity or may be used to spatially extend reserve boundaries in relation to information about species gained from more detailed surveys. The assumption made in using surrogates is that they provide a better result for conservation reserve design than do randomly selecting sites (Pressey 1992; Sarkar and Margules 2002). The key issue in selecting a suitable surrogate is determining the extent to which it indicates the presence of other taxa such that it can be considered a predictor of all biodiversity. Tests of taxonomic surrogacy in Britain and South Africa are not considered encouraging, although results obtained from similar testing in Uganda have been more so (Margules and Pressey 2000). As planning is a matter of comparison, it is most useful to compare different areas using the same type of information. Thus vegetation class mapping may come to provide spatial consistency over large areas.

The scale at which land classes or vegetation types are mapped is an important consideration in reserve system planning as large scale mapping is likely to miss finer detail that may be extremely important in maximizing species diversity. Pressey and Bedward (1991) indicate that as map scale becomes finer, regional conservation reserves may appear less comprehensive requiring a larger area to be included than previously considered. Vegetation type mapping, used extensively in reserve system planning in Western Australia, is at either 1,000,000 or 1:250,000 scale, and while other useful mapping of land systems prepared by the Department of Agriculture Western Australia and CSIRO has been completed, this does not cover the entire state, nor are the mapping categories used consistently throughout.

The limitations of surrogates as reliable indicators of biodiversity have been described by Pressey (1992) and grouped into five broad limiting factors including:

1. Relationships between land classes or vegetation types and the distribution and abundance of species is difficult to quantify. Conservation reserve system planning needs to recognize that surrogates should be seen as hypotheses about biodiversity requiring rigorous testing to validate their credibility.
2. Species that are patchily distributed within a vegetation class may not necessarily be contained within an area of land considered for reservation. Vegetation mapping provides geographical subdivisions more homogeneous than broader landscape

classes (Beard 1990). However, vegetation mapping, (particularly given the scale of mapping in Western Australia) will inevitably include a degree of heterogeneity that makes conservation reserve system planning aimed at including a representative sample of all species impossible (Pressey and Bedward 1991). Noss (1987) claims that conservation reserve networks based on land classifications are a coarse filter through which some species will fall, particularly those which have small, patchy occurrences (Solem and McKenzie 1991).

3. Species restricted in distribution or threatened by environmental changes require special attention. However, knowledge is lacking about species at risk or which have specific habitat requirements restricting them to discrete areas, such that our general reliance on the use of vegetation mapping as a surrogate for biodiversity will continue.
4. Land class and vegetation mapping does not necessarily recognize nor delineate areas containing critical resources such as parts of the landscape required for maintaining populations during periods of scarcity (Pressey 1992). Conservation reserve system planning may be further limited when these critical resources are not fixed geographically and are therefore difficult to identify and map (Woinarski *et al.* 1992).
5. Many species require a combination of habitats not recognized by land class or vegetation type mapping. Some animal species require resources from different parts of the landscape not related to the mapping categories at all (Dunning *et al.* 1992). The components of the landscape required for some species to complete their lifecycles can be widely separated and the patterns of movement can be regular and predictable (Burbidge 1985).

Pressey (1992) concedes that land classes are necessary, but not sufficient if used without additional information, in conservation planning. The limitations to using a surrogate of this type can only be minimized with specifically designed research related to the requirements of specific species; this may take decades, particularly in a state the size of Western Australia, and given resource limitations. It should be possible, however, to begin investigative work to assess and evaluate the usefulness of using vegetation type mapping in designing the conservation reserve system on a reserve-by-reserve basis until resources allow for a broader review. The use of land system mapping by the Department of Agriculture Western Australia would provide a useful starting point in evaluating the diversity contained within reserves.

9.4 Island biogeography

Macarthur and Wilson (1963, 1967) proposed the theory of island biogeography that has been used as a general guide to the design of nature reserves (Terborgh 1974; Diamond 1975; Diamond and May 1976; Shafer 1990; Noss and

Cooperrider 1994). However, Simberloff (1988) warns that the adoption of the principles of this theory in setting aside areas of land for nature conservation may have an adverse affect on conservation values.

The key assertion of island biogeography is that a single large reserve is better than a number of smaller reserves even where the combined area of the smaller reserves is equal to that of the single large reserve. This notion is dependent on a number of factors including:

- the nature of disturbance in those parts of the landscape set aside for reservation;
- the spatial extent of areas impacted by the same catastrophic event such as high intensity wildfires; and
- the demographics of populations within the reserve system.

It is axiomatic that a number of reserves is more likely to contain a greater diversity of habitats and species than is one single large reserve (Kirkpatrick 1994), and the probability of a single reserve being destroyed by a single catastrophic event is likely to be higher than a network of smaller but separated reserves. The dispersal ability of species and their ability to make use of the surrounding areas, and the connectivity of areas, have an important effect on the long-term persistence of populations in reserves. Thus, a highly fragmented habitat will contain a smaller population, more prone to extinction, than the original non-fragmented habitat, as fragmentation causes not only a reduction in habitat area but also may restrict the movement of individuals. The management of the landscape surrounding a reserve becomes important in the event where reserves are surrounded by land uses which seek to significantly modify the environment, in turn restricting the use of this area by mobile animal species. Plant species dispersed by animal and water may also be impacted by land-use activities on adjoining land. The interplay between environmental variation, disturbance regimes, dispersal capability and the size and number of reserves will determine the best spatial arrangement of reserve networks.

In consideration of the ideal shape of a reserve a number of elements are taken into account. For example, natural boundaries of areas containing riparian habitats are not likely to easily conform to circular reserve areas, which are seen as the ideal shape, and so the particular conservation values of these areas may not be effectively captured or managed by having a circular reserve.

The issue of the connectivity of reserves has received considerable attention in the literature (Simberloff and Cox 1987; Noss 1987; Hobbs 1992). Wildlife corridors may, in some instances, enhance the value of reserves but in other instances may have negative affects (Burgman and Lindenmayer 1998).

The general rules for reserve design derived from the theory of island biogeography are generally not applicable, primarily because it will not be possible in practice to acquire sufficient identical areas that sum the total area of a habitat.

It is unlikely that the final choice in reserve system design will come down to one large reserve or two smaller reserves of equal area.

9.5 Procedures for evaluating data

Systematic reserve-selection procedures have been developed to assist with the identification of areas of land having a priority for protection in the conservation reserve system, in the light of limited knowledge about the distribution and abundance of species across the landscape (Margules and Pressey 2000).

Successful conservation reserve system planning is often limited by the type and quality of data available on species diversity and distribution and their particular habitat requirements. Pressey (1992) reviews some alternative procedures used to evaluate data in New South Wales, as summarized below:

9.5.1 Opportunistic reserve selection

Many of the conservation reserve systems throughout the world are the result of opportunistic approaches to reservation. This process often focuses upon the availability of land for reservation simply because it is not required for any other land use, or because an area contains spectacular scenic values, was available for reservation, or is the result of lobby group or political pressures. Pressey (1992) claims that conservation reserves are rarely dedicated with the overriding importance of their representation of natural features as the primary reason for doing so. Opportunistically dedicated reserves can be considered to add to the total extent of the reserve system, but they may only partially protect biodiversity (Pringle 1995). An important point raised by Pressey (1992) is that the task of ensuring complete representation may become more difficult because existing reserves, irrespective of the conservation values they contain, miss important values and accumulate less important natural features inefficiently. If this trend were to continue, the ceiling of reserve area (not defined) may be reached before full representation can be achieved. This model best fits the Gascoyne-Murchison region (Pringle 1995; Pringle *et al*. 2003).

9.5.2 Setting priorities

Simple scoring procedures result in priority sites according to numerical scores of one or more attributes such as diversity, rarity, conservation status and size (Margules and Usher 1981). This procedure is limited in that where sites are to be included in the conservation reserve system based on their scores, a large number of areas may be required to represent all biodiversity (Pressey and Nichols 1989), even though a consistent and explicit result is provided. Scoring procedures ignore the requirement for complementarity of sites (Vane-Wright *et al.* 1991) and may

lead to inefficient reservation that does not fully represent the biodiversity of the area (Pressey and Nichols 1989).

9.5.3 Minimum set algorithms

The most convenient tools used in reserve selection are algorithms, based on explicit sets of rules used to identify areas of land containing specific conservation values (Margules and Pressey 2000). Algorithms are used to assess a range of issues such as policy options, comparisons of outcomes using number of areas or total area, the achievement of the full array of options within time or economic constraints, and what trade-offs may be possible. Algorithms help guide the decision making process, but a range of other information is necessary before final decisions can be made.

Analyses which identify highly complementary sites are referred to as minimum set algorithms because they can be used to identify a small set of sites which together achieve a representation goal.

Algorithms have two limitations according to Pressey (1992). Firstly, the procedure may not select the best configuration of areas for efficient management or the long-term viability of some species. Secondly, the process results in one solution to the best way to represent all biodiversity when there are many ways of doing this. Existing land use patterns, and competition for productive land, may mean that this approach is impractical.

Warman *et al.* (2004) point out that there are a number of uncertainties associated with the criteria used to select sites for conservation. Systematic selection techniques require decisions about both spatial and ecological scales, and it is these decisions that set values for the variables used in the algorithm (Warman *et al.* 2004).

Priority areas identified for conservation using systematic reserve-selection procedures should be considered with caution. Regional scale data will need further analysis at different scales, particularly fine-scale analysis where reserves are likely to be implemented (Rouget *et al.* 2003). Conservation planners must be aware that systematically selected sites may need further refinement to accomplish the reservation goals being sought (Margules and Pressey 2000).

9.5.4 Comparison of biological assemblages

This approach looks at the need for new conservation reserves to be complementary to existing ones and has been proposed as a method of evaluating the adequacy of existing reserves in New South Wales by Belbin (1992). The analysis determines the degree of similarity of species compositions between reserved and unreserved sites. Unreserved sites which have features not contained within the reserved sites identify gaps in the existing conservation reserve system and become the target

for future reservation. It is proposed that this system could be used as a tool for selecting areas for reservation by identifying assemblages which do not occur in the reserve system, then reserving these and repeating the process until all assemblages are represented in the reserve system.

9.5.5 Conservation options and decision analysis

This procedure, referred to as CODA - Conservation Options and Decision Analysis - has been developed to overcome the limitations of algorithms. The process has four main steps:

- set targets for the representation of features to be in the final reserve system;
- identify sites that are highly significant and should be in the reserve system;
- identify additional sites needed for full representation of features; and
- consider alternatives to sites selected in previous step that are inappropriate for some reason.

The procedure allows the user to design a conservation reserve system by including and deleting sites until the planning goals such as representation and land suitability are achieved. This approach requires sufficient resources and political support if it is to be successful.

9.5.6 Levels of irreplaceability

The theory of this concept is that it is possible to consider the extent to which some sites may be replaced as components within the conservation reserve system. Selection of reserve areas is then based on the level of irreplaceability which is registered as a percentage score from 100 to zero with selection then proceeding with the inclusion of areas with the highest scores. Where other land use pressures force departures from the ideal configuration of areas in the conservation reserve system, the index of irreplaceability may be used to suggest the next best alternative area.

9.5.7 Principles of conservation reserve system design

The need to identify new areas for inclusion in the conservation reserve system is recognized and many different approaches have been proposed. Out of the array of methodologies proposed, there is consensus on the recognition of three important principles that underpin reserve selection procedures, namely complementarity, flexibility and irreplaceability (Pressey *et al.* 1993).

1. **Complementarity** is the degree to which an area contributes previously unrepresented features such as species, land surface types, or vegetation types, to the reserve system. The selection of land for inclusion in the conservation reserve system should be as complimentary as possible to existing reserves in terms of the habitats or species they

contain (Vane-Wright *et al*. 1991; Pressey *et al*. 1993). Applying complimentarity minimizes the number or area of new conservation reserves required to achieve the established targets for reservation, thus maximizing the chances of achieving them (Ferrier *et al*. 2000). The selection of areas of land for inclusion in the reserve system should involve the assessment and evaluation of the attributes of the land adding new features to those already within the reserve system. Planning efficiency is a function of the selection process, which minimizes unnecessary duplication of features already in the reserve system (Burgman and Lindenmayer 1998).

2. **Flexibility** allows a range of different representative areas to be substituted for others if they contribute the same unrepresented features (Pressey *et al.* 1993). It has been shown that a representative conservation reserve system may be developed using a range of different combinations of areas containing the same features, and is therefore an important part of the planning process. Flexibility allows the achievement of conservation goals amidst a range of other imposing factors such as economic, social, industry, and political imperatives. The term does convey information about the degree to which areas of land can be substituted with others, an important consideration in conservation planning (Ferrier *et al*. 2000).
3. **Irreplaceability** has two important meanings. Firstly, knowledge about irreplaceability may provide information about the potential contribution of a site to the reserve system, and secondly, it therefore allows for the evaluation of the level of representativeness that is compromised if the site is not included. Ferrier *et al*. (2000) define irreplaceability to mean the "overall importance of an area to achieving conservation targets for the features it contains" (p 305). Rebello (1994) uses the term to describe areas containing unique species, and which are therefore essential to achieve conservation targets regardless of the number of areas acquired for addition to the conservation reserve system. Belbin (1992) defined the term as the "degree of isolation of an area from its closest neighbour in space, including its distinctiveness across all biological variables".

Irreplaceability can be related to the concept of rarity – reflecting the low abundance or restricted distribution of species – and endemism – reflecting the number of features unique to an area (Gaston 1994). Endemic features will always confer total irreplaceability, while features or species classed as being rare will often be related to irreplaceability (Rebello and Siegried 1992; Kershaw *et al*. 1994; Williams *et al*. 1996). When conservation targets are set in terms of vegetation types, the influence of both rarity and endemism on irreplaceability values can be weak (Ferrier *et al*. 2000). Space demanding animal species occupying large areas within a region will be reflected in large conservation targets causing many areas to be highly irreplaceable. This concept assumes the existence of detailed biological and ecological requirements for the range of animal species within a region – this information is not available across the Gascoyne-Murchison Strategy region.

Irreplaceability was originally defined as the percentage of representative combination of areas in which each area occurs (Ferrier *et al.* 2000). This is measured by generating all possible combinations of areas – all combinations of two, three and so on, and then checking which combinations of a particular size are representative (Pressey *et al.* 1994). The application of this approach required a combinational analysis that generated very large numbers of combinations well beyond the capabilities of the most powerful computers. A revised measure of irreplaceability has been developed (see Ferrier *et al.* 2000) that is calculated by dividing the number of representative combinations that include site X but would no longer be representative if site X was removed by the total number of representative combinations. This measure appears to work in practice but further refinement is continuing, including the validation of the method.

9.6 The use of algorithms in reserve system planning

9.6.1 Minimum set approach

The principles of reserve system design are utilized in reserve selection algorithms. Algorithms are the rule sets that are followed in selecting areas for reservation and setting priorities. Pressey and Nichols (1989) selected a minimum number of sites using the following rules:

- select sites having unique land systems;
- select the site that contains the next rarest unrepresented land system;
- if there is a choice, select the site with the highest ratio of unrepresented land systems; and
- if there is still a choice, select a site randomly.

9.6.2 Conservation evaluation

A systematic reserve selection process has been developed in response to the need for an objective approach to the reliance upon perceptions about degree of threat and subjective analysis of site-specific multi-variate indices (Margules and Austin. 1991). According to Margules and Austin (1991), ranking scores awarded from a multi-variate analysis suffers from a number of problems as indicated below:

1. Intrinsic values v. extrinsic values

Intrinsic values include features such as diversity, rarity, degree of threat, and conservation status. These features indicate the contribution a site can make to the conservation reserve system, while extrinsic values include economic, social, and political factors that may affect the achievement of a representative reserve system. Some authors have proposed the evaluation of both the intrinsic and extrinsic information by combining both. This approach has considerable shortcomings (Pressey 1985) in that sites important for the

conservation of biodiversity may be downgraded due to apparent threat or management difficulty, which is not scored highly. Intrinsic values indicate priorities for conservation regardless of practical considerations, while extrinsic values may indicate the most appropriate form of protection or management options (Margules and Austin 1991)

2. Inference

Evaluation criteria can be either observed or predicted (Margules and Austin 1991). Actual records of features including, for example, species diversity, rarity, and endemism fit within the observational domain while predicted measures are those based on factors used to predict or infer values that are unable to be directly observed. Margules and Austin (1991) suggest that the size of a wetland may be used to predict the degree of diversity as an indicator of faunal value. These criteria may limit the costs involved in biological surveys, but their real value is questionable in terms of their predictive capability. There is a need to test the validity of using predictive measures by comparing both observational data and inference.

3. Validity

The development of multicriteria evaluation models requires the recognition of a number important factors including the need to acknowledge that the criteria are independent and that the rankings for different criteria (such as rarity or diversity) are equivalent (Margules and Austin 1991).

4. Averaging rules

One of the key problems with simple additive weighting methods is that sites known to have high conservation values may be hidden by low-scoring values for other attributes. One solution is to have outstanding scoring categories with values that reflect high conservation values in an effort to ensure that these values are not lost within the overall score (Margules and Austin 1991).

9.6.3 No stopping rules

Margules and Austin (1991) discuss the need to consider how far down the ranking list should conservation reserve planners go before an adequate reserve system is achieved. Should one stop after the top ten sites? or the top fifty sites?, and what are the criteria that should be used to make a decision? They suggest that large areas will be needed to maximize diversity at the regional scale. They suggest that amongst the sites ranked highest there will be some attributes of biodiversity that will be duplicated perhaps many times while others may be missed altogether or poorly represented. The larger the area selected for inclusion in the conservation reserve system, then the better chance of including the majority of attributes.

In order to conduct the evaluation of site attributes on the basis described by Margules and Austin (1991), there is recognition that a suitable, geographically complete, data-base must be available. With information about only a few sites

it is impossible to make comparisons between sites, which is the basis of any evaluation process. A suitable data-base is one considered to contain, for example, information about species, land systems or habitats. It is claimed that it is better to have a little information about all sites than a lot of information about a few (Margules *et al.* 1991). Nichols and Margules (1993) argue that inadequate or incomplete information may result in inaccurate or misleading results from this method of choosing a reserve system. Biological surveys are samples of regions and are not complete inventories, requiring correlative statistical models to predict the probabilities of occurrences of species or communities in areas that have not been sampled (Nichols and Margules 1993). When using environmental domains or statistical models as surrogates for species there are assumptions made about relationships between species and the environment, for which Nichols and Margules (1993) claim there is a sound theoretical basis, but with little support from empirical data.

One other important consideration of the use of sampling techniques used to gather biological information is that the environment is both spatially and temporally heterogeneous; species respond to changes to the environment due to seasonal conditions or other external factors which may influence species population distribution and abundance.

9.6.4 Revised Bolton and Specht method

Purdie *et al.* (1986) describe a method of selecting land for inclusion in the conservation reserve system based on analysis of land system and vegetation mapping in the arid and semi-arid land of Queensland extensively utilized for pastoral grazing activities. Their primary objective was to identify areas of land that would meet the region's conservation needs and that these areas should contain representatives of all plant species, landforms, vegetation types and soils together with special habitats, and rare or uncommon plants. The size and location of a reserve needs to satisfy the requirements of individual species and preserve regional genetic diversity as well as the full range of habitats with which species associate (Purdie *et al.* 1986). The arrangement and size of reserve areas was also reviewed in relation to management considerations.

Land system and vegetation maps were used as the primary source of data in selecting a potential conservation reserve system which included conservation values related to diversity, representativeness, rarity and naturalness (Purdie *et al.* 1986).

Following the digitization of land system and vegetation-type map information a computer technique developed by Bolton and Specht (Bolton and Specht 1983, 1984 and Bolton 1986) was used to identify grid squares containing high potential conservation values. Land system diversity within a number of sub-

regions was calculated to indicate how common each land system was within the sub regions and used as a measure of representativeness. Special features such as rare or uncommon species, or important habitats were also included in the analysis. The outcome of the analysis was the identification of grid squares containing the highest theoretical conservation values based on land system or vegetation diversity.

In more disturbed areas, recent LANDSAT satellite images were used to identify areas appearing to be the least disturbed and which therefore rated highest in terms of their state of naturalness.

The conservation network was then identified which had the highest vegetation diversity, ecosystems in the best condition (degree of naturalness), and which contained the greatest number of other special features including scenic, recreational, scientific and educational values (Purdie *et al.* 1986). In the main, the area of land selected for inclusion in the conservation network containing high diversity and representativeness was large, ranging from 27,000 hectares to 141,000 hectares with some smaller areas of around 13,000 hectares to 31,000 hectares containing rare species or other special features.

Due to the need for a national reserve system containing examples of all ecosystems, considerable work has been completed aimed at the development of models, which could be manipulated by computers, to arrive at the best regional framework of land considered as meeting the needs of the reserve system (Purdie 1987). Bolton and Specht (1983) developed a computer-based methodology which would provide reserve system planners with a systematic approach to evaluating criteria used in reserve selection. Purdie (1987) considered the need to include several new steps in the methodology developed by Bolton and Specht, renamed as the Revised Bolton and Specht Method or RBS. The RBS method is based around five criteria used to assess the conservation value of an area of land, viz., representativeness, diversity, naturalness, effectiveness as a conservation reserve and rarity. These criteria have then been used either singularly or in combination for assessing conservation potential of any area of land and are defined by Purdie (1987) as:

> *Representativeness* – the degree to which resource map units typify an entire biogeographic region when measured by their areal extent within that region. Units occupying large portions of a region are considered to be the most representative of the region and are given higher conservation value than smaller units.
>
> *Diversity* – defined as the number of ecosystems per map unit, thus relating to communities and habitats rather than species. Map units containing highest diversity are assigned the highest conservation value. The method considered two levels of diversity. Firstly, theoretical diversity was derived from the number of mapped resource units per unit of area, and secondly real diversity relating to the number of ecosystems actually

recorded per unit of area in the field. Theoretical diversity was measured using land systems while the real diversity was measured in terms of recorded vegetation associations (Purdie 1987).

Naturalness – defined as ecosystems containing predominantly native species that are not obviously disturbed. This was validated by ground truthing and is considered in a regional context. Vegetation considered the most natural was that presumed to resemble the structure and composition which would have existed prior to European settlement (Purdie 1987).

Effectiveness as a conservation unit – this is related to defining areas which contain large, compact areas rather than many small areas, which is a decision related to manageability, that such areas are likely to contain a greater number of species and that they would remain more natural over time. Bolton and Specht (1983) considered that large areas more or less equated to pastoral lease area.

Rarity – related to species, particular ecosystems, habitats or landforms which are uncommon or rare when considered in a regional, state or national context. Where such values are not present within large areas, it will be necessary to define smaller areas containing these features so that they may be included in the reserve system and thus ensure their conservation.

Purdie (1987) then describes each of the 25 steps in the RBS method, the last step assigning a rank to each potential area based on:

1. theoretical ecosystem diversity per unit area;
2. presence and number of special features;
3. number of landscape types represented; and
4. type of ecosystems present and their contribution to the reserve network which will contain as many ecosystems as possible.

Where restrictions on the availability of land exist, areas containing high diversity, representing more than one landscape type, will be ranked highly. By comparing the areas proposed it is possible to determine which ecosystems are present or absent, and the degree to which they are over or under represented compared to the region as a whole.

Once all steps have been completed the final task is to delineate a key area network within the region involving considerable adjustment until the required mix of ecosystems is closest to their proportion in the region. The degree of duplication of ecosystems is also considered. Ecosystems absent from the network are evaluated and if typical of the region are included by adjusting proposed area boundaries.

The final network is aimed at containing samples of the majority of the most representative ecosystems in the region with additional areas selected to ensure the conservation of rare species or ecosystems.

The revised method developed by Purdie (1987) provides a method for selecting areas of high theoretical conservation value while rejecting areas of low conservation value.

9.6.5 Species richness surveys

McKenzie *et al.* (1989) developed an alternative approach to reserve network selection based upon the results of surveys of the richness of birds, reptiles, mammals and plants using the results of a broad-scale ecological survey. The conservation reserve selection procedure has four steps, namely, ecological survey, pattern analysis, modeling to interpolate geographic patterns of distribution and, finally, further field assessment to test the model.

The ecological survey involved a quadrat-based sample design with each quadrat covering 4 km^2. The sample was 0.15% of a 220,000km^2 region indicating that more intensive sampling may have been necessary to provide greater reliability, particularly in relation to mobile and ephemeral species (McKenzie *et al.* 1989).

Data were then analyzed to determine the association between species and species richness maps generated. Areas likely to contain a range of species assemblages as well as areas with few species assemblages were then identified such that locations where the fewest and smallest number of reserves that would achieve the greatest likelihood of representing the biodiversity of the region could be chosen (McKenzie *et al.* 1989).

The analysis of data collected from the sample sites was based on classification of species into groups, based on the quadrats they had in common, with these groups then used as units of diversity (McKenzie *et al.* 1989).

The data matrix generated from the analysis of the data was ordered by developing a contour map representing the geographic pattern of species richness and the quadrats classified according to the level of similarity in species composition (McKenzie *et al.* 1989)

Overlaying the nodes of compositional richness for the assemblages identified then derives the smallest number of sites providing the greatest likelihood of representing the biological complexity of the region. It is recognized that competition for land and its use will compromise the development of a reserve system that includes all species assemblages (McKenzie *et al.* 1989). This is a major constraint to the development of a comprehensive, adequate and representative conservation reserve network in the pastoral rangelands of Western Australia. It should also be noted that this work was conducted in a region of the state having relatively homogeneous vegetation where site-based interpolation might hold more easily than in regions containing significantly more diversity (see for example Burbidge *et al.* 2000).

9.7 Economic considerations

The comparison between the time required for evolutionary processes to occur and the current rate of erosion of biodiversity is an important consideration when dealing with economic considerations related to the establishment and ongoing management of the conservation reserve network. If conservation reserve areas are too small, or fragmented, are unrepresentative of the regional vegetation and landforms, and continue to be lost at a rapid rate, they have little chance of conserving our native species (Lunney *et al.* 1997). Lunney *et al.* (1997) maintain that sustainable economic decisions cannot be made unless ecologically meaningful bases of time and space are incorporated into the decision making process.

Lunney *et al*. (1997) consider that reticence in recognizing the magnitude of the current extinction rate, hesitation in establishing a representative reserve system, and failure to understand the link between extinct species and the need for very large reserves, have increased the environmental crisis, driven up the cost of rehabilitation, and continued to sanction the consumption of our biological wealth. It could be considered that the present status of threatened flora and fauna is the result of an inadequate conservation reserve system, and that from an evolutionary perspective, the full impact of 200 years of occupation on this continent are yet to be felt.

The link between economic and ecological viability has been elucidated on many occasions, for example, the 1940 Royal Commission into the financial and economic position of the pastoral industry (Fyfe 1940), in Francis Ratcliffe's work of the mid 1930s (Ratcliffe, 1953), or the Select Committee into Land Conservation in Western Australia 1991. Lunney *et al*. (1997), in considering the findings of the 1901 Royal Commission in New South Wales, indicate that the findings, although not in ecological terms, were ecological in terms of the insights into the results of unsustainable economic decisions (Lunney 1994; Lunney *et al*. 1994). The continuation of pastoral management, ignorant of the lessons highlighted in the findings of these Royal Commissions and others, has resulted in considerable anguish over the state of the resources in the pastoral zone of Western Australia. Lunney *et al*. (1997) claim that a "… flawed economic and ecological view of the land led to overstocking, soil erosion, decline of perennial plants, and loss of species". The need to adjust stocking rates during times of drought is still a major problem in the Gascoyne-Murchison Strategy region (and perhaps the wider pastoral region) as identified by Bartle (2004), where stock numbers have been held at perhaps twice the recommended level over a four year period when the region was in the midst of a drought. The continued loss of vegetation and soil, increases in salinized areas of land, and the lack of a thorough application of environmentally sustainable development principles point to the

need for rethinking the way the industry operates. The clear message from just a few decades of pastoral development is that both ecological and economic wealth has been lost. This needs to be balanced with the economic contribution to the State's economy, once all cost associated with Government subsidies to the industry are discounted. Due to the inherent difficulty in assigning fiscal values to environmental degradation, or the value of a species lost, some estimates of the cost of lost production arising from the degradation of the natural resource on which the pastoral industry relies, and estimates of the area of pastoral land requiring rehabilitation have been provided by the Western Australian Department of Agriculture (see Table 5 for value of lost production, and Table 6 for estimates of the area of land requiring rehabilitation in chapter 4).

Effective nature conservation is more than nature conservation designed to buy green points for Governments and assist them in retaining office for another term. Nature conservation will never be serious so long as effectiveness is sacrificed in terms of cost (Lunney *et al.*1997).

9.8 Conclusion

The need for a systematic approach to reserve system design is required to identify areas that will provide the best outcome for conservation. Given the limitations to our knowledge about habitats, communities and species, it is necessary to resort to the use of a suitable surrogate for biodiversity – usually related to land systems or vegetation assemblage mapping at a large scale. Surrogates should be viewed as untested hypotheses (with sound theoretical bases) which deal with the prediction of biodiversity but, unfortunately, remain untested. The need to rely on the use of surrogates in reserve system design is likely to remain for considerable time.

The array of theoretical approaches to reserve design is impressive. However, given the limitations to the availability of land for inclusion in the reserve system, many of these theories will remain as no more than theoretical designs useful in providing guidelines for evaluating and prioritizing conservation values. None of the models reviewed include cultural, social, heritage, economic or other attributes that are also important when considering the acquisition of land for inclusion in the reserve system.

These modeling theories indicate what might be possible if all land was equally available for selection in a reserve system. The models are based on current but limited knowledge, and fail to recognize that the shape, and areal extent of the reserve system may need to be changed as information comes to light from further survey programs or other influences such as vegetation decline or clearing. The need for flexibility in reserve design is recognized but may be difficult to achieve in the future.

The consideration of ecology alongside economics provides a reality-check for those involved in conservation planning, for it provides clarity in evaluating the motives for establishing a conservation reserve system aimed at conserving biodiversity over very long timeframes that are generally inconceivable to economists and politicians.

Chapter 10: A Methodology for Selecting a Conservation Reserve System in the Gascoyne-Murchison Region of WA

10.1 Introduction

The opportunity to acquire land for inclusion in the conservation reserve system in the Gascoyne-Murchison Strategy region of Western Australia is unique not only in this state, but within Australia. Although this Strategy recognizes the need for a comprehensive, adequate and representative reserve network as the basis for the conservation of biodiversity, as well as the goal of achieving from 10% to 15% of each ecosystem in the region, extrinsic features such as competing land use make the achievement of this goal highly unlikely. None-the-less, the Strategy has State Government support, and the program of acquiring land for inclusion in the reserve system began in mid 1998. The acquisition program is entirely opportunistic and voluntary; at no stage has there been any compulsory resumptions of land within this program.

From the outset it was recognized that this was an opportunistic approach to improving the existing reserve system recognized as inadequate and biased (Thackway and Cresswell 1995). It was also recognized that it would be necessary to include in the assessment and evaluation process a number of non-scientific attributes such as economic, social, cultural, and management planning, as well as a range of geopolitical issues. A set of criteria addressing the need for consideration of this range of issues was developed by the author as the acquisition program began (see Appendix 1).

The assessment and evaluation of the conservation and other relevant values contained within a pastoral lease was completed systematically using a range of information including vegetation associations (types), land-system mapping where available, special features, such as riverine land systems which are particularly poorly represented in the existing reserve system, and information about rare species or ecosystems. None of this information has been scored or ranked using computer programs. The approach taken throughout the program has been maintained and is systematic in that the assessment of values has consistently followed the same process. This process, developed by the author, is described in this chapter.

10.2 General description of selection method

Areas of pastoral land, usually at the pastoral lease scale, are assessed for the contribution that the area may make to the reserve system on a biogeographical region basis.

Resource maps including Beard's vegetation type (associations) mapping

at 1:250,000 scale and IBRA regions (see Figure 12) covering the Gascoyne–Murchison Strategy region, have been prepared and digitized to allow systematic analysis of pastoral leases within a regional context.

Vegetation types occurring within the existing conservation reserve system are identified and recorded on a Microsoft Excel™ spreadsheet. As land is acquired for inclusion in the reserve system the vegetation type spreadsheet is updated. Each new investigation is reviewed in relation to the vegetation types already known to occur in the existing reserve system. Using this approach, vegetation types not represented at all or which are represented at less than 10% of their original areal extent within the reserve network are quickly identified.

Land to be acquired for inclusion in the reserve system must be in relatively good condition (as described by Rangeland Condition Reports prepared by the Department of Agriculture Western Australia), sustain low numbers of feral animals and weeds, contain high conservation values that improve the level of representativeness and comprehensiveness, and be adequate in size to ensure evolutionary processes continue. The shape of the land area is also assessed to determine the boundary to area ratio as this has important management and ecological implications.

Step 1. Define Interim Biogeographic Regions.

The identification of biogeographic regions across Australia provides the fundamental framework for developing and managing the National Reserve System, and provides common criteria against which the adequacy of the existing reserve system may be evaluated (Thackway and Cresswell 1995).

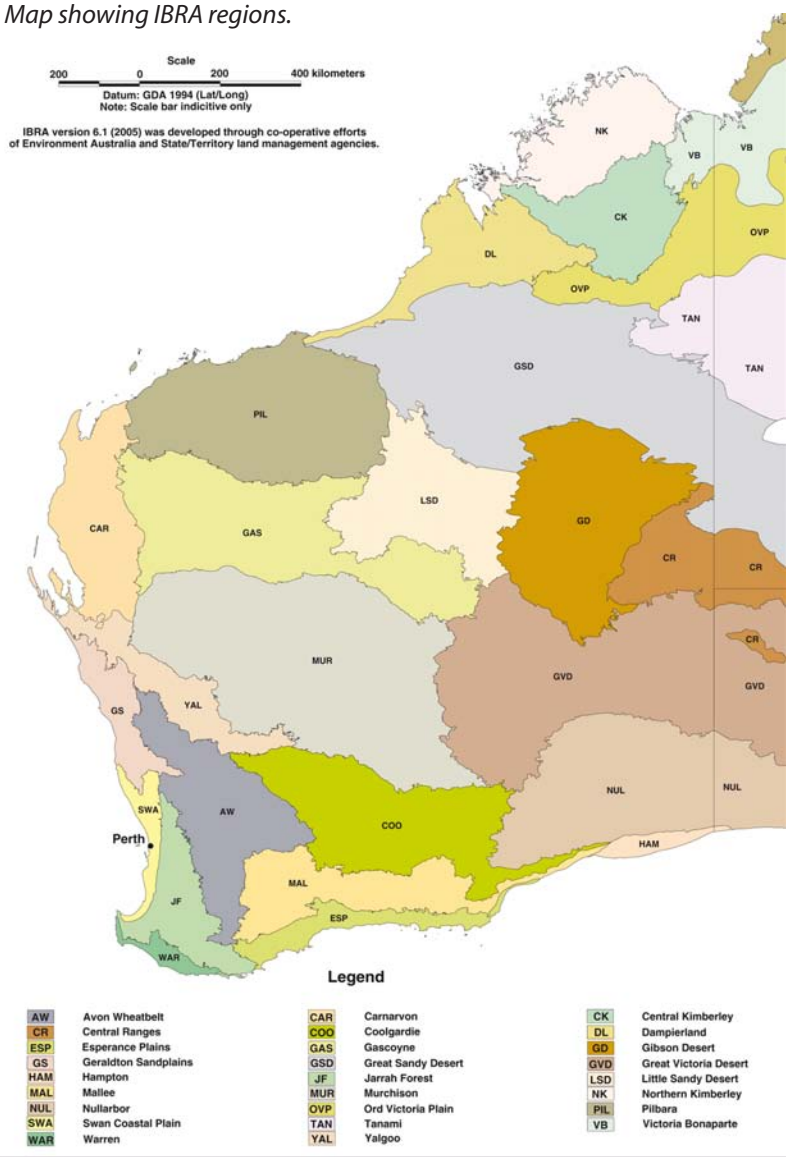
Eighty biogeographic regions have been described throughout Australia with some regions lying across state borders – that is, some of the regions are shared between states or territories. Twenty-six biogeographic regions occur wholly or partially within Western Australia, with 23 occurring wholly or partially within the rangelands.

Step 2. Identifying priority of IBRA region for filling gaps in reserve system.

Biogeographic region boundaries are used as an initial step in the selection process to determine levels of representation within regions. The Interim Biogeographic Regionalization of Australia (IBRA – Thackway and Cresswell 1995) also assigned three levels of priority for filling the gaps in the national reserve system (NRS). Priority 1 reflects the highest need for filling the gaps in the reserve system while the second and third priorities confer a lesser need (Thackway and Cresswell 1995). Priority 1 status is derived on the basis of:

- no reserves or low reservation status;
- nil reserves and/or high bias, and
- conservation values threatened by current land use management activities.

Figure 12. Map showing IBRA regions.



AW Avon Wheatbelt	CAR Carnarvon	CK Central Kimberley	COO Coolgardie
CYP Cape York Peninsula	DL Dampierland	ESP Esperance Plains	GAS Gascoyne
GD Gibson Desert	GS Geraldton Sandplains	GSD Great Sandy Desert	GVD Great Victoria Desert
HAM Hampton	JF Jarrah Forest	LSD Little Sandy Desert	MAL Mallee
MUR Murchison	NK Northern Kimberley	NUL Nullarbor	OVP Ord Victoria Plains
PIL Pilbara	SWA Swan Coastal Plain	TAN Tanami	VB Victoria Bonaparte
WAR Warren	YAL Yalgoo		

There are eleven IBRA regions within the Gascoyne-Murchison Strategy region, five of which have greater than 65% of there total area in the region – Carnarvon, Gascoyne, Murchison, Yalgoo and Little Sandy Desert – the remainder having only a small areal component, with four being less than one percent.

Four of the five most prominent IBRA regions are considered priority 1 for filling gaps in the reserve system – Carnarvon, Murchison, Gascoyne and Yalgoo. Overall, six of the eleven IBRA regions are priority 1; one is considered priority 2 and the remaining four are priority 3.

The Gascoyne-Murchison Strategy region is 56,732,400 hectares in area (Dept. Agric. data). However this increases to 59,253,659 hectares if all the leases and existing reserves that intersect the Strategy boundary (i.e. straddle the boundary) are taken into account.

The area of each IBRA region, shown in hectares, and the proportion of the Strategy region they make up (expressed as a percentage), is shown in Table 8.

As leases are made available for sale, either on the open market or by direct contact between lessees and the Department of Conservation and Land Management, the IBRA region each falls into is identified. Leases falling within IBRA regions of high priority are assigned a similar priority for investigation.

Step 3. Identify and analyze vegetation types within lease

The identification and analysis of vegetation types occurring on a lease offered

Table 8. IBRA regions of the Gascoyne-Murchison Strategy region.

IBRA region	Area (ha)	% of region	Priority for reservation
Avon Wheatbelt	443448	0.75	1
Carnarvon	7503038	12.7	1
Coolgardie	39434	0.07	3
Gascoyne	16556816	27.9	1
Geraldton Sand Plains	1469471	2.5	2
Gibson Desert	1401463	2.4	3
Great Victoria Desert	1282733	2.2	3
Little Sandy Desert	7966898	13.4	3
Murchison	18430888	31.1	1
Pilbara	301222	0.5	1
Yalgoo	3857659	6.5	1
Total	**59253071**	**100.02****	

**Note small error in sum of % due to rounding.

for sale is completed using the vegetation mapping of the region completed by Beard (1980). This process is completed using a Geographic Information System approach, in which the lease boundaries are intersected with the vegetation types occurring in that part of the State. This generates a statement of the vegetation types present and the areal extent of each occurring on the lease (see Figure 13).

Once the areal extent of each vegetation type on the lease is calculated, it is then compared with the total area of each vegetation type occurring throughout the State.

Secondly, the vegetation types occurring on the lease are compared with the vegetation types already known to occur within the existing reserve system. In particular, this will identify if a vegetation type is represented in the reserve system at all, and if represented, at what level (expressed as a percentage of the total area of that vegetation type) it occurs (see Table 9). Of particular interest in this calculation is the determination of whether the vegetation type is represented at less than 10% of its original areal extent, or greater. This is relevant as one of the goals of the acquisition program is to increase the level of representation of as many different habitats (vegetation types) to around 10% or greater (in relation to the original areal extent of the vegetation type), even when they are represented in the reserve system, but at a lower level.

The Table shows a number of vegetation types that are not represented at all, or at less than 10%, in the existing reserve system . The acquisition of this lease would considerably improve the level of representation of a number of vegetation types, three of which are considered restricted in their distribution as they are 50,000 ha or less in area (361, 683, 686).

Leases containing a high level of diversity, expressed by the number of different vegetation types, are considered to have a higher conservation value than leases containing very little diversity. Lease areas containing high diversity, vegetation types of restricted distribution (i.e. original pre-European areal extent 50,000 ha or less), and vegetation types either not represented at all or represented at less than 5% in the existing reserve system, are considered to have the highest priority for acquisition. Leases containing little diversity or which contain vegetation types already well represented in the reserve system are also identified.

Step 4. Identify land systems occurring on the lease.

Land system mapping, completed by the Department of Agriculture of Western Australia, is available for most pastoral leases within the Gascoyne-Murchison Strategy region (Wilcox and McKinnon 1972; Pringle *et al.* 1994; Curry *et al.* 1994; van Vreeswyk and Godden 1998). This mapping program does not cover the entire region and has been completed over a considerable time frame such that some of the earliest work (see for example, Mabbutt *et al.* 1963) describes

land systems in the eastern part of the Strategy region that do not match those identified and described in later surveys.

Land system maps viewed at a lease scale (see Figure 14) indicate land surface and vegetation variability. This results from mapping land systems at a finer scale (1:100,000) than vegetation mapping, providing more detailed information about specific landform-vegetation features not identified in the broader scale mapping by Beard (1980). Differences in geology and geomorphic features are used, amongst other features, to define land systems. This information is important in recognizing important habitats such as breakaways and wetlands, as well as severely degraded and eroded areas, all of which guide the selection process. Of particular interest is the identification of unique land systems within areas of a lease that may have been mapped by Beard as being made up of a similar vegetation type. For example, if the vegetation map and land system map of Warriedar (Figs 13 and 14) are compared, it is immediately apparent that there is a greater diversity of land surfaces, including the vegetation occurring there, within areas mapped by Beard as being homogeneous.

This information adds a further dimension to the information used to determine ecological diversity contained within a lease, and hence the prioritization of a particular lease for acquisition and inclusion in the conservation reserve network.

Step 5. Identify the occurrence of significant species or ecosystems.

The Department of Conservation and Land Management maintains a regularly updated register, including map information, of the location, description, distribution and abundance of unique plant species considered to be rare or in need of priority treatment due to limited knowledge about distribution, abundance, threatening processes or reproductive biology.

The state of being rare is the result of a human value being placed upon a species known to be uncommon, or as Main (1982) considers, "it is a relative state that allows a value to be placed on it", and that rarity is a consequence of the anthropocentric trait of collecting objects. Species have become extinct as a result of land clearing processes, for example, and future land clearing must consider the long-term persistence of all species. The alternative view, that extinction is a normal biological process that cannot be interfered with, suggests that rare species are heading for extinction anyway, therefore leading to the conclusion that it may be wasteful of limited resources to try to conserve them.

The factors involved in species becoming rare include changes in climate, recurrent disturbances, geomorphic processes (e.g. erosion) resulting in remnant land surfaces (Pringle 1994), variability in seasonality (including climate change), and the presence of biological interactions such as predation by feral animals

Table 9. Vegetation type analysis showing comparative data in relation the occurrence of the same vegetation types in the existing reserve system, and improvement in their reservation status if the pastoral lease is acquired. (Pastoral lease intentionally not identified).

	Beard Code	Vegetation Description	Area in IUCN Reserves I-IV* (ha)	% in IUCN Reserves I-IV*	Area on this station	New total area in IUCN I-IV* Reserves (ha)	New % in IUCN I-IV* Reserves
420	a9,19Si	Shrublands; bowgada (*Acacia ramulosa- Acacia linophylla*) and jam (*Acacia acuminata*) scrub	53278	6.21%	30990	84268	9.82%
419	a9,19m6Sc	Shrublands; bowgada (*Acacia ramulosa- Acacia linophylla*), jam (*Acacia acuminata*) and *Melaleuca uncinata* thicket	98769	31.43%	27977	126746	40.33%
361	a1Lr a9,17Si	Shrublands; bowgada (*Acacia ramulosa- Acacia linophylla*) & miniritchie (*Acacia grasbyi*) scrub with scattered mulga (*Acacia aneura*)	1715	1.96%	26831	28546	32.59%
2685	a14,19Si	Shrublands; *Acacia quadrimarginea* & jam (*Acacia acuminata*) scrub on greenstone	32	0.05%	15058	15090	25.86%
683	a8,11Sr (k3)Ci	Succulent steppe with open scrub; scattered Acacia sclerosperma and snakewood (*Acacia eremaea*) over samphire	0	0.00%	14241	14241	28.11%
365	e6,22Mr a9,19Si	Shrublands; bowgada (*Acacia ramulosa- Acacia linophylla*) and jam (*Acacia acuminata*) scrub with scattered York gum (*Eucalyptus loxophleba*) & red mallee (*Eucalyptus oleosa* group)	1879	3.36%	13573	15452	27.63%
364	ceLr a9Si	Shrublands; bowgada (*Acacia ramulosa- Acacia linophylla*) scrub with scattered eucalypts and cypress pine (*Callitris columellaris*)	198337	38.84%	9996	208333	40.80%

Table 9 (contd). Vegetation type analysis showing comparative data in relation the occurrence of the same vegetation types in the existing reserve system, and improvement in their reservation status if the pastoral lease is acquired. (Pastoral lease intentionally not identified).

	Beard Code	Vegetation Description	Area in IUCN Reserves I-IV* (ha)	% in IUCN Reserves I-IV*	Area on this station	New total area in IUCN I-IV* Reserves (ha)	New % in IUCN I-IV* Reserves
243	a9,17Si	Shrublands; bowgada (*Acacia ramulosa- Acacia linophylla*) and miniritchie (*Acacia grasbyi*) scrub	370	0.25%	5565	5935	3.99%
404	a9,20Si	Shrublands; bowgada (*Acacia ramulosa- Acacia linophylla*) and *Acacia murrayana* scrub	6716	3.25%	910	7626	3.69%
686	e6,22Mi	Medium woodland; York gum (*Eucalyptus loxophleba*) & red mallee (*Eucalyptus oleosa* group)	837	6.45%	823	1660	12.79%
10	e22Mi	Medium woodland; red mallee (*Eucalyptus oleosa* group) group	3726	2.56%	712	4438	3.04%
202	a1,14Si	Shrublands; mulga (*Acacia aneura*) and *Acacia quadrimarginea* scrub	78796	17.59%	158	78954	17.62%
125	sl	Bare and poorly vegetated areas; salt lakes, lagoons and claypans	295498	8.46%	115	295613	8.46%
2081	a9Si	Shrublands; bowgada (*Acacia ramulosa-Acacia linophylla*) and associated spp. scrub	194020	14.58%	109	194129	14.59%
1413	acmSc	Shrublands; *acacia*, *casuarina* and melaleuca thicket	204759	12.16%	66	204825	12.16%

Figure 13. Map of part of Warriedar pastoral lease showing location of vegetation types.

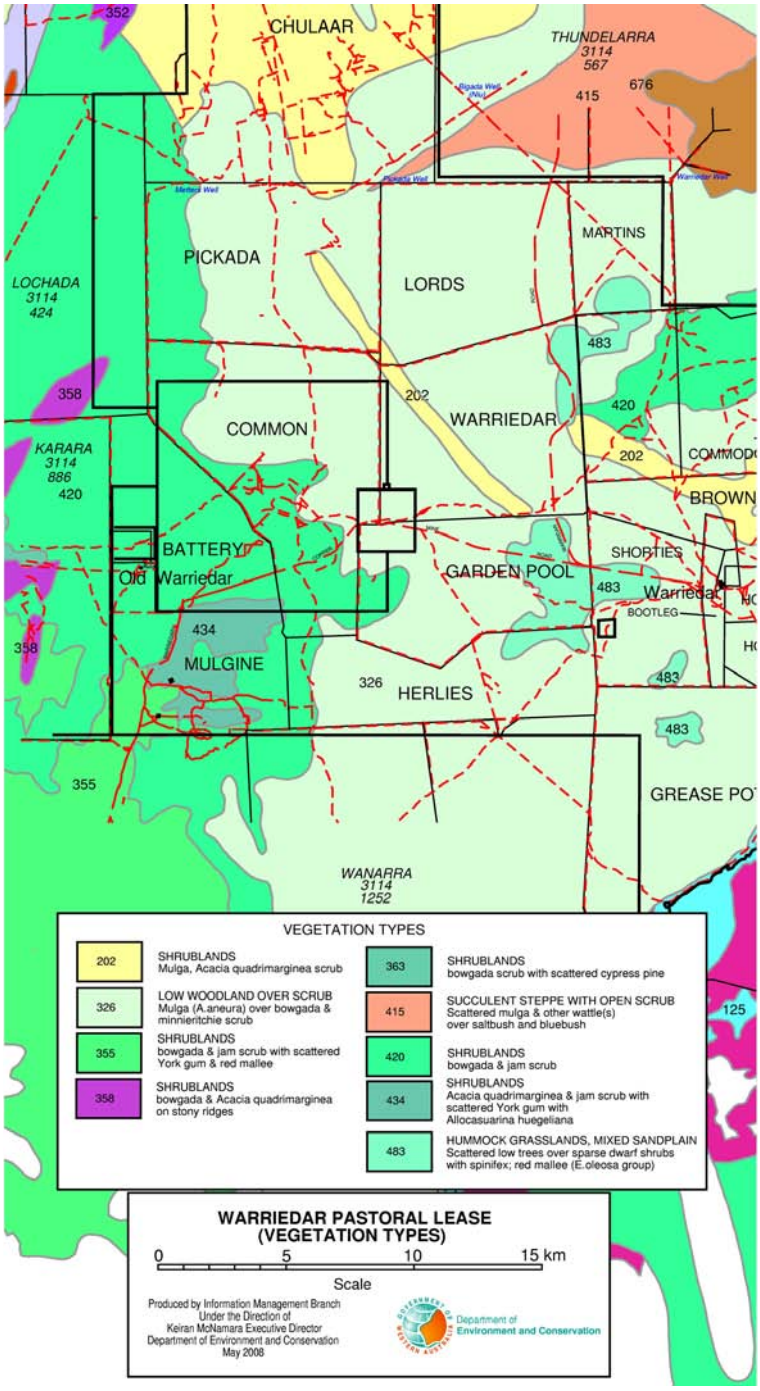
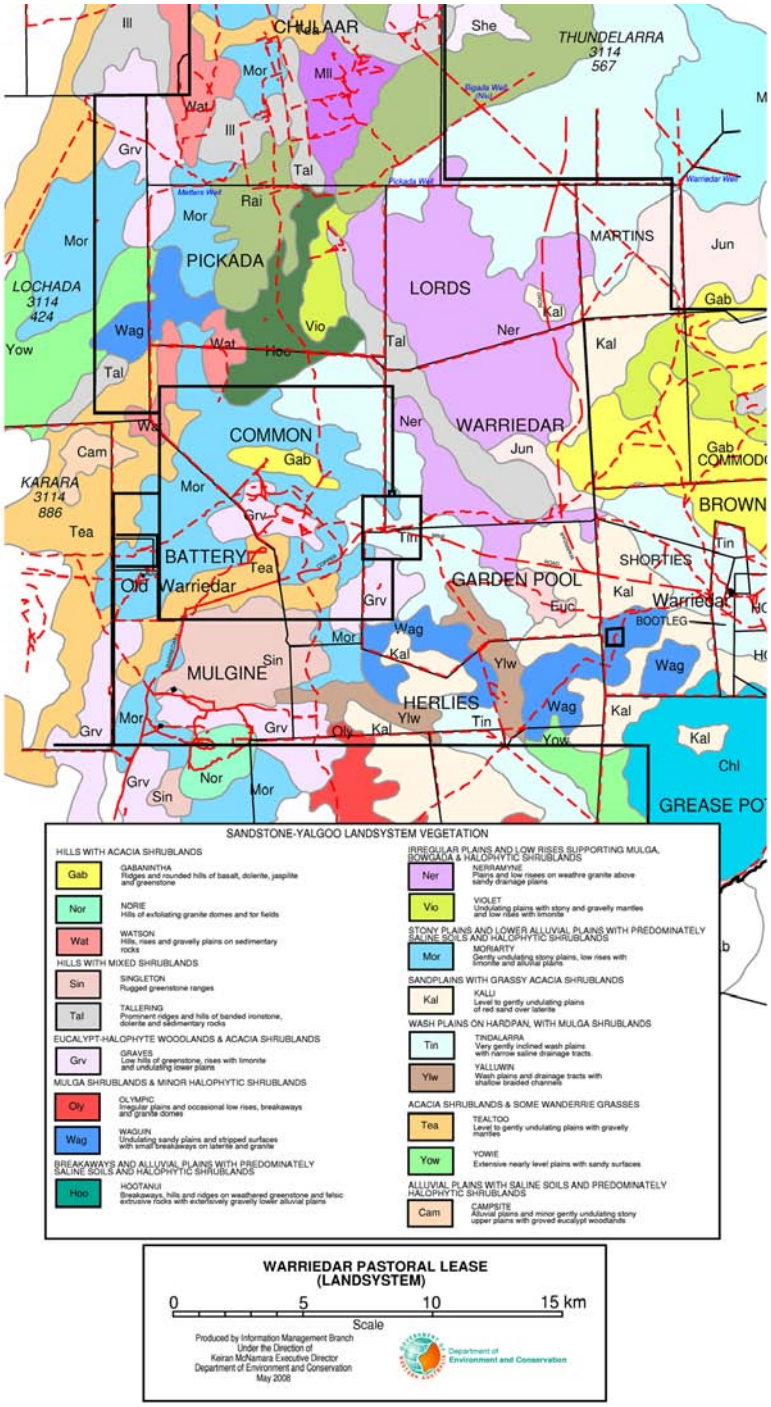


Figure 14. Land system map of part of Warriedar pastoral lease.



(Main 1982). As there are many causes of rarity, it follows that conservation of rare species cannot be easily achieved by their protection within the conservation reserve network, and many different approaches to achieving conservation of biodiversity outcomes may be required (Main 1982).

The identification and mapping of significant species and ecosystems throughout the State, including the Gascoyne-Murchison Strategy region, results from survey programs which have been conducted over many years by the Department of Conservation and Land Management, the Western Australian Museum, the Department of Agriculture Western Australia, and mining companies. However, given the area of the State, in particular the rangelands, these extraordinarily low intensity surveys, (c.f. Rangeland Condition Surveys conducted by the Department of Agriculture Western Australia), are far from complete and the data gathered is considered preliminary. More comprehensive biological surveys covering part of the Gascoyne-Murchison Strategy region have been conducted in conjunction with the Western Australian Museum in the southern Carnarvon Basin (Burbidge *et al.* 2000) and the North East Goldfields (McKenzie and Hall 1992). It is recognized that the results of these biological surveys may be distorted due to, for example, geographical and seasonal sampling bias, uneven taxonomic resolution and strongly localized endemism (Burbidge *et al.* 2000). A much more systematic and comprehensive survey of the rangelands is required to obtain reliable information about the occurrence and significance of particular species or ecosystems.

Information regarding significant species or ecosystems is considered for the pastoral leases under review in the reserve land acquisition program. The priority weighting of a pastoral lease may be influenced by the occurrence of significant species or ecosystems, but a lease is not assigned a high priority on this basis alone. The fact that significant species or ecosystems may not remain significant in the medium to long term, as new information comes to light about their distribution and abundance, influences the value placed upon them.

Step 6. Check perennial vegetation and soil condition reports

Rangeland condition survey reports prepared by the Department of Agriculture Western Australia are available for most of the pastoral leases in the Gascoyne-Murchison Strategy region (see Wilcox and McKinnon 1972; Payne *et al.* 1987; Curry *et al.* 1994; Pringle *et al.* 1994). The report on lands of the Wiluna-Meekatharra area (Mabbutt *et al.* 1963) covers part of the region in the east, but is somewhat dated. These reports provide substantial information about the vegetation and its condition, land systems and soils of the region.

Pastoral lease condition reports, also prepared by the Department of Agriculture Western Australia on a more regular basis, provide up to date information about

the condition of the perennial vegetation and soil, based on traverse point ratings. Severely degraded and eroded areas are reported and quantified while vegetation condition is rated as good, fair or poor. Trends in condition ratings are provided using comparative data from earlier surveys.

Much of the rangeland has been impacted to a greater or lesser degree (Office of the Auditor General, Anon 1994; Environment WA 1998; ANZEEC and ARMCANZ 1999; Govt. of Western Australia 2002), and individual leases tend to follow regional trends. However, leases may vary from regional trends therefore necessitating field assessment to validate lease condition, as this is in part a result of the vicissitudes of climate and weather, the extent and distribution of pastorally productive land, the influence of exotic species (for example, buffel grass, feral goats), and may change over a matter of a few years.

Step 7. Assess mineral prospectivity

Records of Mining Act tenements – Mining Leases, Prospecting Licences, Temporary Reserves and Exploration Licences, are intersected using the Geographic Information System process using the data base maintained by the Western Australian Department of Industry and Resources, with pastoral lease boundaries to determine the level of mining activity on a lease.

Temporary reserves are areas of land deemed by Government to contain values requiring control over resource allocation, of a mineral or environmental nature.

Exploration Licenses are issued for the conduct of investigations into the particular geology of the land to prove, or otherwise, the mineral values contained therein. These licenses are considered to be speculative and only a very small number (about 10%) are actually investigated with an even smaller number (about 0.1%) resulting in the discovery of significant ore bodies. About one in one thousand Exploration Licenses result in mining activities (Caporn, Dept. CALM pers. comm.).

Pastoral leases containing geologically significant areas in terms of their potential or established prospectivity are likely to have any proposal to change tenure to conservation reserve resisted by the mining industry and Department of Industry and Resources (Caporn pers. comm.). This resistance is the result of statutory requirements for both houses of Parliament to agree to mining in A class Nature Reserves and National Parks, making mining applications on conservation reserve land time consuming and costly. Even though more recent changes to these requirements have meant some degree of relaxation, where mining proposals in A class Conservation Parks outside the South West land division now require only the recommendation from the Minister for the Environment and the consent of the Minister for State Development, but not the consent of both houses of Parliament, there is still a high degree of resistance to tenure

change. Unclassified Conservation Parks will require the recommendation of the Conservation Commission, as well as a recommendation from the Minister for the Environment and the consent of the Minister for State Development.

The current Government policy of no mining in National Parks and Nature Reserves provides the basis for continued concern from the mining industry, making achievement of environmental policy objectives related to the establishment of a conservation reserve system more difficult. However, if land containing important conservation values is not included in the conservation reserve system due to its economic value, then the conservation network would continue to be biased, and would not include the full range of ecosystems associated with particular geological features. For example, the greenstone belts of the State containing important economically valuable mineral deposits such as gold, nickel and other base metals, would be excluded from the reserve system. The conflict between economic and environmental issues remains an important issue.

Step 8. Conduct field inspection

Field inspections are a necessary part of the lease evaluation process to validate vegetation condition reporting, identify areas showing degradation, quantify the extent of introduced plants and animals, assess the condition of infrastructure – particularly boundary fences and their effectiveness in controlling stock incursions from neighbouring leases - and the likelihood of expensive repair or upgrading requirements to infrastructure.

Check validity of Vegetation mapping

Broad scale vegetation mapping identifies differences in vegetation structure, growth form and key floristic associations (Beard 1990). The scale of mapping over the Gascoyne-Murchison Strategy region is 1:250,000 and although considerable field checking was carried out by Beard to validate remote sensing from aerial photographs, any vegetation type identified and mapped at this scale will contain a considerable level of heterogeneity.

It is necessary to field check each vegetation type to ensure that broad plant associations are mapped correctly. Experience has shown that mapped units are generally accurate although there are examples of pronounced differences when checked in the field. Overall there is a high level of confidence in the vegetation type mapping.

Rangeland and infrastructure condition

As the condition of the vegetation may change throughout time, particularly as a result of periods of below average or unseasonally high rainfall, it is important to determine the current condition status. The determination of condition is best done in the field. The inspection traverse route along existing station tracks is determined using a combination of vegetation and land system mapping data as

well as the location of lease infrastructure. Ideally, the traverse will intersect all vegetation types and land systems, so that at the completion of the inspection, the mapping of these two important parameters has been verified. Areas containing vegetation of particular interest, particularly those showing insignificant modification from the impacts of grazing, are noted.

If possible, the location of rare plants or plants requiring priority management action for their survival are also checked. Checking these plants is not always possible due to lack of easy access, and difficulty in identification when not flowering.

During the field assessment stage it is convenient to check the condition of the infrastructure on the lease as this has a range of implications for ongoing management planning, operational activities and resource requirements. In this component of fieldwork, all infrastructure is inspected including buildings, water point facilities, and fences, particularly boundary fences.

Special features such as areas of rock outcrop, river frontage, historic sites, including historic buildings, grave-sites, stock routes, and trees marked by early explorers, are also identified and assessed for their historic or heritage value. This process also includes identification and mapping of sites of apparent cultural value for Aboriginal people or areas with particular features such as spectacular views, unusual geological formations, unusual vegetation, making them important for future recreation or tourism planning.

The occurrence of declared or environmental weeds (for example *Cenchrus ciliaris*), their impact and area of infestation and evidence of feral animals such as goats, pigs, horses, camels, foxes and cats is also noted. This information is recorded on station plans for future reference including the need for management action if the lease is acquired and becomes part of the conservation reserve system.

Information exchange

The field-checking component is always carried out with the lessee. This provides an excellent opportunity to provide information about the land acquisition program, and for pastoralists to raise issues they see as important for future management of the area, or to satisfy themselves about the conservation management objectives espoused by Government.

Pastoralists are also able to pass on information about special places or features having historic or conservation value, or how they see future management should plan for recreational or tourism activities. Pastoralists have often been on the lease for considerable time and many have been quite observant with regard to issues such as where water sheds and floods out, plants that appear to have increased or decreased in abundance or distribution, or changes in the numbers of feral animals over time. This type of information is of particular importance as once lessees move away from an area this information may no longer be available.

Step 9. Review property valuation

It is a statutory requirement that compensation offered to lessees for the purchase of a lease must be based on a valuation provided by the Valuer General's Office of Western Australia.

Valuations are based on the pastoral value of the land including the value of all lawful improvements made by the lessee. Valuations do not consider the value of land for conservation purposes, nor the comparative value of leases purchased by conservation organizations or Government for this purpose.

Valuations are used as a guide when negotiating sale price with pastoralists, and there are limits to the degree of variation from the valuation that can be made (these guidelines do not consider the importance of conservation values). The requirement to adhere to the valuation and guidelines has meant that it is sometimes difficult to negotiate the purchase of land for the reserve system even where the area contains highly important values for conservation. A number of important areas for conservation have not been able to be purchased due to these procedural requirements. In other instances alternative offers from the market have resulted in the land being sold to others intending to continue pastoral activities.

Step 10. Evaluation of conservation values

An approach to the evaluation of the range of values discussed here has been developed allowing scoring of important selection criteria which then provides the opportunity to rank different pastoral leases in order of importance for conservation (see Figure 15).

The approach taken relies heavily on judgment based on a combination of extensive practical experience and scientific training. Relevant staff of the Department of Conservation and Land Management with appropriate expertise have played a part in the refinement of the process providing a greater degree of confidence in the way relative scores are applied.

The process may be viewed as a tool for clarifying those conservation values of greatest importance when evaluating pastoral leases, and for sharpening the discussion about further action. The systematic approach leads to careful consideration of the range of issues reviewed in the assessment and evaluation of each pastoral lease (or part of lease), improves the level of confidence in the assessment process and reduces controversy about the purchase price. Properties with high diversity, unique features making them difficult to replace with alternative areas, high degree of naturalness, or which are part of the broader land management planning process, are likely to be accepted as important and be less economically controversial.

Figure 15. Criteria for assessment of relative conservation values.

Value		Rank Order				
Conservation values		1	2	3	4	5
1. IBRA region priority						
2. Diversity	Level of diversity using vegetation types					
	Vegetation types new to reserve system or poorly represented.					
	Level of diversity using land systems					
3. Significant species or ecosystems	Rare species					
	Threatened ecological communities					
4. Uniqueness/irreplacability						
5. Degree of naturalness						
6. Significant geological/geomorphic features	Coastline					
	Landscape and other values					
7. Recreational values	Scenic value					
8. Heritage/scientific/cultural values						
9. Wilderness values	Management issues					
10.Infrastructure condition	Boundary fencing					
	Buildings					
	Access tracks					
11.Rehabilitation requirements						
12.Adjoins existing conservation Reserve	National or internat.ional Recognition (e.g. WHA, RAMSAR)					
13. Area part of regional planning process	Govt Dept or other					

A range of conservation, planning and operational factors (including costs) are considered in the process. These factors are not easily combined into a single index signifying overall relative value of one area of land over another, or to justify the relative economic value of that land in acquisition negotiations.

Each criterion (Fig. 15) is assigned a numerical rank having a consistent range from 1, lowest value, to 5, highest value. The overall sum of ranking scores is used to validate the value of conservation assets.

Step 11. Prepare summary report and recommendation

Following the assessment and evaluation of all information and the completion of the field checking component, a report is prepared providing a succinct summary of

key information including vegetation analysis, range and infrastructure condition, feral animal and weed occurrence and impacts, contact with neighbours, Mining Act tenements and likely impact, the valuation, and a recommendation to purchase a property. This report also refers to the importance of an area in relation to the IBRA framework and priorities for reservation as well as the Gascoyne-Murchison Strategy conservation objectives.

Pastoral leases investigated, which are considered to have environmental degradation or management issues which will cause future problems, may not have the entire investigation process completed. Reports for these leases are not prepared and the lessee is informed of the decision not to proceed with further action.

If the recommendation is supported by the Executive Director of the Department of Conservation and Land Management, then negotiations to purchase a pastoral lease, including the conditions for purchase, are undertaken with the lessee.

Step 12. Negotiate with pastoral lessees

The climate for conducting a successful negotiation meeting is set some time in advance as pastoralists will have had considerable interaction with the officer responsible for the acquisition program. During discussions, mostly by telephone, but often including face-to-face meetings such as during the field survey period, a cordial and cooperative approach is established. During the opening phase of discussions the Government position and background to the acquisition program are carefully outlined. It is then important to discuss particular interests occurring on the lease, and the priority placed on these values in establishing a comprehensive reserve network. In the main, these discussions are more general than specific in nature, and are aimed at providing background information to the prospective vendor. Quite a number of lessees have gained a good understanding of the objectives of the land acquisition process from their own inquiries. These discussions are brief in nature so that potential vendors are not left with so much information that they feel bewildered and confused (see Scott 1981).

Once formal negotiations begin it is necessary to recognize the attitude of the potential vendor as expressed through their language and behaviour – there are usually quite clear signals about the position that will be taken by the potential seller. In the main, negotiations have progressed in a positive way with successful outcomes achieved in almost all instances. However, in several situations prospective vendors have quite clearly indicated that it would be difficult to progress negotiations. In the author's experience it is best to break off negotiations at this point, but only when both parties clearly understand the position of the negotiations, and what the next moves will be, if any.

Being able to establish a high level of trust with the potential vendor is an important component of the negotiation process. To some extent the initial contacts between the two parties will establish this, based on the perceived level of openness apparent in conversation. Potential vendors will often have a clear perception of the credibility and integrity of the government negotiator based on information gathered from others who have already dealt with this person. Openness is established by expressing a willingness to discuss issues in an open and frank manner, including the willingness to make one's own views known to the other party. Obviously there is a limit to what any negotiator should enter into in discussions, determined by the situation and personalities, and care should be taken that information offered is not used in an inappropriate way by the other party. Experience working on pastoral leases has been of great benefit to the author in negotiation meetings with lessees, as discussions about pastoral management and related matters add to the acceptance and credibility of the negotiator. Lessees are immediately aware that the person they are interacting with has a background in pastoral management, as well as a thorough understanding of the key environmental issues affecting a lease.

Step 13. Finalize negotiation outcome

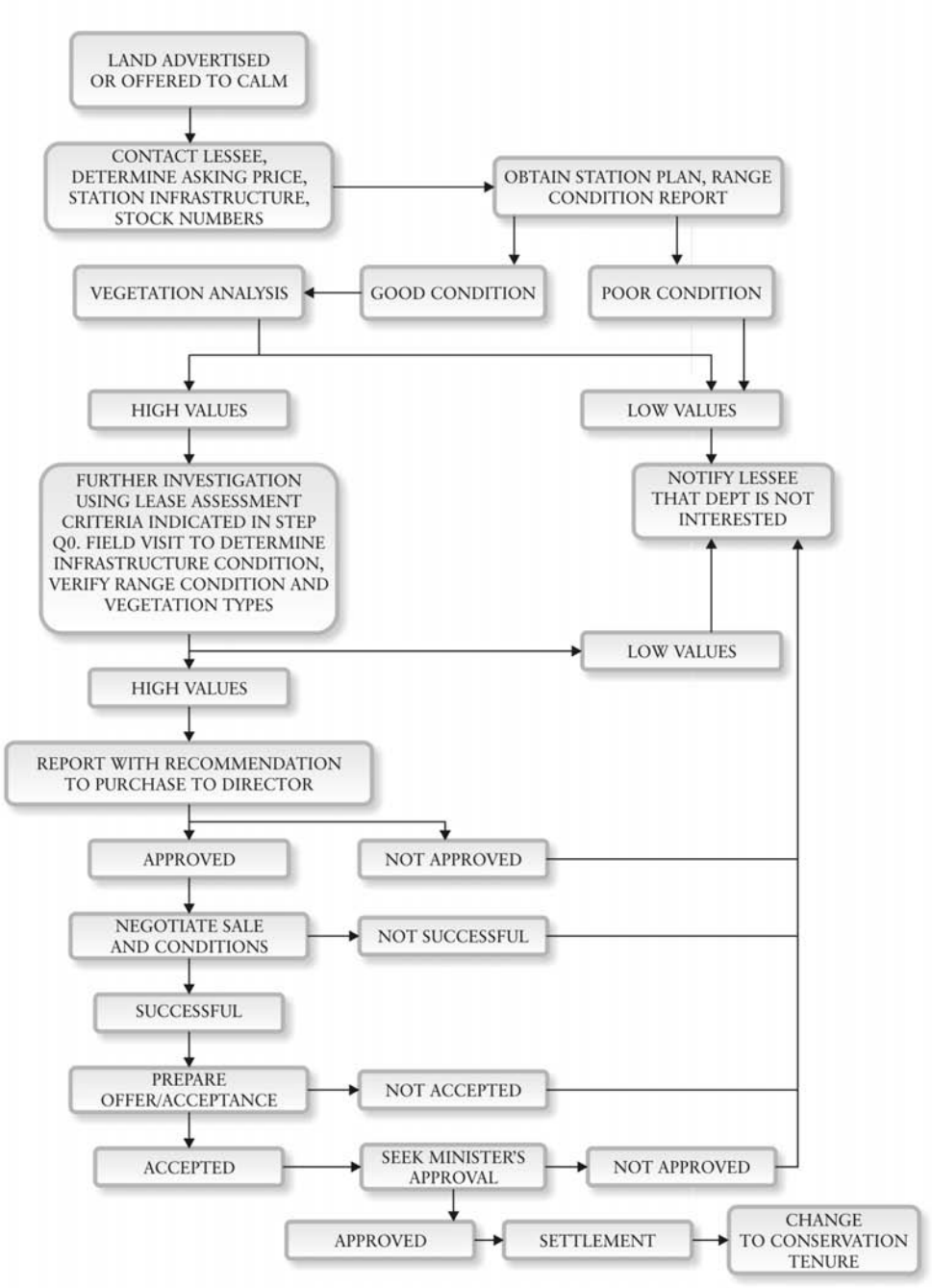
Once agreement over purchase price and conditions of sale has been reached, a number of administrative requirements are implemented beginning with the preparation of a formal letter of Offer and Acceptance setting out the agreed detail for signing by both parties.

Once the signed letter of Offer and Acceptance has been returned a number of issues must be dealt with, including Ministerial approval for the proposed purchase, approval of the Pastoral Lands Board, lease surrender documents prepared, and conveyancing completed. This is sometimes a protracted process taking up to five months or more, during which time close contact with the vendor is necessary.

The outcome of this process is that the pastoral lease is surrendered to the Crown, thus changing the tenure from pastoral leasehold to Unallocated Crown Land. The tenure of the land remains as such until changed to conservation reserve tenure. During the period between surrender and the achievement of conservation reserve tenure (National Park, Conservation Park or Nature Reserve), the land is managed for conservation purposes under section 33(2) of the Conservation and Land Management Act.

Ministerial support for the program has been maintained throughout the land acquisition program during which time there has been a change of government in Western Australia. However, towards the end of the program there has been an insistence from government that the acquisition program be conducted strictly along purchasing policy (economic) guidelines. These guidelines, while allowing

Figure 16. Flowchart showing land acquisition process.



the Minister responsible to exercise discretion, provide for fair compensation based on the valuation by the Valuer General's Office, which may be varied by no more than 10% – 'the one hundred and ten percent rule'. Acquisition proposals outside these guidelines have not been supported. This has resulted in some pastoral land with identified high conservation values not being included in the conservation reserve system. The decision not to support some proposals is based neither on an evaluation of conservation values, nor on the contribution that a parcel of land may have made to the overall comprehensiveness of the reserve system, but rather has been made along fiscal procedural guidelines. As many of the valuations prepared by the Valuer General's Office fall below the expectations of pastoral lessees, it will be difficult to achieve the policy objective of having a comprehensive, adequate and representative conservation reserve system. This is particularly so when pastoralists have been approached over the potential for government to purchase their lease, rather than negotiating an offer following the decision of pastoralists to sell their lease and advertise this position on the open market.

Having the flexibility to negotiate the acquisition of land with important conservation values outside the one hundred and ten percent guideline, and therefore requiring the support of government ministers, is important if the achievement of a comprehensive reserve system is to be achieved. Without the recognition of the importance of conserving the State's biodiversity, the extremely long time frames over which evolutionary processes occur, and the high level of threat to some species or ecosystems, the process of establishing a comprehensive, adequate, and representative conservation reserve system will be frustrated. If a 'bargain basement' approach to conservation of biodiversity continues, only those lands meeting the required economic framework will be included in the reserve network, and other opportunities for acquiring land containing irreplaceable or highly vulnerable ecosystems will remain under threat. The acquisition process is summarized in Figure 16.

10.3 Conclusion

The pastoral lease assessment process outlined provides a method that is consistent and repeatable. It has been developed and refined by the author for use in the acquisition program of the Gascoyne-Murchison Strategy. The method is pragmatic and provides a framework for gathering and assessing a range of relevant information about the values contained within pastoral leases offered for sale. It allows for the assessment and evaluation of leases which are then compared with the remainder of the conservation estate to determine the specific contribution to the reserve network that an individual lease will make, hence its contribution to the regional and statewide conservation reserve network.

The method allows for the efficient assessment of a range of values pertinent to a pastoral lease and the identification of leases that are likely to make a significant contribution to the reserve system. Leases containing values already represented within the existing reserve system (have a high degree of replication), or which are degraded or significantly altered, or which pose difficulties for ongoing management, are readily identified.

Given the reality of extensive historical and contemporary degradation in the rangelands resulting in the loss of biodiversity, it is important for government to recognize the need to extend and improve the conservation estate, while at the same time acknowledging the importance of managing land for conservation purposes that is not within the protected area network.

Political decisions based on fiscal procedures limiting the ability to achieve the goal of a comprehensive, adequate and representative conservation reserve system in the rangelands of Western Australia, will ultimately impact on policy outcomes, and in some areas, land with important values for conservation will not be included with the risk that they are degraded, or destroyed by other land uses. For governments to be serious about nature conservation, it will be necessary to provide sufficient ongoing expenditure to meet stated goals, which is likely to cost considerably more than expending just enough to placate the green vote so that another term in office is assured. The achievement of realistic conservation goals can never be taken seriously while governments continue with short term economic rationalist objectives, which do not match the extraordinarily long time frames required for evolutionary processes to continue.

Chapter 11: Ongoing Management

11.1 Introduction

The conservation of biodiversity does not end with the establishment of suitable areas of land dedicated as National Park, Nature Reserve, or Conservation Park. Defining boundaries using fences, or signage, does not provide any surety that biodiversity will persist and that evolutionary processes will continue.

Pastoral leases or parts of pastoral leases purchased by the Government of Western Australia for inclusion in the conservation reserve system will be managed for the conservation of biological diversity with the primary aim of allowing the land to gradually return to its natural state. Defining a natural state is difficult as there is little information about ecosystems and their condition prior to the arrival of Aboriginal people perhaps 40,000 years ago, or Europeans about 200 years ago. There can be little doubt that since the arrival of Europeans there has been considerable alteration of the landscape due to a range of settlement and developmental pressures. Depending on the degree of these impacts, some parts of the landscape may take a long time to recover to something like their former composition and structure – some highly impacted ecosystems may never recover to contain the original suite of plants and animals that once occurred there.

The key objective in managing the conservation reserve system must be the persistence of species, habitats, and ecosystems that would otherwise not persist if they remained outside the reserve system.

All domestic stock will be removed from acquired areas and stock encroachment from neighbouring leases kept to a minimum. Feral animals, such as goats, camels, donkeys, horses, foxes and cats will be controlled using appropriate measures including trapping, shooting and poisoning programs, conducted as far as possible in cooperation with neighbours.

Where it is possible to control feral animals, particularly feral predators, it may be possible to reintroduce animals now locally extinct, rare or patchily distributed, such as mallee fowl (*Leipoa ocellata*), boodie (*Bettongia lesueur*), bilbie (*Macrotis lagotis*), greater stick-nest rat (*Leporillus conditor*) and rufous hare wallaby (*Lagorchestes hirsutus*).

Artificial water sources on proposed conservation reserves, such as bores and dams, have led to increased population abundance and distribution of feral animals, some native animals such as kangaroos, and a number of bird species, particularly given the absence of predation by dingoes (Caughley *et al.* 1980 Landsberg *et al*. 1997).

On the other hand, many palatable plants and ground cover have been dramatically affected as a result of concentrated grazing pressure, particularly

around artificial water points (James *et al*. 1997). Water points will be closed down once domestic stock have been removed, in a way that is sensitive to native animal populations that have become reliant on them for survival. During this adjustment period, it will be important to monitor the number of native herbivores migrating to adjoining properties to ensure that unreasonable grazing pressure does not occur on adjoining leases. However, as a result of increased erosion resulting from reduced vegetative cover, or the alteration of surface hydrology, or lowered ground water tables resulting from water abstraction, some previously natural soaks or springs may no longer provide a water source for native animals. Just how many natural water sources have been affected is unknown. In some instances, the closure of artificial water sources may disadvantage some native animals where natural water sources no longer exist. One important source of information about the location of natural water sources is from previous pastoral lessees who have comprehensive knowledge of their lease.

The Department of Conservation and Land Management wishes to retain people with an interest in ongoing management for conservation of biodiversity, or nature-based tourism on leases acquired for addition to the conservation reserve system. It is generally in the best interest of the local community and the Department to have a presence on the former leases to maintain infrastructure, assist with the control of feral animals, and to act as a first point of contact in the event of an emergency such as a wildfire or accident. There is also a social benefit in retaining people in the rangelands to maintain a population level necessary for the continuance of services such as telecommunications, mail, and road maintenance.

A key feature of the Department's approach to ongoing management will be the continued consultation with a wide range of stakeholders as areas are acquired, reserved and managed. These stakeholders include neighbouring pastoralists, pastoral industry bodies, the Pastoral Lands Board, Aboriginal groups, local government, conservation groups, the mining and tourism industries and other government agencies.

11.2 Management conflicts

Conflicts between conservation agencies and neighbouring pastoral enterprises are inevitable due to differing land use objectives (Wilson *et al*. 1984). Feral and native animals, fire, or noxious plants are not confined by boundary fences, and at some stage will migrate across boundaries to potentially disrupt management activities of one or the other land users. Obviously land managers on both sides of the fence have the same legal and ethical obligations to prevent stock, fires, feral animals and weeds from entering onto neighbouring land. It must be acknowledged that the changes to management regimes on conservation reserves will undoubtedly result in a build up of biomass leading to higher fire-fuel loadings making wild

fire control sometimes more difficult than when that land was under an intensive grazing regime.

Feral animals, particularly the herbivores such as goats, camels, donkeys and horses, may move over quite large areas in search of feed. Such animals compete for grazing space and preferred feed with native and domestic animals, and can cause damage to fences and other infrastructure. Where neighbours perceive that high numbers of feral animals are harboured in conservation reserves, conflicts will arise.

The same conflicts will arise if the range of introduced plants is increasing through cross-boundary extension. Noxious plants are generally not a major issue in the rangelands (there are some notable exceptions such as buffel grass, *Cenchrus ciliaris,* and mesquite, *Prosopis pallida*) and the evidence of declared weed control in the arid rangelands is limited to isolated areas often associated with water points.

There is clearly a need for the Department to undertake a range of operational activities aimed at minimizing conflicts that may arise in relation to some or all of the issues raised that may lead to conflict. These activities are referred to as 'necessary operations' undertaken to ameliorate the impacts of such issues, but also to ensure that other key issues such as public safety are adequately addressed. It is a requirement that the Department prepare planning guidelines which allow for consideration of issues of immediate importance that will need to have a level of management from the outset, and which will be considered among the range of key issues once they have been prioritized.

Once the areas of land acquired for inclusion in the reserve system have had their tenure formally changed (e.g. National Park, Conservation Park, Nature Reserve) it will be necessary for formal statutory management planning to be completed as time and resources allow. This process involves the consideration of all issues that may at some time impact on the long-term conservation management of the area.

11.3 Planning for management

The 1984 Conservation and Land Management Act (as amended) directs the Department to prepare management plans for all land vested and that these plans will be prepared on behalf of the controlling body through the agency of the Department. The preparation of management plans is carried out as resources are made available. As all of the land acquired under the Gascoyne-Murchison Strategy has yet to be formally gazetted as conservation reserves, it remains Unallocated Crown Land. However, the Department is made responsible for the management of this land under section 33(2) of the Conservation and Land Management Act and upon the recommendation of the Minister responsible.

One of the priority actions undertaken by the Department is the preparation of Interim Management Guidelines as set out in Administrative Instruction 23. These guidelines recognize that it may be a considerable time before approved management plans as per section 56 of the Conservation and Land Management Act are developed and that section 33(3)(b) allows for certain operations to be carried out where there is no management plan. In accordance with Departmental Planning Policy, operations must be carried out in a planned manner through the development and implementation of Interim Management Guidelines. Any measures in the Interim Guidelines should be the minimum required to meet the needs of management and should not seriously pre-empt future considerations and options of formal Area Management Plan.

There is no formal requirement for public participation in the preparation of Interim Management Guidelines, although it is desirable that other agencies, or industries with special interests in the area, are consulted.

Interim Management Guidelines focus on the key issues that pose a need for immediate action such as feral animal control, fire control, boundary fence maintenance or replacement, destocking, public safety, landscape function, and control of activities such as tourism and recreation. Wilderness areas require special attention in this process so that management activities planned by the Department, or access and tourism activities, do not compromise future options.

An example of an Interim Management Guideline is provided in Appendix 3.

11.3.1 Fire

Fire is a necessary part of ecosystem functioning in Australia, affecting the distribution and abundance of plants and animals, as well as impacting on climate and climate change (Bradstock *et al*. 2002).

At a broad scale of mapping, the Strategy region contains three distinctly different bioregions; namely, the hummock or spinifex grasslands in the north and east, the arid mulga woodlands across the majority of the central area, and the Acacia shrublands and heaths further to the west. The plants (and animals) within each of these broad regions will have different responses to fire, with mulga (*Acacia aneura*) considered to be fire sensitive particularly where grasses such as spinifex occur as part of the understorey (Allan and Southgate 2002; Hodgkinson 2002). Hodgkinson (2002) claims that extensive grazing and altered fire regimes within the mulga woodlands probably threatens the survival of increasing numbers of species through dysfunctional landscapes. Fire frequency in the mulga woodlands is generally low. Luke and McArthur (1978) estimated that frequency could be from 30 to 50 years due to infrequent rainfall necessary to sustain grass growth, such that high fuel levels are of short duration (Hodgkinson 2002). The Australian heathlands are renowned for their flammability (Chandler *et al*. 1983), and appear

capable of supporting intense fires throughout much of the year, even a short time after substantial rain (Keith *et al*. 2002).

Inappropriate fire regimes are implicated in the local extinction of several vascular plant species across Australia (Gill and Bradstock 1995; Keith 1996), and Leigh and Briggs (1992) consider 19 plant species are threatened with extinction due to inappropriate burning practices. Ashby (1924) considered that indiscriminate burning was the major cause of the disappearance of many of our rarer bird species, and inappropriate fire regimes are implicated in the decline of 51 bird taxa in Australia (Garnett 1992).

Fire exclusion combined with intensive grazing pressure following settlement and development of the pastoral rangelands, has led to the extinction of many plant species (Leigh and Briggs 1992). It is now well understood that many of the ecosystems in the rangelands require periodic burning to maintain stable animal and plant populations and that the maintenance of appropriate fire regimes is necessary to achieve this (Freudenberger *et al.* 1997). However, Freudenberger *et al.* recognize the importance of understanding the ecological requirements of plants and animals in defining fire management objectives.

All Australian rangelands will be burnt at some time as a result of natural or induced (deliberate or accidental) causes. Wildfires may have a direct destructive impact on pastoral infrastructure and also affect the environment in a number of ways. The need for the protection of life and infrastructure, on both sides of the boundary, from the destructive impacts of wildfire is well understood, and will require the development of wildfire response strategies involving local government and neighbours. Fire control plans have been developed across the rangelands and form the basis of all future fire response actions.

There are other aspects of fire that require more thorough understanding, particularly in the context of planning for fuel reduction burning, where strategic areas of the landscape may be burnt on a more regular basis.

Fire rejuvenates the environment, in that all plants are reduced to the position of having to regenerate at the same time creating an opportunity for plant species ratios to be re-established in a more natural order than may result from selective grazing by domestic animals (Harrington *et al.* 1984). Fire may also temporarily alter the dynamics of hydrology and nutrient status of the burnt landscapes as a result of the removal of all or most of the vegetation (Gill 1981).

Burning impacts on the environment include death or damage to plants according to species and individuals; the return of nutrients and minerals to the soil or atmosphere; the soil surface will be bare of vegetation for some time; heating of seeds may destroy some but improve germinability and dispersal of others; growth of some plants may be stimulated, e.g. epicormic buds in the vascular tissue of some woody plants; and variable survival of fauna depending

on their ability to avoid fire (Harrington *et al.* 1984 ; Freudenberger *et al.* 1997). Some plants killed by fire rely on re-establishment from seed while others rely on the ability to regrow from buds on stems and trunks.

Most plant communities appear to recover in some order, at least in the absence of grazing (Freudenberger *et al.* 1997). Patterns of compositional changes following episodic fire events generally conform to the following sequence (Noble 1989; Remmert 1991; Griffin 1992):

- early occupation and dominance by short-lived forbs and grasses in relation to post-fire rainfall;
- establishment of perennial species by regrowth from lignotubers, or epicormic growth, or from seeds;
- progressive dominance by perennial species; and
- slowing of rate of compositional and other structural changes once perennials are established.

While fires may be quite extensive and appear to have burned all vegetation, it is rare for this to be the case as not all components of the landscape are consumed in the one event. Some of the vegetation will not be consumed by fire as a result of rocky outcrop areas where fuel loads are such that fire is not carried; changes in wind direction; wet or damp areas or the occurrence of roads which interrupt the forward progress of fires. These unburnt areas form refuges for animals and plants, which may then recolonize burnt areas (Harrington *et al.* 1984). Plant communities which burn regularly, but only after a period of time during which fuel is accumulated, burn in patches which are self perpetuating such that the extent of the area burnt is dependent on the fuel load of the adjoining patch burnt in the previous fire. This results in a mosaic of habitats at different stages of succession.

Intentional prescribed burning activities must be carried out in the full understanding of the impacts on native vegetation and fauna and how these recover from the effects of fire. Given that our understanding of ecology at a species level is extremely limited, the precautionary principle must be applied.

Setting clear objectives for prescribed burning is a key management requirement for particular landscapes or ecosystems. This is necessary so that fire regimes may be matched with desired outcomes that can then be assessed and evaluated (Hodgkinson *et al.* 1984; Gill *et al*. 2002). In conservation areas the principal objective is to maintain biodiversity. However, there are usually at least two major objectives in the context of fire: maintenance of biodiversity and protection of life or property. Other objectives may include the control of plants that have become a problem as a result of grazing pressure, for example woody weeds (increaser species), or to ensure the exclusion of wildfire from fire-sensitive vegetation types, for example mulga dominated vegetation associations.

The decision to burn vegetation requires a thorough understanding of fire behaviour, impacts on ecosystems and the economics of carrying out such programs (Hodgkinson *et al.* 1984). Ecological impacts are related to life histories of plants and their reaction to burning, the habitat requirements of animals that are part of the ecosystem, and the at least temporary effects of denuding the soil of vegetative cover.

Different plants will respond to burning frequency in different ways (Hodgkinson *et al.* 1984). For example, herbaceous plants flower in the year following a burn while most woody plants do not produce seeds for at least three years or so after a burn. Burning on a three to four-year cycle will interrupt seeding cycles resulting in lack of regeneration of those perennial plants. Fire-sensitive plants can be locally eliminated by frequent burns which may interrupt regeneration from seed hence preventing them reaching maturity and setting seed (Hodgkinson *et al.* 1984, Gill *et al*. 2002).

Prescribed burning may be used to reduce fuels, making control of wildfires possible (at least under certain prevailing weather conditions), or for controlling woody weeds, and creating a mosaic of vegetation having different fire histories hence differing successional stages. Prescribed burning activities remain a significant challenge, given the juxtaposition within the landscape of land managed for quite different outcomes by the pastoral industry, recreational industry, or cultural pursuits. Understanding plant and animal ecology needs to be an ongoing requirement of research so that introduced periodic fire does not impact adversely on the long-term survival and evolution of native plants and animals.

11.3.2 Kangaroos

Wilson *et al.* (1984) point out that the dispersion of kangaroos from conservation reserves onto adjoining land is a highly contentious issue although the validity of these claims is not established. Kangaroo population numbers are monitored on land recently acquired for inclusion in the conservation reserve system to provide up-to-date information upon which to determine the possible relevance of control measures. The control of kangaroo numbers (on conservation reserves) that may impact on neighbouring properties is as much an exercise in conflict resolution and local politics as controlling potential grazing impacts on adjoining leases managed for pastoral production. With the progressive closure of artificial watering points on all land acquired for reservation, it is expected that a new balance between the productive capacity of the native vegetation and availability of water from natural sources for native animals will eventually be established (Caughley 1977). Progress towards a new balance, or natural state, of kangaroo and other native animal populations in a situation where their key natural predator, the dingo, has been removed will need careful monitoring.

The development of the rangelands by the pastoral industry, particularly through the provision of artificial water points, has provided a benefit to kangaroo populations (Ealey 1967; Newsome 1975). Their control is linked to the need for sustainable use of the rangeland resources (Jennings *et al.* 1979). Prince (1984) raises the issue of the precedence of economic issues of the pastoral industry over the conservation of kangaroos, which have generally been considered as pests by the industry. Prince claims the evidence supporting the "simplistic link" between elevated levels of kangaroo numbers and the viability of the pastoral industry is lacking. High levels of kangaroo harvesting has been noted by Prince (1984) as a result of the pastoral industry holding domestic stock numbers for the most part near their short-term environmental limits, such that during the inevitable drought periods kangaroo populations "were at once attacked" (see also Jennings *et al.* 1979) even though the environmental damage had already occurred.

There is an overall requirement to ensure that both domestic stock and kangaroo populations are managed so that the total grazing pressure does not exceed the productive capacity of the natural resource on which both the introduced and native herbivores depend. It should be pointed out that the control of kangaroo numbers on pastoral leases will not resolve management issues which have resulted in the degradation of the pastoral rangelands, such as the reduction in vegetative cover or changes in species composition, particularly in relation to the emergence of 'increaser' species. These problems will only be addressed through the adoption of responsible management of domestic stock numbers related to the carrying capacity of the native vegetation.

Within the conservation estate, kangaroo populations may be controlled through shooting programs involving professional shooters taking primarily commercial weight animals. However, where numbers are considered high, shooters have been instructed to remove non-commercial animals under a contract for service agreement with the Department of Conservation and Land Management.

Kangaroos, wallabies, potoroos, bettongs and rat-kangaroos (*Macropodoidea*) are Australia's best known faunal group, and the 20 million (Pople and McLeod 2000) or so kangaroos make up one of the world's most abundant large terrestrial mammal populations (Higginbottom *et al.* 2004). Although commonly viewed as overabundant and requiring harvesting and control, it is far less common to hear of discussion about how best to manage their numbers in an overall sense, nor their role in tourism. This is surprising given that the nature-based tourism industry in Australia, promoting the understanding and appreciation of native wildlife and unique landscapes, is now a significant economic activity, and growing rapidly (Blamey and Hatch 1998). The non-consumptive use of wildlife around the world has attracted increasing numbers of tourists (Vickerman 1988), with wildlife viewing proving more economically valuable than primary production in the same region (Muir 1987).

Kangaroos are identified as a key icon in promoting a tourist destination to establish a unique position in the market (Moutinho 1995). In a study aimed at assessing the importance of the kangaroo as a tourism icon, 2000 American tourists were asked to assess icon recognition. The study established that 98.3% of the sample correctly identified the kangaroo as Australian – the only better recognized icon was the Statue of Liberty (Higginbottom *et al*. 2004). Kangaroos and koalas were more popular than any other types of animals, with 43% of international tourists wanting to see a kangaroo during their visit (and 44% wanting to see a koala).

The kangaroo, with its high recognition as being synonymous with Australia, provides a useful image to use in marketing communications (Higginbottom *et al*. 2004). A balanced approach to the management of kangaroos, involving consideration of vegetation condition (rehabilitation requirements), population density, the impact of controlled shooting programs, and the part played in tourism activities where this is a part of the overall business of the pastoral enterprise, is necessary.

11.3.3 Emus

Mass migrations of emus (*Dromaius novaehollandiae*) from the arid interior in response to drought have been recorded (Noble 1991). Grice *et al.* (1985) found high population densities occurred in the sheep pastoral zone probably due to the provision and availability of artificial water sources.

The mass movement of emus away from regions suffering drought into areas which have recently received rainfall, is thought to be the result of population pressures since pastoral development, where now many more live and breed than can be supported in dry periods (Davies 2002). It is only when food and water become scarce that emus extend their feeding range, during which time they encounter many other birds seeking the same food source. The combination of pairs and small groups of birds may eventually lead to large numbers migrating from one landscape to another as reported in major drought periods in 1932, 1959, 1969 and 1976 (Davies 2002). Such mass migrations of emus result in the death of many birds.

Emus also congregate around water points or concentrated food sources (Davies 2002) but aerial surveys of their dispersion conducted between 1965 and 1976 within an area of 2,000 square kilometers showed that most were in pairs and remote from other pairs.

The removal of artificial sources of water from land acquired for inclusion in the conservation reserve system should result in an overall reduction in population abundance and modify the distribution of the animals. Mass migrations may mean that many birds travel across areas of land set aside for conservation of biodiversity with little impact, or they may travel to conservation land not experiencing

drought conditions. In the second instance, although a natural event, the high population numbers that have resulted from developmental impacts may result in quite heavy grazing impacts and disturbance of resident animal populations, necessitating consideration of control activities.

11.3.4 Feral animals and weeds

With the development of pastoralism in the late 1800s came a range of pest animal and plant species. Some of these, including rabbits, foxes and cats appear to have arrived at some earlier stage (see, for example, Carnegie 1898). Today feral animals are estimated to make up approximately 10% of all Australia's terrestrial mammal species (Rolls 1969; Mckay 1984; Dyne and Walton 1987). The impact of these exotic animals on native species is not well understood and evidence of direct displacement is scarce (Jones 1986; Fox 1990). It has been claimed (Wilson *et al.* 1984; Simpson and Holmes 1983; Environment Western Australia 1998) that the impact of feral animals may have had a greater effect on native plants and animals than the introduction of domestic stock.

There are increasing societal demands for the control of feral animal populations given the noticeable and adverse impacts these animals have on indigenous animal and plant populations (Woolnough *et al*. unpublished). Woolnough *et al.* have estimated population increases over a period from 1987 to 2002 using a calculation method developed by Caughley (1977). Their calculations are based on aerial survey results covering 1.2 million square kilometers in the southern rangelands of Western Australia. In this work population estimates for feral goats, camels and donkey are projected to 2010.

Earlier work by Southwell (1996) indicated that feral goats were increasing by about 18% each year, even after the effect of harvesting. During the period from 1987 to 2002 the feral goat population in Western Australia has increased threefold (Woolnough *et al.* unpublished). The increase in population is quite significant given that during the period of the surveys of population abundance a feral goat eradication program (1993 – 1998) was conducted which greatly reduced numbers (253,053 goats destroyed – Dept. Agric. WA).

There has been a similar long-term population increase in feral camels and donkeys in the southern rangelands of Western Australia (Woolnough *et al.* unpublished). However, both species are at relatively low numbers at present, and it is estimated that their numbers are increasing at a lesser rate than goats.

Feral goat numbers remain of particular concern for conservation management, and Woolnough *et al.* (unpublished) maintain that without government support for the control of goat numbers, the issues of rangeland degradation and loss of biodiversity will become more apparent with population increases. Parkes *et al.* (1996) suggests that current control practices relying on shooting, mustering and

trapping may not be sufficiently efficient in controlling the goat population and alternative measures may be necessary.

Feral cats are well established in Australia and may have been in the country well before European contact (Carnegie 1898; Long 1988). Cats were deliberately introduced into many parts of the country as they were seen as a useful means to control rabbits (Rolls 1969). Cats prey on native birds, reptiles, invertebrates and small mammal species although young rabbits, when plentiful, are a major prey animal for them (Short *et al*. 1997).

The impact of feral cats on native animal populations is not known. Impacts on native animals may result from direct predation, or the spread of disease carried by them such as toxoplasmosis (Dickman 1993; Braithwaite and Griffiths 1994; Christensen and Burrows 1995).

The control of feral cats is difficult, as poison bait programs have met with limited success in the past (Algar and Burrows, in prep). Adverse environmental conditions such as prolonged drought do not appear to result in population fluctuations, perhaps due to the ability of cats to capture and survive on reptiles and invertebrates (Burgman and Lindenmayer 1998). Where baiting programs aimed at the control of other predators, such as the fox or dingo, are used, feral cat numbers may increase markedly in response to the reduction in competition for food and direct predation (Pettigrew 1993; Christensen and Burrows 1995). Feral cat predation has been implicated in the failure of wildlife re-introduction experiments in Western Australia (Christensen and Burrows 1995) and the Northern Territory (Gibson *et al.* 1995).

The European red fox (*Vulpes vulpes*) was introduced into Australia in the late 1860s and 1870s (Troughton 1957) and is considered to have had a major impact in the decline of native animal populations over the last century (Morton 1990). The most dramatic declines have been observed in the non-volant mammal species with body weights in the range of 35g to 8000g (Burbidge and McKenzie 1989).

The control of foxes in the southwest of Western Australia over the past two decades has demonstrated that there is a concomitant increase in native animal populations with the reduction in fox predation (Kinnear *et al.* 1984; Kinnear *et al.* 1988; Burbidge and Friend 1990; Friend 1990; Kinnear 1990; Kinnear 1992; Morris 1992). Armstrong (1998) claims that fox control is one of the most pressing issues in reversing the decline of many native animal species.

Thomson *et al.* (1998) conducted fox control experiments in the rangelands near Carnarvon, Western Australia, and were able to demonstrate a dramatic decline in fox numbers as a result of baiting using dried meat injected with 3 mg of 1080 (Sodium fluroacetate), a naturally occurring animal toxin. Very high mortality of foxes (> 95%) is reported from this work indicating the efficacy of the baits and baiting technique with high mortality within the first three or four

days following baiting (Thomson *et al.* 1998). Follow-up baiting of a buffer zone around the core of the experimental area proved effective in maintaining low population levels within the buffer (25% - 32% of former level) suggesting that baiting in a buffer will minimize immigration into the core area. The implications for this in controlling immigration into protected areas such as conservation reserves are great (Thomson *et al.* 1998).

Weed species such as buffel (*Cenchrus ciliaris*) and birdwood grass (*Cenchrus setiger*), mimosa bush (*Acacia farnesiana*), mesqite (*Prosopis* sp) and sorghum (*Sorghum x almum*) have also been deliberately introduced in an effort to improve the availability of fodder for domestic stock and hence the productivity of the pastoral industry.

Environmental weeds are those species that invade native vegetation and adversely affect the survival of native flora. Some of these weed species are having a significant impact on biological diversity at genetic, species and community levels (Anon. 1999).

One of the most widely distributed and highly invasive weeds is buffel grass, an introduced exotic plant now considered an environmental weed and established over considerable areas of the pastoral rangelands, that is able to out-compete native flora (Humphreys *et al.* 1991; Franks 2002). It is considered that buffel grass was introduced in about 1910 in the stuffing of pack-saddles (see Suijdendorp unpubl.) but others consider introduction may have occurred earlier than this (see Marriot 1955; Humphreys 1967; Paull and Lee 1978; Cavaye 1991). The negative impact is in part due to this plant's ability to establish particularly well on disturbed sites, partly through its ability to chemically suppress other plants (Cheam 1984). Best (1998) has shown that there is a reduction in the total number of invertebrates in the presence of buffel grass. Buffel grass has also been shown to increase the intensity of fire, possibly increasing the threat to long-term survival of some plant species tolerant only to mild fires (Latz 1991; Pringle pers. comm.).

As this weed has now invaded major drainage systems and floodplains (Griffin 1993; Payne *et al.* 2003), it is now more likely that these areas, once buffel grass is established, will support fires of greater intensity than under native grasses and that infested areas will act as 'wicks', spreading fires still further (Humphries *et al.* 1991).

It has been predicted that about 58% of mainland Australia is highly to very highly suited to the establishment and survival of buffel grass (Lawson *et al.* in press). More recently, the Department of Agriculture has assessed and revised upwards the carrying capacity of leases within the Ashburton River catchment (Payne *et al.* 2003) based on the increase in the occurrence of buffel grass which has spread since the area was first mapped in 1976. The 2003 survey found that buffel grass (*Cenchrus ciliaris*) and birdwood grass (*Cenchrus setiger*) have spread considerably since the survey of the 1970s. Sixteen land systems have been identified as having had an increase in the occurrence of buffel grass (see Table 10).

Table 10. Changes in the area of buffel grass since 1978

Land system	Buffel grass occurrence in 1978	Buffel grass occurrence in 2002
Ashburton	34%	88%
Cheela	5%	64%
Dollar	0%	4%
Donovan	0%	0%
Edward	0%	12%
Firecracker	0%	2%
Globe	8%	0%
Jubilee	0%	2%
Kooline	0%	8%
Minderoo	0%	2%
Nanyarra	80%	80%
Onslow	14%	6%*
River	30%	30%
Rous	38%	41%
Turee	0%	2%
Yanrey	23%	23%

*Original estimate considered too high. Source: Dept. Agric. Western Australia 2003.

In relation to the introduction of exotic plants, Australia is a signatory to the 1992 UN Convention on Biological Diversity and is committed to "… prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species" (Article 8 (h), UNEP 1992). Best (1998) states quite eloquently that "Australia cannot fail to protect its remaining biodiversity. This can only be achieved by limiting the impact of extremely threatening species such as *Cenchrus ciliaris* where this is possible, and by ensuring that further introductions of such damaging weeds are prevented in the future".

It is interesting to note that the Land Act 1933 (now repealed) allowed for the sowing of non-indigenous pasture species "for the purpose of enhancing the stock carrying capacity of the lease or for such other purposes as are approved by the Minister" (Section 105 (2)). The Land Administration Act (1997) (this Act replaces the Land Act 1933) section 119(1) states that "the Board may, on an application in writing from a pastoral lessee, issue a permit for the lessee to sow and cultivate non-indigenous pasture on specified land under the lease". This appears in contrast to the commitment of the Commonwealth government to the 1992 UN Convention.

The introduction of buffel grass to areas of degraded and eroding land, particularly in valley bottoms, has been effective in stabilizing these areas and reducing the continued movement of soil. It has also increased financial benefit to the pastoral industry and its ability to tolerate the impacts of fire, drought and heavy grazing and these are seen as significant reasons to continue with the introduction and spread of buffel grass by the pastoral industry. However, buffel grass has the attributes of a weed and its control will be difficult in most areas of infestation. Thus identifying and prioritizing areas that are important for biodiversity conservation may be the best management option for activities such as the application of appropriate weedicides. As buffel grass will be impossible to control in most of the conservation reserve system, it will be necessary to accept its presence, and that a new balance between this plant and other native grasses may eventually establish.

The control of buffel grass infestations will remain a significant management issue for conservation areas into the future. Control will relate to the containment or eradication of existing infestations as well as new infestations from neighbouring properties, particularly along drainage systems. The control of other weed species will also require carefully planned management activities.

11.3.5 Closure of artificial water sources

Water supply has increased dramatically in the pastoral rangelands allowing both domestic stock, kangaroos and feral animals to graze a much larger area of the landscape than previously (Landsberg *et al.* 1997). It is claimed that the provision of this vastly increased water supply is a potential threat to biodiversity in arid and semi-arid Australia (Landsberg and Gillieson 1996).

James *et al.* (1997) conducted a review into the effects of the provision of artificial water points on native flora and fauna. Recorded changes to vegetation as an indirect result of water points indicated that:

- a zone of extreme degradation up to 0.5 km radius from the water point exists where the soil crust in broken, with associated high levels of erosion and forbs dominant after rain;
- there is an increase in the number of unpalatable perennial plants beyond the sacrifice zone (0.5 km), particularly in the arid and semi-arid woodlands; and
- there is a decrease in abundance of palatable native perennial grasses due to selective grazing.

The direct effects of the provision of artificial water points included:

- the development of wetland habitats, particularly in the case of free- flowing artesian bores;
- the expansion of the geographic range of many bird species utilizing the water points;

- an increase in the range and abundance of native animals that require drinking water (e.g. kangaroos); and
- a possible expansion of the breeding ranges of many invertebrates that require water for certain stages of their life cycle.

Indirect effects on native fauna are poorly documented (James *et al.* 1997) but published effects of grazing on native fauna include:

- speculative discussions that attribute the recent extinction of medium-sized native mammalian species to grazing by introduced stock;
- the displacement of some ground-dwelling birds form heavily grazed areas and a reduction in the range of others; and
- changes in the distribution and abundance of invertebrates such as grasshoppers, ants and collembolans (small wingless insects).

Changes to native flora and fauna also result from the use of artificial watering points by feral animals. Foxes and cats use water points as a focus for hunting and drinking, and larger feral herbivores create grazing impacts, particularly where their population numbers are high.

11.3.6 Destocking

One of first issues to be dealt with following the acquisition of pastoral leases is to ensure that all domestic stock are removed. This is necessary to allow native vegetation to recover from the impacts of grazing which have occurred over considerable time.

Grazing by domestic stock is not uniform across the landscape and is influenced by distance from water, the salt levels of the grazed vegetation and the general palatability of the fodder (Landsberg *et al.*1997; Harrington *et al.* 1984; Curry *et al.* 1994; Pringle *et al.* 1994).

Destocking will usually involve the former lessee progressively trapping and mustering sheep and cattle until all stock are removed. Former lessees are able to conduct destocking activities over a period of several years, as it would not normally be possible to effectively destock in a shorter time frame.

Once destocking is considered complete, stragglers may be mustered where numbers are sufficient, or destroyed where mustering is not an option.

11.3.7 Dividing fences

The prevention of domestic stock encroaching onto conservation land from neighbouring properties (and the movement of herbivores from the conservation estate onto pastoral land) is a major management issue requiring the maintenance of boundary fences in a stock-proof condition and vigilance in monitoring breaches in them. Section 5 of the Dividing Fences Act (1991) defines a dividing fence as

one that separates land of different 'owners' whether the fence is on the common boundary of adjoining lands or on a line other than the common boundary. The practice throughout the pastoral rangelands is to accept the location of the boundary as the erected fence, even where this fence is clearly not aligned with the cadastral boundary by survey. Consideration of the standard of fencing in relation to its ability to resist the trespass of cattle or sheep is required and section 5 of the Act defines a 'sufficient fence' as:

- a fence prescribed as a sufficient fence by the relevant local government under a local law; or
- a fence of the description and quality agreed by the parties concerned; or
- if there is no local law or agreement made, any substantial fence that is ordinarily capable of resisting the trespass of cattle and sheep; or
- any fence determined to be a sufficient fence by the Court of Petty Sessions.

Section 4 of the Dividing Fences Act (1991) provides that it does not bind the Crown. That is, the Crown is not required to contribute to the construction and maintenance of boundary fences between Crown land and pastoral leasehold land. Given the length of boundary between pastoral leases and land being managed for the conservation of biological diversity, the Department of Conservation and Land Management has developed a good neighbour policy aimed at addressing the inequity of requiring pastoralists to bear all costs associated with boundary fences (Brandis 2003). By being involved in the process of maintaining boundary fences, the Department is showing good will to neighbours while at the same time ensuring stock encroachment onto conservation reserves is minimized.

11.3.8 Research

Effective conservation management is based on a thorough knowledge and understanding of the nature and extent of biological communities and their structure and function.

Further detailed study is required in conservation reserves and surrounding land in areas such as mulga regeneration, the effects of fire, the impacts of feral animals, the ecology of threatened species and detailed inventories of the native and introduced flora and fauna occurring there.

It has been recognized that the knowledge base for environmental reporting in respect of rangeland ecology is inadequate (ANZEEC and ARMCANZ 1999). The collection, interpretation, recording and communication of information about rangeland condition at the time of acquisition is an important step upon which management decisions depend, particularly in establishing monitoring programs aimed at detecting native vegetation and animal recovery trends following destocking.

While the Science and Information Division within the Department is responsible for most research work on Departmentally managed lands, research may also be carried out by Universities, environmental consultants, and the CSIRO. Much more can be achieved through cooperative arrangements and the Department must increase its efforts in this regard so that strategically important research is more closely aligned to conservation management goals. Potential research opportunities can be jointly considered and lead to real savings in time and resources, with improved outcomes for the conservation of biodiversity.

Reliable information about visitor usage of conservation land, including the number of visitors, their destination within these areas, their purpose for visiting and their perceptions of the conservation values and management of the area is also required. This information is valuable when making management decisions about visitor facilities, interpretive material and general information about the reserve network. The impacts of visitor activities need to be closely monitored to ensure that the conservation values are not adversely affected.

11.3.9 Wilderness areas

While there is a wide range of views on what the values of wilderness are, there is none-the-less a broad level of understanding about the wilderness concept (Robertson *et al.* 1992), and most Australians see the maintenance of such areas as highly important (McKenry 1975). One of the most important values of wilderness areas is their contribution to "the preservation of species diversity and the maintenance of a diverse gene pool" (Feller *et al.* 1979). Robertson *et al.* (1992) maintain that wilderness protection and management should involve the following values:

- natural values including the integrity of ecological processes, the protection of biodiversity and the moderation and minimization of global change;
- cultural values including the protection of cultural diversity;
- instrumental values, including research and education, recreation and economic benefits; and
- intrinsic values - "what is especially valuable about the products of natural processes is that they are products of something larger than ourselves" (Goodin 1991).

Any use which depends on wilderness values but which results in any degree of loss of remoteness or naturalness is incompatible with the protection of wilderness areas (Land Conservation Council 1991). Even where Aboriginal cultural activities are practiced, there may be some degree of loss of wilderness values through the use of modern technology, for example the use of four-wheel-drive motor vehicles and high-powered firearms. Land use activities that are particularly incompatible with the protection of wilderness values include resource utilization (including mining activities or forestry), the development of new roads and tracks providing

access for recreation, animal transport such as horses and camels, aircraft and motor boats, agriculture or pastoralism, beekeeping, hunting and fishing. Given so many incompatible activities, it may seem that the area should be 'locked up'. However, as Feller (1978) points out, wilderness can be used for flora and fauna conservation, scientific reference areas, non-mechanized recreational activities and, in some instances, catchment protection.

Wilderness represents one end of a continuum of land use and condition, from highly developed urban areas to wilderness. A number of approaches to identifying wilderness areas have been developed (Robertson *et al.* 1992) including the Wilderness Quality Survey approach developed by Kirkpatrick and Haney (1980) and the National Wilderness Inventory methodology developed by Lesslie and Taylor (1983). Both methods refer to the scoring of factors such as remoteness and naturalness as the key attributes by which to judge wilderness values. Several large tracts of land acquired for inclusion in the conservation reserve system as part of the GMS program appear to fall into the category of wilderness although they have not been formally reviewed. The future management objectives applied to these areas are therefore important in the context of preserving such wildness values.

Robertson *et al.* (1992) point out that if Australian society wishes to maintain the "wild end of the continuum" then careful management will be necessary. The need for a consistent national approach to the management of wilderness has been identified for some time now (CONCOM 1986; Sinclair 1987; Baird-Lambert 1988) and some progress has been made towards achieving this objective. The national code proposed by Robertson *et al.* (1992) includes the need to consider the following issues:

- access and transport
- recreation
- research
- cultural heritage
- nature conservation
- introduced species
- fire
- external influences
- restoration

Robertson *et al.* (1992) propose a draft National Code of Management of Wilderness Areas related to these issues.

The Department of Conservation and Land Management has recently (2003) released a Draft Wilderness Policy (for public comment) to guide the development of future management activities that reflects the draft National Code. Areas identified

as wilderness will be classified by way of a section 62 (CALM Act 1984) notice in the Western Australian Government Gazette (as a requirement of section 62(1) of the Conservation and Land Management Act). All planning for future management activities will be guided by this policy.

11.3.10 Recreation and tourism

Boniface and Cooper (1987) define recreation as any activity engaged upon during leisure time, while tourism has been defined as the temporary movement of people to destinations outside their home or workplace (Mathieson and Wall 1982).

The attraction of many of the State's natural areas has resulted in an "explosive level" of growth in tourism (Newsome *et al.* 2002), which has the capacity to impact either positively or adversely on the environment. Globally, it has been estimated that natural-area tourism has risen from about two percent of all tourism to about 20% today (Weaver and Opperman 2000). Tourism is the fastest growing industry in the world and eco-tourism the fastest growing component, now contributing about twelve per cent of the world's gross domestic product (WTTC 1995).

Newsome *et al.* (2002) discuss environment-tourism as being a part of the sustainability concept: tourism planning must be integrated with resource management such that environmental quality is sustained in the long term. A major challenge for managers of the conservation estate is to meet recreation and tourism needs while maintaining conservation values.

Natural areas are defined as areas that have remained undisturbed by human exploitation and development activities (Newsome *et al.* 2002). The landforms, native flora and fauna and ecosystems remain essentially in their natural state.

Nature-based tourism provides opportunities for fostering greater understanding of the natural environment and the need for conservation of biodiversity within the protected area as well as the broader environment. The focus for tourists engaged in nature-based tourism is both the abiotic and biotic elements of the landscape which provides a basis for understanding the environment and conservation (Newsome *et al.* 2002). Nature-based tourism is synonymous with eco-tourism although the latter is more focused on the provision of interpretive and educational material. Eco-tourism comprises a number of interrelated aspects including:

- it is nature based;
- it is ecologically sustainable;
- it is environmentally educative;
- it is locally beneficial; and
- it generates tourist satisfaction.

Dowling (1996) considers the first three characteristics to be essential elements of eco-tourism while the remaining two are highly desirable.

Many tourism activities are considered to have a negative impact on the environment as a result of attracting attention to natural treasures increasing pressure on them (Wall 1994). Adverse environmental pressures are described by Hvenegaard (1994) and include overcrowding, over-development, pollution, disturbance of wildlife, and vehicle use.

There are also many positive benefits to arise from the natural area tourism relationship, including provision of an economic justification for conservation; it builds support for conservation and assists with the provision of new or additional resources for conservation by increasing political and economic support (Phillips 1985).

Careful planning is required for the protection of the environment within the conservation reserve system from the impacts of tourism activities, while at the same time providing information leading to improved understanding of it.

One of the key management planning aspects of natural-area tourism is the way in which tourism activities are separated from other aspects of reserve management either in space or time. This is often referred to as zoning, where tourism activities are partially or totally excluded, depending on other conservation values or management activities.

For Aboriginal people, there is an increasing interest in becoming involved with tourism ventures, and tourism on land containing places of special cultural interest, while accepted to a degree, requires some safeguards to ensure that access to some of these places does not occur. Aboriginal people and representative organizations should be included in tourism planning as they often have unique perspectives to offer which can improve the natural-area experiences of tourists.

11.3.11 Monitoring

Smyth and James (2004) consider monitoring to be a "systematic activity involving the collection of repeated data over time for a particular purpose". They consider that there is little biodiversity monitoring being undertaken at the present time on a large scale in any biome, and that as a result, governments have a limited foundation on which to base future planning, including the allocation of scarce financial resources.

In the conservation reserve management context, a monitoring program is implemented to assess the changes in the environment using a baseline standard as a control, or to assess the impacts of management programs on the environment or its component ecosystems or species.

Burgman and Lindenmayer (1998) discuss the use of statistics in determining the deviation from some standard (baseline data) using the convention of testing the

difference between the null hypothesis and the alternative hypothesis. The aim of environmental monitoring is to detect impacts on, or changes to the environment, as a result of some action. The null hypothesis states that there is no effect as a result of some action, while the alternative hypothesis states that there is some resultant effect from particular management activities. There are only two possible outcomes: one is that an impact exists; or there is no significant impact. The determination of the kind, frequency, distribution and number of sample points must be specified in monitoring programs once the objectives are set. Burgman and Lindenmayer (1998) suggest that the quality and efficacy of monitoring programs is dependent on the collection of data that are sensitive to both quantitative and qualitative attributes of the changes intended to be measured.

The choice of indicators upon which to base the measurement of change is critical to any monitoring program. A process for choosing indicators is described by Suter (1993) which includes management goals, and the subsequent specification of assessment and measurement outcomes. An example of an assessment outcome might be the continued maintenance of natural populations of native flora and fauna across the extent of their natural range, while measurement outcomes are the indices that will be used in field measurements. These may include annual measurements of species, their relative abundance and distribution. Smyth and James (2004) group biodiversity indicators into biotic, ecophysical, pressure and management attribute types. They describe biotic attributes as entities that are native to an area that respond to changes in the state of ecophysical attributes or the pressures of land uses. Ecophysical attributes are those related to climate, topography, soil properties, landscape function, vegetation / habitat characteristics or other natural resource features that influence spatial and temporal distribution. Response indicators (Smyth *et al.* 2003; Landsberg and Crowley 2004) are biotic and ecophysical attributes combined, often referred to as a threatening process caused by human activities such as total grazing pressure and the introduction of feral predators.

Remotely sensed data may be used to measure ecophysical and pressure attribute type impacts but may be less useful in measuring biota at resolutions that are comparable to site data (Smyth and James 2004). There has been considerable research directed at the use of surrogates and landscape metrics to indicate vegetation and land condition.

The purpose of monitoring biodiversity in the rangelands will inevitably influence the choice of biodiversity indicators considered to provide the best information. While biodiversity indicators have already been selected for national State of the Environment Reporting (Williams *et al.* 2001), the Tropical Savannas CRC recommends 11 indicators as a minimum requirement for monitoring rangeland biodiversity.

Developing a monitoring program is an iterative process requiring careful design to ensure the information provided answers the questions being posed. Monitoring is essential because the information provided allows the assessment of management decisions and provides for feedback as part of the overall planning process (Smyth and James 2004).

Choosing indicators to measure changes in ecosystems is an important step in designing monitoring programs (Connor 1988, Landres *et al.* 1988) as the measurement of only a particular range of species will be possible. Unfortunately, indicators are rarely verified as being particularly useful in predicting the state of other species (Noss 1990). However, as it is not possible to monitor all species, only a limited range of species can be monitored. Indicator species are broadly defined as:

- bio-indicator species used to measure long-term changes that may result from global warming or changed fire regimes;
- pollution indicators which reflect the impact of pollutants on biota;
- recovery indicators that reflect the extent of recovery of an ecosystem following disturbance; and,
- management indicators, used to measure the impacts of disturbance.

Management indicator species are ideally sedentary, specialized species or those at the top of the food chain (Milledge *et al.* 1991), but selection will depend upon response characteristics, ecological function, spatial and temporal scales of response to disturbance and their ability to reflect changes.

It is important to recognize the difficulties associated with interpreting the implications for the environment as a result of the measurement of changes to populations of indicator species. It is generally considered that indicators are unlikely to reflect the full range of responses to environmental disturbance at all temporal, spatial and organizational levels (Landres *et al.* 1988, Probst 1991, Wood 1991).

Monitoring changes in population abundance and distribution following the destocking of pastoral leases acquired for inclusion in the conservation reserve system is an urgent management requirement. The knowledge provided by the outcome of a monitoring program is important in shaping future management planning options that consider the recovery, or decline, of plant and animal species.

The provision of baseline information about abundance and distribution of species must remain a high priority for monitoring programs and every effort should be made to design suitable assessment tools for this purpose. The use of aerial photography coupled with ground level photographic monitoring sites may provide information about changes in vegetative cover, species richness and species diversity. Monitoring based on remote sensing is relatively cost effective and can be applied at a broad scale in detecting overall trends in landscape function (Ludwig *et al.* 1997).

At this point in time no monitoring program has been developed, with the result that no monitoring has been undertaken on land acquired for inclusion in the conservation reserve system. Unfortunately, the opportunity to establish baseline data at the time pastoral leases were destocked has not been taken, and the reliance on remotely sensed data from historic records including aerial photographs and Landsat imagery, remains the primary source of data. The development of a monitoring system utilizing suitable surrogates where appropriate, will require considerable time and effort so that key questions about deviation from baseline levels are adequately addressed.

11.3.12 Cultural and heritage issues

The importance of European and Aboriginal cultural heritage is recognized and addressed in planning for management of a conservation reserve.

The involvement of Aboriginal people in managing conservation reserves is consistent with the objectives of the National Reserves System Cooperative Program, which aims to improve the management of all protected areas. Recognition of the rights of Aboriginal people, their interests in land, and their involvement in its management, is an important issue to be considered in improving management (Smyth and Sutherland 1996). Indeed, the Royal Commission Into Aboriginal Deaths in Custody (Commonwealth of Australia 1991) recommended that special measures be taken to provide for joint management of protected areas by Aboriginal people as a means of reconnecting them with the land. The House of Representatives Standing Committee on the Environment, Recreation and the Arts (HoRSCERA 1993) recommended that measures to preserve sites of Aboriginal significance should be included in management plans developed for National Parks. In Western Australia it is a statutory requirement to notify the Department of Indigenous Affairs of any area considered to be of importance as an Aboriginal cultural area. Planning for management should also recognize the need to promote public understanding and appreciation of Aboriginal culture.

European history and places of importance are also to be addressed in planning and management activities. The records of early explorers often provide comprehensive accounts of the country at the time they traversed regional areas of the state. These may be the only account of the condition of the country before pastoral development took place. The preservation of structures including grave sites, buildings, yards, survey markers or marked trees is important in recognizing the historic place of our early settlers and explorers in opening up our state.

11.3.13 Education and communication

In his forward to the Victorian Educational Education Strategy (Victorian Environmental Education Council 1992) Professor Fensham focuses on the need

to raise the level of awareness, understanding, commitment and skills that would result in a reduction in the level of threat to our environment. He goes on to briefly explain how the Government of Victoria has accepted the major responsibility for environmental education as part of the follow-on from the release of that state's Conservation Strategy. In pointing this out, he also raises the need for the community and other organizations to make a contribution to this process, rather than rely on Government alone.

Unfortunately, there is no such environmental education strategy developed in Western Australia to provide clear direction, although many individuals and organizations have endeavored to progress the delivery of educational packages aimed at raising the level of awareness and commitment towards a range of environmental issues.

Ehrlich *et al.* (1977) stated that "in the United States and around the world there has clearly been an almost total failure to prepare people to understand and make decisions relating to the population-resource-environment crisis" (p. 824). Other writers such as David Eagan and David Orr (1992) ask what has gone wrong with people's education that they continue to behave in an environmentally irresponsible way.

The National Principles and Guidelines for Rangeland Management (ANZEEC and ARMCANZ 1999) recognizes the needs of land managers for information, skills and commitment "to ensure that rangeland enterprises are economically and ecologically sustainable" (p. 16). This strategy continues with a number of recommendations aimed at addressing the perceived problem.

The challenge for the Department of Conservation and Land Management and other organizations dealing with environmental issues is to develop multidisciplinary approaches to the provision of knowledge and understanding, in shaping values, attitudes and behaviour aimed at the long-term sustainable development of our rangelands (Brandis 1996). This challenge involves overcoming the mindset which society has about education, seen almost entirely by many as what happens in the formal schooling system. In proposing a strategic approach to the education of land users and the broader community educators need to give thought to what Eagan and Orr (1992) describe as the non-traditional pedagogy. That is, everyone, young and not so young, needs to be empowered to take action, based on a thorough and broad understanding of environmental issues at the local, regional and national level.

The Department of Conservation and Land Management has been involved in the provision of educative material and information about the natural environment for many years through the publication of scientific information and the Landscope magazine, collaboration with Universities, particularly post graduate students, Landscope expeditions involving members of the public, and

interpretive material either of a static nature or by discussion between the public and CALM staff. However, much of this material is focused on the provision of information in the context of a single issue, often a species of plant or animal or landscape, rather than the interrelationships between all components of the environment. The Department does not have an environmental education strategy in place to provide a framework for the development of educational materials aimed at providing knowledge and understanding for a range of audiences and to deal with issues related to single species or the broader environment. Much more needs to be done about the education of both the pastoral industry and broader community within a rangeland context.

The Department has been active in the provision of information about its activities leading to the acquisition of land for inclusion in the conservation estate – the need for this action, and the management activities that will be undertaken for the conservation of biodiversity and how these often need to be integrated with land management across boundaries. Communication has been somewhat targeted and strategic and a Communication Strategy has been prepared by the author (Appendix 2).

This Strategy provides the overall direction for communicating with stakeholders involved in land management activities in the rangelands. The goals set out in the strategy clearly indicate the need for the provision of information about the Department's rangeland activities related to the conservation of biodiversity, the need to establish support for the work being undertaken by the Department, and to establish the credibility of the Department in its rangeland conservation activities through building quality relationships with those engaged in, or with an interest in, rangeland management.

11.3.14 Access and camping

The impacts of increasing numbers of visitors wishing to participate in natural area activities results in the need for careful planning of access roads, tracks and trails dependent on the level of environmental sensitivity and the effectiveness of management within different parts of a reserve (Newsome *et al.* 2002).

The negative impacts of roads include the need for clearing native vegetation, increased potential for weed invasion, disturbance of wildlife in relation to noise, disruption of overland water flow (Pringle and Tinley 2003), and road kills of native fauna. The mortality of native animals resulting from road traffic has been recognized as a significant issue, particularly in the case of snakes and larger mammals (Rosen and Lowe 1994; Gibeau and Heurer 1996). Roads also act as barriers to animal movement and fragment habitats, reducing habitat effectiveness (Gibeau and Heurer 1996). However, there are some ecological positives resulting from the construction of roads including the creation of edge effects which some

birds prefer, and may result in an increase in breeding populations (Jarvinen and Vaisanen 1977). Road kills also provides a food source for some animals which feed off carrion, for example the large lizards (*Veranus* spp.), predisposing them to high levels of mortality.

Vehicle access on unsealed roads has increased dramatically since the early 1970s following the four-wheel-drive vehicle boom. Off-road driving, particularly in sensitive areas, has the potential to cause increased soil erosion, spread weeds and disturb animal populations.

With good planning, provision of trails can be used to focus hiking, even horse riding, to less sensitive parts of the landscape thus reducing more random and widespread impacts caused by trampling of vegetation and erosion. Trail degradation has been studied by Weaver and Dale (1978) who identified a number of relationships that determined the degree of degradation including the amount and type of recreational activity, slope angle, roughness of slope, soil physical properties and moisture conditions, rainfall characteristics and vegetation type. All should be taken into account in carefully planning the location and construction of trails.

Camping is a popular recreational activity which has the capacity to cause significant localized effects including soil erosion, vegetation decline and impacts on animal populations. Negative impacts also include litter and the disposal of human wastes which have the potential to compromise social and health issues. In a recent study of recreation impacts in the Nuyts Wilderness area in Western Australia (in the south west of the state), the amount of litter was rated as an important factor which influenced the camping experience (Morin *et al.* 1997). The need to provide camping facilities to accommodate the increased recreational demand will require careful planning, including the assessment and monitoring of the resultant impacts (Farrell and Marion 2001; Leung and Marion 2000).

11.3.15 Mining

The Western Australian Government permits exploration and mining in conservation reserves under section 24 of the Mining Act. Exploration and mining are also subject to the provisions of the Environmental Protection Act.

Exploration and mining within the conservation reserve system is subjected to an assessment of the likely impacts by the Department of Industry and Resources, the Environmental Protection Authority and the Department of Conservation and Land Management. Mining Act tenement proposals on conservation reserve land are reviewed by the Department of Conservation and Land Management and appropriate conditions imposed. Compensation for loss of conservation values is also sought for operations impacting on conservation values within the reserve system.

Guidelines for exploration and mining activities which are endorsed by the Department of Conservation and Land Management are provided to industry.

Fossicking is not permitted on conservation reserves and the possession of a Miners Right does not permit mineral detection or extraction to be carried out.

11.3.16 Risk management

The Department of Conservation and Land Management has a genuine concern for visitor and staff welfare. It also has legal and moral responsibility for the safety of visitors to land (and water) managed by the Department for the conservation of biodiversity. The Departmental policy related to this issue commits the agency to the provision of resources necessary for the identification and mitigation of potential safety risks.

The process of identifying safety risks is undertaken by trained agency staff or by others with specialist expertise where necessary. The Department also keeps comprehensive records of any accidents with the view to taking appropriate actions to avoid similar events occurring in the future. The types of risks faced in the semi-arid and arid parts of the state can by classified into those associated with natural events – for example, extremes of temperature, lack of water, wildfires; the natural environment – for example, steep, rocky areas, extensive arid areas such as dune fields; or the developed environment – for example, structures that have been built to improve access, or provide shelter. Other structures that remain on land once developed for pastoral or mining activities, such as wind mills, wells, buildings, fences, mine shafts and treatment sites, all must be identified and made safe.

In many instances safety information must be provided to guide visitor access and behaviour so that the Department's exposure to public liability is minimized.

11.4 Conclusion

The completion of interim management planning activities allows the careful identification of key, prioritized, environmental management issues that are likely to cause conflict with other land users managing land for different (usually economic) outcomes, and risk assessment. The planning process usually draws together key personnel with conservation reserve system planning and management experience as well as those with operational experience. This way, the important initial planning is undertaken to identify the operational activities considered necessary for the protection of flora and fauna, habitat, sensitive or special areas, and the minimization of the impacts of threatening processes including fire and feral animals. This strategic planning exercise provides an opportunity to look at

the bigger picture in terms of overall nature conservation outcomes while at the same time focusing on local areas and issues.

Management planning, and the guidelines produced as a result of this process, needs to be flexible and adaptive so that future options are not excluded and activities can be changed in the light of new information. One of the most important issues for management is that planning and operational activities are monitored to ensure that there is a strong feedback link to the identified management objectives. Without this link, it is not possible to determine the validity of these objectives nor the need for alternative thinking when the lack of achievement of objective outcomes becomes apparent.

The need for continued liaison, communication and education with neighbours, industry, local government and the broader community remains perhaps the most important single issue for the Department: changing the values, attitudes and behaviour of many of those who see the emergence of a new and different land use as a threat at the local or regional level. This activity is made all the more difficult in the changing economic and seasonal conditions besetting most pastoralists.

Chapter 12 : The Conservation Reserve System – Regional Overview and Status Report

12.1 Introduction

The 1997 Gascoyne-Murchison Rangeland Strategy report to Cabinet Sub-Committee recommended the establishment and management of a comprehensive, adequate and representative conservation reserve system, as well as supporting the Department of Conservation and Land Management's proposal to develop a managed off-reserve conservation network on existing leases. After five years of pastoral lease acquisition the Department has overseen the purchase of approximately 3.84 million hectares of land containing high conservation values. This land, formerly managed for pastoral production, will now be managed in perpetuity for the conservation of biodiversity.

The acquisition program should be seen as an important step in improving the conservation reserve system, the existing reserve network across the region being judged to be inadequate and biased (Thackway and Cresswell 1995). However, given the economic, political and social constraints, and competing land use pressures, the achievements to date indicate that with careful assessment of conservation values, rapid assessment of rangeland and infrastructure condition, and patience and consideration in dealing with lessees, it has been possible to make good progress with the extension of the reserve system.

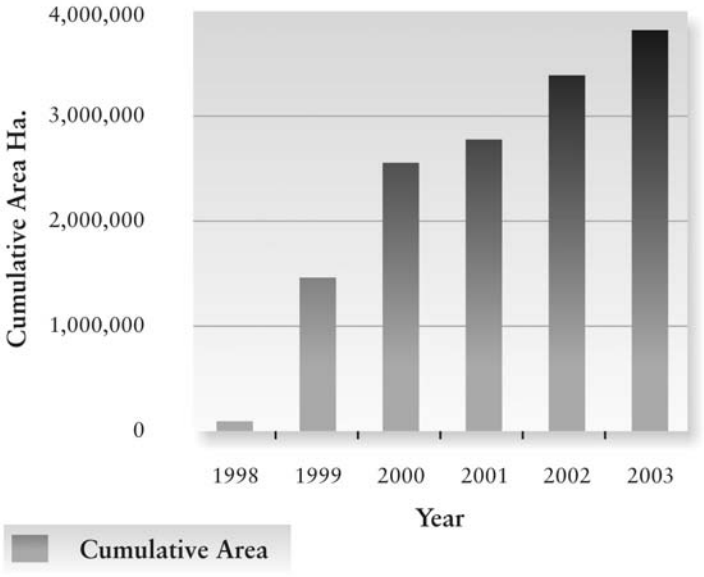
An assessment and evaluation of what the land acquisition program has achieved, and the gaps in the conservation reserve system that still remain has been carried out based on the vegetation type mapping of Beard (1990). Results are presented by IBRA regions as defined by Thackway and Cresswell (1995).

12.2 Progress to date

At the beginning of the land acquisition program (1998) there were 1,414,915 hectares of land within the conservation reserve system. This represents about 2.4% of the Strategy region. At June 30th 2003, the area of land managed for the conservation of biodiversity within the Strategy region is over 5.2 million hectares or about 8.8 percent. The increases in area of land for inclusion in the conservation reserve system over the life of the acquisition program are indicated in Figure 17.

The additional land acquired for conservation management contains a variety of conservation values important to the improvement in the level of comprehensiveness, adequacy and representativeness of the reserve system. These areas also contain areas of scenic, tourist and cultural importance as well as wilderness values in some parts. The increase in area alone should not be seen as the most important outcome of the program, rather the improvement in the level

Figure 17. Growth of the conservation reserve system resulting from pastoral acquisitions which commenced in 1998.



of representativeness of the range of ecosystems within the region should be used as an appropriate measure.

The land acquired for inclusion in the reserve system is located throughout the Strategy region thus improving the geoclimatic distribution of the network and the range of ecosystems contained (see Figure 18).

Due to the range in pastoral productivity of the land in the region, combined with higher levels of degradation on high pastoral value land, most of the land acquisitions reflect lower pastoral productivity. High pastoral value land is more tightly held by the industry, and purchase opportunities have been rather more limited. There has also been a negative reaction from the industry to government purchases of pastoral land containing higher pastoral production values. The perceived value of this land, though often more extensively degraded, has resulted in a reactionary campaign of negative comment from individuals and the industry.

The Department of Agriculture Western Australia using extensive land system mapping throughout the rangelands has determined pastoral potential value for each system. Overall, the acquisitions comprise 1,775,584 hectares of low pastoral value land, 1,246,143 hectares of moderate pastoral value and 166,804 hectares of high pastoral value land. The results shown in Table 11 are provided as an indication of the proportional representation of land of different pastoral value contained in the acquired pastoral land. The allocation of pastoral value to all land within the Strategy area has not been completed with large areas on Mooloogool, Doolgunna, Earaheedy and Lorna Glen (total of 635,698 hectares) not mapped.

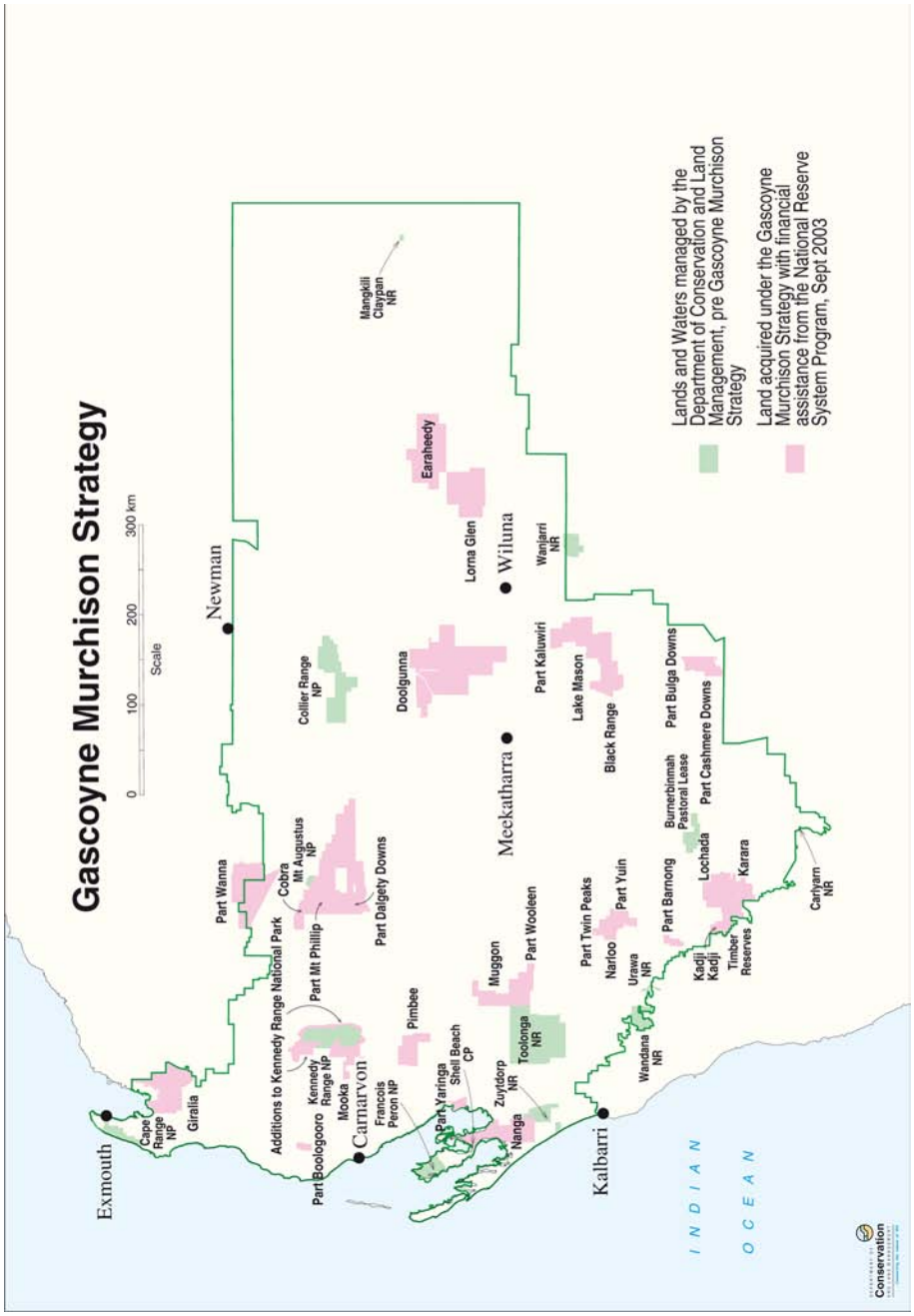


Figure 18. Map showing acquisitions since the beginning of the program.

Table 11. Pastoral land acquired under the Strategy, by pastoral potential value classes

Pastoral Potential Value (total hectares)						
	Very High	High	Moderately High	Moderate	Low	Very Low
	12558	154246	474520	771623	756254	1019330
Sub Total	**166804**		**1246143**		**1775584**	
Total	**3,188,531***					

* Note: The total area for leases within the area covered by land system mapping.

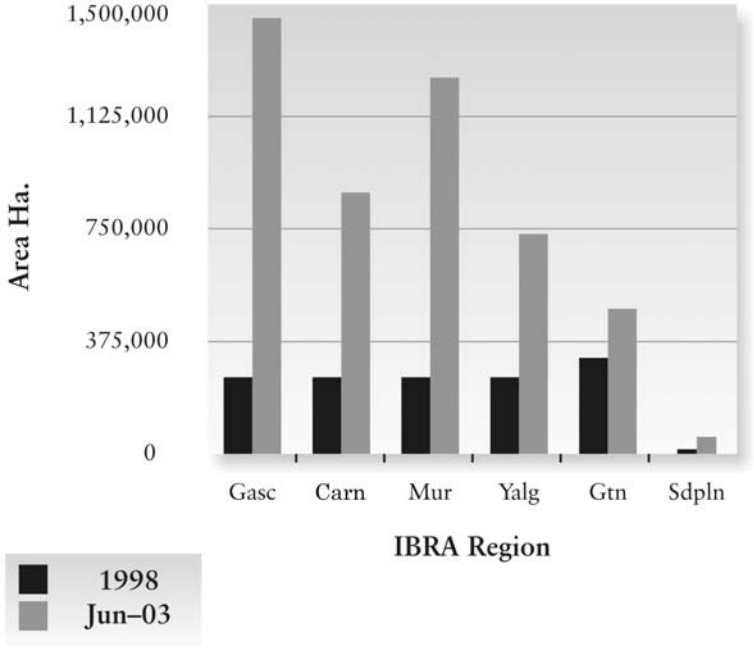
Table 12. Conservation reserve area (in hectares) by biogeographic regions having high or medium priority for increasing the reserve system, showing increase from 1998 to 2003

IBRA region	1998		IBRA Region area	2003		15% of region (ha)	Additional Area required (ha)
	conservation reserves (ha)	% of region		conservation reserves (ha)	% of region		
Gascoyne	244438	1.48	16556817	1756818	10.6	2483523	726705
Carnarvon	265908	3.54	7503038	871810	11.62	1125456	253646
Murchison	82170	0.45	18430888	1374380	7.46	2764633	1390253
Yalgoo	486136	12.6	3857659	683947	17.73	–	–
Avon Wheatbelt	18629	4.2	443448	45993	10.37	66517	20524
Geraldton Sandplain	313919	21.36	1469472	479225	32.61	–	-
Total	**1411200**			**5212173**			

12.3 Protected areas within IBRA regions

The Interim Biogeographic Regionalization of Australia process established a framework for establishing a comprehensive, adequate and representative reserve system in Australia (Thackway and Cresswell 1995). The Gascoyne-Murchison Rangeland Strategy region is made up of eleven IBRA regions or parts of regions. The improvement in the area of each IBRA region that is within the conservation reserve system (see Table 12) is varied across the region, but there has been an overall improvement in the level of reserved land in each (see Figure 19). Biogeographic regions having a high or medium priority for increasing the conservation reserve system network have provided the focus for land acquisition, with other regions identified as low priority, and thus having no additional land acquired.

Figure 19. Area of land in the conservation reserve system by biogeographic regions.



12.4 Improvement in representativeness across the region

At the beginning of the land acquisition program, of the 259 vegetation types occurring within the Strategy region, 74 (28.6%) were protected within the existing conservation reserve system. However, of these only 19 (7.3%) had more than 10% of their area within the conservation reserve system. That is, 92.7% of the vegetation types occurring within the region were either not represented at all or were under-represented.

At the end of June 2003 there are an additional 72 vegetation types within the reserve system, bringing the total to 146 or 56.4% of all vegetation types in the region of which 82 (31%) have more than 10% of their area represented.

In summary, the overall levels of representation (expressed as a percentage of their original area) are:

- 82 of 259 vegetation types have > 10% in the conservation reserve system;
- 8 of 259 vegetation types have 7.5 – 10% in the reserve system;
- 9 of 259 vegetation types have 5.0 – 7.5% in the reserve system;
- 19 of 259 vegetation types have 2.5 – 5.0% in the reserve system; and
- 28 of 259 vegetation types have 0.0 – 2.5% in the reserve system.

The remaining 113 (43.6%) vegetation types are not represented at all in the conservation reserve system.

Vegetation types having an area of less than 50,000 hectares are considered to be restricted in distribution making them vulnerable to the effects of overgrazing or regular controlled burning (A. Hopkins pers. comm.). Of the 146 vegetation types now included in the conservation reserve system 62 have an areal extent of less than 50,000 hectares. Fifty-one of those vegetation types of less than 50,000 hectares area are now represented in the conservation reserve system at greater than ten percent.

There are 83 vegetation types with restricted distribution (less than 50,000 ha) remaining outside the conservation reserve area system throughout the Strategy region. Fifteen of these occur in more than one IBRA region. Table 13 indicates their distribution in the Strategy region. This information can be used to direct further investigations into land acquisition opportunities once all assessment criteria have been investigated.

Table 13. Restricted distribution vegetation types remaining outside the conservation reserve system

IBRA region	Priority for reservation	No. of restricted-distribution vegetation types
Avon Wheatbelt	1	6
Carnarvon	1	23
Gascoyne	1	19
Murchison	1	24
Geraldton Sandplain	2	9
Yalgoo	1	17

Table 14. Pastoral leases containing three or more restricted vegetation types remaining outside the conservation reserve system

Pastoral lease	No. veg. Types	IBRA region(s)	Pastoral lease	No. veg. Types	IBRA region(s)
Ballythunna	4	Mur. Car. Gas.	Mellenbye	6	Avon Wh. Yal.
Bidgemia	4	Car. Gas.	Millbillillie	3	Mur.
Byro	5	Mur.	Mt. Gibson	4	Avon Wh. Yal.
Carey Downs	4	Car. Gas.	Ninghan	3	Avon Wh. Yal.
Coburn	4	Car. GS. Yal.	Prairie Downs	6	Gas. Pil. GVD. Mur.
Coolcalalya	3	Yal.	Tallering	7	Yal. Avon Wh.
Curbur	3	Mur.	Tamala	3	GS
Dairy Creek	4	Car. Gas.	Tangadee	3	Gas.
Gabyon	3	Yal.	Towera	3	Gas. Car.
Hamelin	6	Car. GS. Yal.	Turee Creek	3	Gas. Pil.
Jimba Jimba	5	Car.	Windimurra	3	Mur.

On a lease basis, those (leases) containing more than three restricted vegetation types that remain outside the reserve system are shown in Table 14. Some of the vegetation types occur on more than one lease.

12.5 Areas of high biodiversity value in the region

Tinley (2003 unpublished) has identified a number of areas throughout the Strategy region that contain high biodiversity. Of those in pastoral areas, many remain outside the conservation reserve network. In some instances, areas occurring over a number of pastoral leases have been identified as significant for inclusion in the conservation network.

Areas identified by Tinley that are contained within rugged hills and ranges are likely to be a low priority for acquisition as the impacts of pastoral grazing are minimal and localized. It is recognized however, that the impacts of feral animals will continue in these areas without active ongoing management.

12.6 Regional overview of key gaps, priorities and opportunities for further land acquisitions

It is clear from the information presented in sections 12.4 and 12.5 that the establishment of a comprehensive, adequate and representative conservation reserve system is still some way off – there are major gaps in the level of representativeness of the full array of ecosystems in the region.

In keeping with the use of vegetation types as a surrogate for ecosystem diversity, those having restricted distribution (less than 50,000 ha in area) have been identified and sorted by IBRA regions. The same exercise has been conducted for pastoral leases containing three or more of the restricted distribution vegetation types, thus providing targets for further assessment and potential acquisition. This exercise could be conducted to identify those leases containing one, two or more vegetation types of restricted distribution, but for this exercise only leases with three or more restricted vegetation types have been identified.

Now that the acquisition program has come to a conclusion, any further purchases for conservation management will have to clearly show significant improvement in the level of representation of ecosystems, or the inclusion of features that have been identified as important through ongoing planning activities or social pressures. For example, areas of high international importance such as migratory bird sites or containing important geological features, particularly where such areas or features are under threat of alteration from activities such as pastoral grazing, clearing or mining.

Further work will be necessary to identify the best remaining options for acquisition while this policy remains supported by State and Commonwealth governments.

12.6.1 IBRA regions having high priority for increasing the reserve system

A brief overview is given here of the high priority IBRA regions.

Carnarvon

This region is comprised of moderate to very high pastoral potential country that has been well developed for pastoral activities. Pastoral country in this region is tightly held particularly where pastoral potential is high or very high. The region has also seen the introduction and spread of buffel grass *(Cenchrus ciliaris)* to the detriment of native grasses and shrubs; that is, there has been a reduction in biological diversity that will be difficult, if not impossible, to reverse. The successful establishment of buffel grass has improved the stock carrying capacity of leases to the point where their economic value has been increased as a result.

Many properties within this region have considerable areas of land that have been degraded with extensive surface soil stripping evident on many. Much of the land in this IBRA region is not suitable for inclusion in the conservation reserve system due to the decline in ecosystem function, loss of soil, and a reduction in biological diversity.

Opportunities for the acquisition of high pastoral value land have been limited and where they have arisen, the high level of disturbance, occurrence of introduced plants, and high economic value has resulted in very little being acquired.

At the end of 2003, approximately 872,000 hectares of land is included in the reserve system, representing 11.62% of the region. An additional 253,646 hectares of pastoral land is required to bring the total area of conservation land to 15 percent.

There are 23 restricted distribution vegetation types (less than 50,000 ha) within this region that remain outside the conservation reserve system. Some of the leases occurring entirely or partially within this region containing more than three of these vegetation types have been assessed and evaluated but due to extensive land degradation no further action has been taken.

Gascoyne

Much of this region is comprised of low or very low pastoral value country. Dominant vegetation is mulga in open woodlands on shallow earthy loams over hardpan, with *Eremophila* shrublands on the shallow stony plains. The eastern portion of the region is characterized by extensive salt lake systems supporting succulent steppes.

Approximately 1,760,000 hectares of land is within the conservation reserve system at the end of 2003 representing 10.6% of the region. An additional 730,000 hectares is required to bring the area of land within the conservation reserve system to 15 percent.

Nineteen restricted distribution vegetation types occurring within the region remain outside the conservation reserve system. Preliminary assessments of leases containing three or more restricted vegetation types indicate highly modified landscapes with erosion and introduced plants.

Murchison

This region is the largest in the Strategy region and is comprised of mostly moderate and high pastoral value country in the western two thirds, with very low and low pastoral value country in the eastern portion. The better country particularly along river frontages is mostly heavily impacted by grazing and is degraded.

About 1,375,000 hectares of land in this region is within the conservation reserve system representing 7.5% of the regional area, well under the target value of ten to fifteen percent. An additional 1,390,000 hectares is required to achieve 15% of the region.

Twenty-four restricted distribution vegetation types remain outside the conservation reserve system. A number of pastoral leases with potential for acquisition have had formal assessment completed, while others have had preliminary assessment completed. Opportunities to purchase leases containing high conservation values exist within this region although this will be difficult to achieve given the current political imperatives for the strict adherence to fiscal procedures.

Tinley (2003 unpublished) has identified some areas of very high diversity within this region but, due to fiscal constraints, no progress has been made in acquiring these leases.

Yalgoo

The Yalgoo region comprises a range of pastoral value country from very low to high and occurs in a part of the state considered to be a botanical interzone between the south-west and eremean botanical districts. The southern portion of the region is characterized by vegetation types now extensively cleared in the adjoining agricultural zone thus making this region of high importance for conservation of biodiversity.

Conservation land in this region is about 680,000 hectares representing 17.73% of the total area. This implies that the objective of reserving 15% of the region has been met, but on further analysis many vegetation types remain outside the conservation reserve system. Seventeen restricted distribution vegetation types remain outside the conservation reserve system, with one pastoral lease primarily in this region containing seven restricted vegetation types. Preliminary assessment of rangeland condition of leases containing three or more restricted distribution vegetation types indicate that there would be value in completing more thorough assessment and evaluation of these leases. Only one of these leases has been

offered for sale, with an indicated high economic value making it doubtful that government could purchase the property.

Avon Wheatbelt

The majority of this region lies within the agricultural zone of Western Australia and has been extensively cleared for the production of grains and wool. The region is rich in endemic flora. About 440,000 hectares of this region occur within the Strategy area making up just 0.75% of the total.

At 2003 the region contained about 46,000 hectares of land within conservation reserves, or 10.37% of the region. An additional 20,500 hectares is required to achieve the 15% target. There are limited opportunities within this region for increasing the area of the reserve system, however six restricted distribution vegetation types are not managed for conservation objectives within reserves. The management of parts of leases important for conservation by pastoralists under some form of conservation management agreement with the Department of Conservation and Land Management, or alternative grazing regimes developed through the Regional Environmental Management Program of the Strategy, appear likely to provide the best outcome.

Pilbara

Only a small proportion of this region occurs within the Strategy area representing 0.5% of the total area (abt. 300,000 ha). No land has been acquired in this region as part of the Gascoyne-Murchison Strategy land acquisition program .

12.7 Results

At the Strategy region level, 113 (43.6%) vegetation types remain totally unrepresented in the conservation reserve system and only 82 vegetation types (31%) are represented at greater than 10% of their original areal extent.

When the high priority biogeographic regions are considered, it is also clear that major gaps remain in the reserve system, even where the level of reservation is near to or exceeds the target of 15 %.

The goal of the Gascoyne-Murchison Strategy is to achieve a conservation reserve system making up between 10 and 15% of the Strategy region, (the objective to have at least 10% of each ecosystem represented in the conservation reserve system is set out in the National Strategy for the Conservation of Australia's Biological Diversity (ANZECC and ARMCANZ 1999); less than 10% of the region is now within the reserve system.

The results also indicate that the careful selection of pastoral leases containing high diversity which complement the conservation values contained within the existing conservation reserve system has resulted in a doubling of the number of

vegetation types (from 74 to 146) now managed for conservation. Of the number of vegetation types now within the conservation reserve system, 82 have greater than 10% of their areal extent represented. This is a significant increase as there were only 19 vegetation types in the conservation reserve system at the beginning of the acquisition program represented at greater than 10 percent.

Of the 62 vegetation types having restricted distribution now within the conservation reserve system, 51 have greater than 10% representation.

12.8 Conclusion

A significant improvement in area of land within the conservation reserve network has been achieved through the land acquisition program of the Gascoyne-Murchison Strategy. Within this land many ecosystems not previously managed for conservation, or which were represented at less than 10% of their original area, are now included or have had their area of representation improved to greater than ten percent.

At the regional level, the conservation reserve system is still not comprehensive with a significant number of ecosystems not represented at all, or not sufficiently represented. While a number of pastoral leases are identified which have a range of diversity in terms of the ecosystems they contain, further investigation into a range of selection criteria, including the impacts of pastoralism, will be necessary. The Department should consider discussing the management of areas having high conservation value on pastoral leases not available for acquisition with the aim of conserving these values in the long term.

The continued support of government will be necessary in order to make further gains in improving the level of comprehensiveness of the reserve system.

Chapter 13: Future Management in the Rangelands

13.1 Introduction

At the national level there is acknowledgment that Australia's rangelands are a neglected asset, and that their continuing degradation is an urgent problem requiring a coordinated national response. The Commonwealth Government agreed to work with State and Territory governments, industry, Aboriginal people and special interest groups to develop a National Strategy for Rangeland Management. The release of the National Principles and Guidelines for Rangeland Management in 1999 (ANZEEC and ARMCANZ) provides a strategic framework to guide stakeholders to facilitate and manage change in the rangelands to ensure future options are maintained.

If there is to be a future for the pastoral rangelands there must be sufficient effort by governments, industries and interested stakeholders to ensure that the economic, social and environmental pressures placed on the natural resources are balanced, and that land management is focused on sustainable outcomes and the conservation of biological and cultural heritage (Pringle *et al.* 2003).

There is an urgent need to recognize that much of the rangelands have been, and are being, altered with a resultant loss of biodiversity, increased erosion, reduction in carrying capacity, decline in economic return, and loss of people and services. The recognition of the need for action should translate into the implementation of the recommendations from the many inquiries into the industry, as well as reviewing policy and practices that can be used to address the need for a sustainable future. Future planning for a viable and sustainable industry capable of addressing the issue of ecologically sustainable management must involve rangeland communities, government and the broader community in order to address these issues in an integrated and strategic way. Without a strategic and holistic approach to environmental management, many of the state's conservation reserves will become islands of remnant species with little hope of conserving our diminishing biodiversity. Issues such as sustainable pastoralism, conservation of biodiversity, rehabilitation, pest plant and animal control have been repeatably identified in strategic documents such as the R and D for Sustainable Use and Management of Australia's Rangelands (1994), Managing the Rangelands (Anon. 1999), National Principles and Guidelines for Rangeland Management (ANZEEC and ARMCANZ 1999), Regional Environmental Management Program of the Gascoyne-Murchison Strategy, and the Western Australian State Sustainability Strategy (Government of Western Australia 2002). There is an identified need for governments, both State and Commonwealth, to show leadership in addressing these issues and while progress is being made under

some programs, particularly the Regional Environmental Management Program, much more needs to be done.

This chapter outlines some of the key issues for consideration in future planning for sustainability.

13.2 The future of rangelands in the Gascoyne-Murchison region

13.2.1 Pastoralism

It would be folly to ignore the findings of the many inquiries into the pastoral industry, particularly the wool and sheep sector, much of which appears to continue in an economically marginal or unviable state, while maintaining pressure on the natural resources of the region. There has been considerable economic evaluation of the industry that indicates a significant number of leases do not have a viable future.

The underlying crisis for the pastoral wool industry is the continual worsening of terms of trade (Jennings *et al.* 1979; Anon. 1993) affecting the industry. The terms of trade has been moving against the wool industry at around 4% per annum over the last 30-40 year period (Pastoral Wool Industry Inquiry, Anon. 1993). These terms have declined because the prices received for wool have increased at a much slower rate than the cost of production inputs resulting in a steady decline in profit margins. As these terms of trade are relatively small, the effect on annual income, which can vary substantially from year to year for a number of reasons, may not be recognized. When coupled with a high level of vegetation degradation in parts of the region, the vicissitudes of climate, a declining workforce and low commodity prices, the outlook for a sustainable industry looks grim. The evidence of the declining profitability of the pastoral wool industry is obvious from the lack of capital investment and increasing indebtedness (Pastoral Wool Industry Inquiry, Anon. 1993).

Lack of capital investment has resulted in much of the infrastructure developed during earlier periods, when the industry was showing good profitability, being in poor condition. Replacement or repair costs have now risen to a point where it is too costly to carry out these activities. This is in spite of the condition attached to all pastoral leases that all infrastructure be maintained in good repair; the Pastoral Lands Board has not enforced compliance with this requirement.

The condition of the natural resource on which the industry is based, and the size of pastoral leases, provide little opportunity for pastoralists to increase the size of their flock to a level considered necessary for viability. This leaves lessees with little opportunity to change the pattern of resource usage (such as addressing total grazing pressure) such that it is not further depleted causing even greater loss of biodiversity and reduced productivity. The concept of sustainable development

is that the environment should be managed so that resources are maintained or improved, while sufficient dividends from resource use arise (Dovers 1990; McNeely *et al.* 1990).

The concept of total grazing pressure exerted by native and introduced (both managed and feral) herbivores on the indigenous vegetation requires greater understanding by pastoralists. The control of grazing pressure, while a fundamental requirement if rangeland resources are not to be further degraded, is rarely evidenced with pastoralists showing little regard for grazing impacts on vegetation, but maximum regard for short term economic considerations (Harrington *et al.* 1984; Bartle 2004). Overgrazing perennial grasses and shrubs is the prime cause of degradation and the reduction in productivity of the semi-arid woodlands. The control of animals to reduce grazing pressure, particularly in periods of drought, must include kangaroo and feral goat populations. It is well recognized that the broader, sympathetic and sustainable management of pastoral land is necessary for many species to survive in the long term.

The Western Australian Environmental Protection Authority (2002) recognizes that the state's 'ecological footprint' indicator suggests our economy is not utilizing natural resources sustainably, and that government will need to ensure the economy is more ecologically and socially sustainable. There is recognition that land management practices aimed at an economically sustainable business enterprise do not necessarily coincide with management necessary to achieve an ecologically sustainable landscape (EPA 2002). There are challenges confronting contemporary land-use in relation to the need to maintain sustainable grazing practices while at the same time maintain ecological sustainability at the regional scale. The establishment of a regional conservation reserve system consistent with the principle of being comprehensive, adequate and representative, will be of value to the pastoral industry in establishing its credentials as an industry that is sensitive to the broader issue of conserving biodiversity.

A set of principles outlined by the Western Australian Environmental Protection Authority (2002) recognizes the need for shared responsibility for environmental protection between government, industry and regional communities. Close cooperation between these sectors is necessary so that land users are aware of the objectives for overall ecological sustainability. The need for careful consideration of the way rangelands are managed for pastoral activities in the future must take into account issues of ecologically sustainable production, the productive capacity of the vegetation as it relates to carrying capacity, the need to consider stock management in the context of climate and to seek a sustainable balance between economic returns, the environment, and social needs expressed by the broader community.

The Western Australian government has established a Sustainable Pastoralism working group to provide advice and guidance to government and industry to achieve sustainable land management.

13.2.2 Alternative views of the industry

The perception of the broader community about the continued degradation of the rangelands causes many to consider why governments allow the continuation of the industry. Some have even proffered their view that the industry should be closed down, resulting in some reduction of grazing pressure on the environment, and reduce the financial and administrative burden on the state which is seen as supporting a moribund, even terminal industry (Auty 1994). Auty (1994) puts forward a plan for maintaining a population in the rangelands if much of the pastoral industry were to be closed down, engaged in shutting down artificial waters, controlling feral animals, and developing tourism.

13.2.3 Viability of the industry

Many pastoral wool enterprises based on less than 10,000 stock units continue to struggle for viability today (Pastoral Wool Industry Inquiry 1993; EPA 2000). At the outset of the Gascoyne-Murchison Rangeland Strategy (1997) it was recognized that the economic situation of the industry was critical, and that almost all wool growers recorded a net business loss in 1991-92, with 40% recording negative incomes. The predicament of the pastoral wool industry is not new, and issues confronting it are the same now as those identified by Jennings *et al.* (1979). It is suggested that improvement in wool prices following 1979 diminished the urgency to resolve the problems faced by the industry, and therefore the findings of earlier inquiries into the industry were disregarded (Gascoyne-Murchison Rangeland Strategy 1997). While short-term increases in wool prices reduce the imperative for action by governments, the underlying problems of the industry continue.

The Gascoyne-Murchison Strategy proposed *inter alia*, a structural adjustment package aimed at allowing leases that were clearly unviable to be purchased, then allocated to adjoining leases thus improving the viability of the enlarged leases. A theoretical analysis was undertaken to identify the extent of the adjustment required which resulted in an estimate of 66 leases requiring adjustment to achieve a sustainable industry in the Strategy region. The analysis used a benchmark area within different Land Care Districts that assumed a minimum area required for a lease with average land resources, animal production and business costs, needed to generate a financial surplus of five percent of gross income. Recommendation 3 of the Strategy proposes that leases be restructured to increase the area and thus the number of stock carried with the goal of making each lease viable. At this point in time there has been very little lease adjustment with only one lessee entering into this process with the aim of acquiring part of a neighbouring lease.

Governments must review the return from the pastoral industry to the State's economy in relation to the adverse environmental impacts arising from the mismatch between total grazing pressure and the long-term productive capability

of the land. If establishing leases of larger area with concomitant higher stock numbers (based on carrying capacity and not just area) results in a decrease in pressure on natural resources while at the same time increasing economic viability, then there is a need for decisive action by government. Considerable effort is necessary to gain a better understanding of rangeland ecosystems and the long-term productive capacity of the vegetation if this is to be achieved.

Pastoral lease tenure as well as stock carrying capacity has been an administrative issue for governments for some time (Final Report on Pastoral Land Tenure 1986). However, the state has maintained a pastoral industry based on term leases, originally administered from London in the form of Colonial Office Circulars, to the present day. The term of pastoral leases has been incrementally increased since 1851, eight years, 1872, fourteen years, and then a common expiry date was introduced in 1882. The 1917 amendments to the Land Act 1898 allowed for the surrender of an existing lease and the granting of extended tenure to 31 December, 1948 – the 50 year lease. Amendments in 1932 again extended lease tenure to 31 December 1982, then further amendments in 1963 provided for leases to be extended from 1982 to 2015. At the time of the 1963 Amendments it was proposed that the government should fix a minimum economic pastoral unit at 6,000 sheep. Unfortunately many leases still exist today with far fewer stock numbers than recommended at this time (Curry *et al.* 1994; Payne *et al.* 1994; Pringle *et al.* 1994; Van Vreeswyk and Godden 1998).

Governments have not been able to bring about the necessary adjustments to lease area and viable stock numbers based on carrying capacity, and virtually all existing leases will now be extended after 2015. The opportunity to review this important issue has not been taken up at a time when there is national and state recognition of both land degradation arising from overgrazing, and considerable difficulty within the industry to maintain economic sustainability. Achieving the goal of sustainable management must be addressed through the review of the full range of ecological and socio-economic issues (Noble 1994; Walker 1996; Stafford-Smith 1994).

13.2.4 Research and monitoring

Stafford-Smith (1994) suggests that there is a need to classify rangelands into appropriate regions to address issues such as production potential, conservation value, resilience of vegetation in the face of grazing pressure and social-economic viability. Walker (1996) recognizes conflict arising from the need for pastoralists to remain economically viable, with the goals of the broader community wishing to conserve biodiversity. One option is to classify different landscapes by their economic viability and their conservation value (Ludwig *et al.* 1997). Where landscapes of low economic viability have a coincidentally high conservation

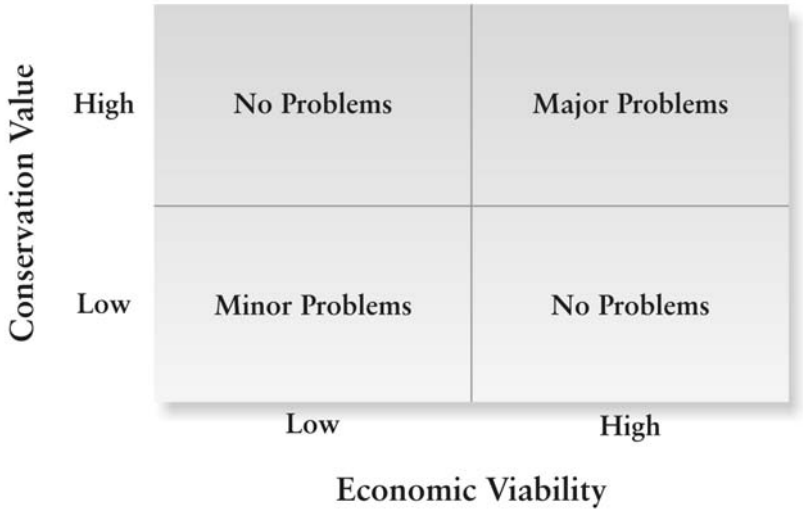
value, it is unlikely there will be conflicts over land use. Landscapes with high economic viability but low conservation value are similarly not likely to have major conflicts over land use. However, major conflicts over land use are likely to arise where a landscape has high economic viability as well as high conservation value (see Figure 20). The successful integration of land use management will require a cooperative approach if both land use objectives are to be achieved.

A survey of rangeland research activities undertaken by government departments and universities was conducted by the LWRRDC (Land and Water Resources Research and Development Corporation 1994). When all responses (85.5% response) were pooled, two themes – grazing impact / management, and biodiversity / multiple use - were identified as having the highest priority for future research. These two themes remain a major priority for action, and are identified, among other issues, in the National Principles and Guidelines for Rangeland Management (1999). Other issues identified in the National Principles and Guidelines document include regional planning processes, managing change, and the need to address land tenure.

Economic viability

Walker (1996) suggests that the same approach to ecologically sustainable and economically viable development can also be applied at the paddock scale. Ludwig *et al.* (1997) maintain that a thorough understanding of the way landscapes function will greatly assist in determining land uses which are ecologically sustainable under grazing pressure. Clearly, there is an urgent need for research aimed at providing an understanding of how landscapes function, which in turn

Figure 20. Conflicts arising when economic viability and conservation values are compared (Walker 1996).



assists in determining ecologically sustainable land uses and how these relate to economic potentialities for the pastoral industry. Political and social analyses help determine what land uses might be possible (Ludwig *et al.* 1997).

Indicators of sustainability

The identification of reliable and easy-to-measure indicators of how rangeland ecosystem condition changes over time is an urgent research need (Ludwig *et al.* 1997; ANZEEC and ARMCANZ 1999). Reliable indicators can then form the basis of monitoring programs, the results of which must then be integrated with sustainability goals and adjustments made to production programs providing a balance between ecological and socio-economic outcomes when necessary.

Where there is evidence of continued degradation of the landscape, or where a degraded landscape is not recovering under the existing grazing regime, action to reduce total grazing pressure, including changes to stocking levels and control of feral and native herbivore numbers, will be required. The need for the identification of sustainability indicators based on landscape function will lead to the early identification of the way in which a landscape is functioning (Ludwig *et al.* 1997). The early prediction of declining landscape function, or loss of biodiversity, would provide land users and administrators with a powerful indicator of the need to change management regimes. This is in part the objective of the Regional Environmental Management Program of the Gascoyne-Murchison Strategy and the Environmental Management Unit (EMU) that has been developed to achieve ecologically sustainable land use (Pringle and Tinley 2001). The process developed by Pringle and Tinley (2001) emphasizes that diversity is dependent on replacement, requiring systems to recover from the effects of grazing.

Unfortunately, even though there have been early warning signs of land degradation and loss of biodiversity in the Western Australian rangelands (Fyfe 1940; Durack 1945; Wilcox 1964; Wilcox and McKinnon 1972; Jennings *et al.* 1979), pastoralists and land administrators have not addressed the need for changing grazing management regimes, even when current land uses are clearly unsustainable in parts of the landscape. The Environmental Management Unit process is addressing these issues with pastoralists (Pringle and Tinley 2001).

Information about monitoring programs and the changes in range condition over time must be made available to all stakeholders in a form that is clearly understood. Where necessary, education and extension programs for land managers and the broader community should be developed. Pastoralists working with the Environmental Management Understanding program (Pringle and Tinley 2001) are encouraged to monitor changes in vegetation and landscape using a range of short-term early warning and longer-term factors. They are encouraged to continue with any monitoring they may have already been involved in as this is seen as a means of learning more about grazing management practices and

landscapes. The Department of Conservation and Land Management needs to consider the gains made in imparting knowledge about how landscapes react to pastoral management, how different landscape components are interlinked, and to utilize the benefits of lessees' local knowledge.

As the rangeland pastoral industry is conducted on Crown land, land that is fundamentally public land, there is continued and growing concern by the public about how this land is managed under existing lease arrangements. As well as the need for responsible stewardship by pastoralists, the broader community also has concerns about access for recreation and tourism.

Christensen *et al.* (1996) considers that to move from the general rhetoric to modifying management activities on the ground will require defining sustainable goals and objectives, and the identification of appropriate management and monitoring programs. This will require input from all community sectors with an interest in sustainable rangeland management.

13.2.5 Conservation of biodiversity

Off-reserve conservation

Regional biodiversity conservation must be addressed through the establishment of a comprehensive, adequate and representative reserve system, complemented by off-reserve conservation measures including the broader ecologically sustainable management of all rangeland landscapes (Anon 2003; Pringle and Tinley 2001; Pringle *et al.* 2003). The land acquisition program of the Gascoyne-Murchison Strategy (1997) has delivered a conservation reserve system that has improved the level of representativeness of regional ecosystems. However, opportunities for the development of the conservation reserve system aimed at further improving overall comprehensiveness, adequacy and representativeness should continue to be a priority of government with adequate resources provided by both State and Commonwealth governments.

Biological diversity and the threats to it extend across land use boundaries. At the beginning of the Gascoyne-Murchison Strategy implementation phase, about three percent of the region was within the conservation reserve system. Now at the end of the five-year life of the Strategy, an additional 3.8 million hectares of pastoral land with identified conservation values, has been acquired for inclusion in the reserve system. Once this land is included in the reserve system, about eight percent of the region will be within the conservation reserve network. The remainder of the region is managed for a range of outcomes, with pastoralism the most extensive activity. Part of the region consists of Unallocated Crown Land with little management input, part is managed for the extraction of a range of minerals, and part is managed as Aboriginal living areas, often involving a degree of pastoralism. That is, about 92% of the region is not within the protected area network.

According to Burgman and Lindenmayer (1998), an audit of our conservation reserve system will show that many species, including rare species, are not represented at all or are under-represented in the conservation reserve system. They maintain that about 40% of all endangered plant species are within protected areas in Australia.

Even if it were possible to achieve the reservation of 15% of the original pre-European extent of all vegetation types, the remainder is outside the protected area system. Therefore, the conservation of biodiversity management on all land is an important objective for land managers. Burgman and Lindenmayer (1998) state that "the failure to take account of the potential conservation value of off-reserve areas could result in substantial losses of biodiversity" (p. 68).

Species most likely to persist in conservation reserves will be those that have had their habitats maintained in adjoining areas (Diamond 1987; Laurence 1991). Therefore the need for cooperative management of the environment across land use and administrative boundaries is particularly important if conservation of biodiversity is to be successful.

There are social and political barriers to effective management of off-reserve areas, and the attitude and behaviour of many land holders towards managing parts of the land they utilize for pastoral production for biodiversity conservation as well, is not positive. However, this attitude is slowly changing, particularly as a result of the Regional Environmental Management Program work.

Some of the more productive land utilized for grazing can make an important contribution to conservation and the maintenance of ecological processes. This land is usually tightly held, often modified by intensive grazing over a long period of time, and are areas that are likely to be under-represented in the reserve system (Wilson *et al.* 1984; Pringle 1995).

The Gascoyne-Murchison Strategy recognized that conservation reserves alone would not result in the protection and maintenance of biodiversity and proposed the development of an off-reserve program. Identifying pastoral land containing areas of potential high conservation value is a necessary step in providing information that may lead to management agreements between pastoralists, mining companies or Aboriginal people for the protection of important components of the landscape and conservation of biodiversity overall.

Tinley (unpublished) has begun the identification of land surfaces containing potentially high biodiversity across the region. These areas are referred to as hotspots, or centers of diversity. The resultant description of hotspots is useful not only in identifying land for potential acquisition, but also in conjunction with the use of the vegetation surrogate to identify areas important for conservation outside the conservation reserve system.

The approach is based on a map overlay technique involving seven different

layers of information. When all layers are in place, the areas with the coincidental occurrence of the largest number of physical and vegetative features identify the areas having the highest landscape diversity. Areas containing potentially high levels of diversity are considered to occur where there is a conjunction of:

- wide variation in terrain relief and soil types;
- high geodiversity – high diversity of near-surface rock types which contribute to a range of soil types;
- high interspersion of different vegetation types and land systems;
- high species richness, endemic plants or animals or significant outlier populations, where known; and
- other unique features including ungrazed or least-grazed areas remote from water.

The synoptic ecosystem approach is based on a number of premises (Tinley, unpublished) including:

- vegetation type reflects climate;
- ecojunctions are areas of potentially highest biodiversity – these are areas of confluence between a number of different ecosystems;
- juxtaposition of land systems provides high ecotonal diversity;
- ecotones can develop new habitat features;
- the hydrologic process is the result of water movement across the landscape;
- ecosystem physiognomic features integrate flora and fauna into the community;
- the geomorphic landscape is the base for biogeoclimatic processes.

The synoptic ecosystem approach has been used in Western Australia to indicate areas of highest habitat diversity as part of a biological survey conducted by a mining company in the Pilbara region (Tinley 1991). Subsequent surveys discovered one of the richest herpetofaunal assemblages recorded in Australia and was the result of the close juxtaposition of high geomorphic and vegetation diversity (How *et al.* 1991).

The identification of areas of potential high biodiversity provides the focus for developing working relationships between pastoral lessees and the Department of Conservation and Land Management aimed at conserving biodiversity values in the long term. Historically, Departmental personnel have not been particularly successful in interacting with pastoralists on matters of conserving biodiversity, and will need to become much more aware of the opportunity to make significant gains for conservation through this process.

Providing positive incentives for lessees to conserve native vegetation in its natural state through formal agreements requiring destocking, is most often quite difficult due to the existing economics of the pastoral wool industry. The provision of compensation for grazing values that may be forgone if an area important for conserving biodiversity is to be destocked, is increasingly difficult due to existing

government budgetary constraints. Where identified hotspots occur on country of low or negligible pastoral value it has been possible to enter into conservation management agreements with pastoralists under section 16A of the Conservation and Land Management Act.

Section 16A agreements are legally binding on the parties and provide for long-term conservation management security over the area. The agreement provides for a caveat on the land title so that it may continue in the event of a change of lessee. The role of the Department of Conservation and Land Management is to provide advice and assist with the development of suitable management activities such as the control of feral animals or weeds.

Only two section 16A conservation management agreements have been established with pastoralists, both involving land of little pastoral value. The agreements contain management direction clauses which set out activities that may or may not be conducted, and have an exit provision included in the deed of agreement.

Other less formal conservation management options exist such as a Memorandum of Understanding, and are used in a number of instances where mining companies are leasing pastoral properties as part of their mining activities. These agreements are more flexible than CALM Act section 16A agreements, in relation to management opportunities and timeframes, and are not binding. While they serve as an important arrangement between the two parties in sharing information and in cooperative management, particularly of land adjoining existing conservation reserves, they may be discontinued at short notice.

It should be noted that the activities of the Environmental Management Unit have resulted in six projects aimed at conserving biodiversity within pastoral leases now funded by the Commonwealth through the Natural Heritage Trust. These projects have been developed through cooperation and genuine concern about the environment and are completely voluntary. The techniques and approach taken to achieve these outcomes can be extended and utilized by Department of Conservation and Land Management staff engaged in nature conservation activities.

Opportunities for developing off-reserve conservation agreements with pastoralists require considerable ongoing commitment and effort, particularly by government agencies. The identification of a number of regional landscapes considered to have potentially high biodiversity has been completed but will require further refinement at the property and paddock level. The development of opportunities for off-reserve conservation management agreements arising from this process will be the subject of continued interaction between relevant government agencies and pastoralists.

Broader land management

Ecologically sustainable pastoral management is a requirement of the Land Administration Act (1997). Adjusting stocking rates and adopting land

management practices that encourage the regeneration of land adversely affected by natural and enterprise pressures are necessary actions required of pastoral lessees. Furthermore, recent policy developments aimed at achieving a better balance between environmental and socio–economic issues for a sustainable future have been developed (Anon. 1998; ANZEEC 1999).

The Gascoyne-Murchison Strategy acknowledges the Environmental Protection Authority's development of environmental criteria for biodiversity conservation and ecological sustainability. The Strategy recognizes the need for new natural resource information and the development and acceptance of environmental objectives for broad-scale land uses in the region.

One of the key components of the Strategy is the Regional Environmental Management Program aimed at developing and implementing more enlightened environmental management practices throughout the region (Pringle *et al.* 2003). Curry and Hacker (1990) showed that most native plants and animals persist when the structure and composition of native vegetation is maintained. In order to address the issues of stewardship of the land, improving productivity and reducing costs, Pringle and Tinley (2001) describe an approach to managing pastoral land within the context of ecological sustainability, based on the need to maintain diversity dependent on the recovery and replacement process following periods of grazing. Using knowledge about the country, built up over a long period of time, pastoralists are encouraged to look at their country from a different perspective to improve their awareness of the various components of ecosystems and how different ecosystems are interlinked. Understanding pastoral management problems aimed at achieving sustainable outcomes for their enterprise and the environment are encouraged and discussed. Ongoing support to maintain interest in improving pastoral land management is provided, and pastoralists are encouraged to monitor particular issues that they are addressing.

The identification of areas containing important conservation values is also an outcome of the process developed by Pringle and Tinley (2001). This may lead the way forward in establishing a real commitment to conservation management by pastoralists who could work together with appropriate government agencies to achieve important conservation objectives. Monitoring outcomes of this process will be necessary to evaluate the overall impact and success of the approach and make further sensitive adjustments to grazing management as necessary.

Pastoralists wishing to develop pastoral management activities into a formal property management plan as part of an Environmental Management System are encouraged to do so as part of a process aimed at improving their environmental credentials (Taylor 2002). Being able to show that management practices at the enterprise and industry level take account of the need to address ecological sustainability issues is becoming increasingly important, and may ensure access to certain markets demanding evidence of responsible environmental management.

Responsible stewardship by land users is an increasingly important political and social issue which must be recognized by all land managers including those involved in the pastoral, mining, tourism, conservation and cultural management arenas. The broader community has the right to expect that environmental costs are evenly distributed and that one industry sector does not make all the economic gains at the expense of the environment while the general public are left with the costs of rehabilitation or loss of future production opportunities.

There is an urgent need for governments, as the landlord of Crown land, to develop objectives and guidelines for ensuring ecologically sustainable outcomes across the pastoral zone are achieved in balance with socio-economic values and requirements. Understanding the need for sustainable production, along with implementation of actions aimed at achieving broader sustainable land-use goals, will see a move towards conserving biodiversity.

13.3 Pastoral lease renewal at 2015

All pastoral leases in Western Australia expire on June 30, 2015. Pastoral lessees have been notified over a period of time that parts of selected leases containing important conservation values (as well as other values not discussed here) would be excluded from the lease at the time of renewal. Many of the proposed areas for exclusion have been in the public arena for many years, including those put forward by the Environmental Protection Authority in the mid 1970s (Reports of the EPA Conservation Through Reserves Committee). There are a number of other leases, mostly in the south west of the state, which will not be renewed in 2015. Of all the pastoral leases, a total of 57 are identified as having areas of high conservation value (covering an area of about 1.5 million hectares). Many of these high conservation value areas will be excluded from the lease in 2015; some areas will be managed under a cooperative management agreement between pastoralists and the Department of Conservation and Land Management. Many of the areas of interest for conservation management have been assessed in relation to the conservation values determined by detailed biological assessment carried out either by the Department of Conservation and Land Management or the Environmental Protection Authority.

Pastoralists have the option of either accepting the exclusion of land from the pastoral lease, in which case the remainder of the lease will be renewed from July 1, 2015; or, withdraw from the lease from June 30, 2015; or, enter into negotiations on the area to be excluded from the lease, or the rent to be paid, as a result of the exclusion.

While a number of lessees have chosen to accept the exclusions as proposed, the majority indicated they wish to negotiate the area of the lease to be excluded, primarily in relation to existing infrastructure. The negotiation process is well

underway, with positive progress in many instances, and it is expected that the excluded areas will make a significant contribution to the existing conservation reserve system.

Even though the exclusions will not occur until 2015, a number of pastoralists have indicated that they are keen to see these areas excluded from the lease as soon as possible, enabling management for conservation of biodiversity much sooner than proposed in the legislation.

Others have indicated a willingness to enter into a formal conservation management agreement with the Department of Conservation and Land Management for the period up to 2015, after which time the land would be excluded from the lease. Small areas of land assessed as critically important for protection of small, often isolated threatened ecological communities, are likely to be managed under a formal conservation management agreement in the long term, providing pastoral lessees are willing to do so.

13.4 Carbon sequestration

The role of carbon credit trading in future land management has already been given consideration by governments in Australia through the National Carbon Accounting System (Australian Greenhouse Office 2002) and the Cooperative Research Centre for Greenhouse Accounting. The Australian Greenhouse Office (2002) acknowledged from the outset that there are substantial gaps in understanding necessary for estimating both carbon emissions and sequestration. Rangeland pastoral activities are considered to be a major challenge for cost-effective opportunities for carbon sequestration, and improvement of grazing management is an important outcome for greenhouse action. While the carbon sequestration potential on rangelands is low per unit area, given their extensive coverage of the state, large sequestration outcomes may be realized (Sampson and Scholes 2000).

Australia has agreed to the need to limit the growth of greenhouse gasses to eight percent above 1990 levels by 2008-20012. All industries in Australia are affected by this decision. Australia's agricultural and pastoral industries contribute significantly (about 20% of total) to overall carbon dioxide emissions (CRC for Greenhouse Accounting undated).

It is estimated that by the first commitment period (2008-2012) carbon credits may be trading for at least A$20 per tonne of carbon (CRC for Greenhouse Accounting).

Vegetation is important in relation to the greenhouse affect as it absorbs carbon dioxide from the atmosphere. A carbon store is built up in plant material both above and below the ground, creating a carbon sink. Recent research has estimated that opportunities may exist to store in excess of 300 million tones of

soil carbon through rehabilitation of degraded rangelands in Australia (Hill *et al.* 2002); however considerably greater research efforts will be necessary to validate this estimate. Changes to rangeland management could have significant impact on Australia's carbon balance. Rangeland sinks are likely to remain difficult to measure due to spatial and temporal variability, and the long period of time taken to build up stored carbon. The major sink potential will result from the reduction and reversal of degradation, and the adoption of management systems aimed at returning native vegetation to something similar to its original state prior to the introduction of domestic stock (Hill *et al.* 2002). Sinks may provide opportunities for carbon trading which will have a positive impact on Australia's economy, improve vegetation condition on degraded rangelands, and conserve biodiversity.

Using a broad-based analytical framework of regional scale based on a model described by Stafford-Smith *et al.* (1997), scientists have attempted to prepare best estimates of rangeland carbon storage (Hill *et al.* 2002). The model is based on the state and transition model of ecosystem change (Westoby *et al.* 1989) that describes rangeland dynamics in terms of different vegetation states occurring over time as a result of management or natural events. Different states of vegetation condition correspond to different carbon storage capacities in biomass and soil. The model utilizes a framework of broad ecosystem definition used in the Atlas of Australian Vegetation (AUSLIG 1990) to define different carbon states and potential transitions.

Within the Gascoyne-Murchison Strategy region four broad vegetation communities are described, viz. mallee, arid mulga, hummock grasslands and saltbush and bluebush. The arid mulga community is the most extensive community in the Strategy region. Within this region it is recognized that pastoral use has led to a decline in perennial understorey plants thus reducing soil carbon. Within the hummock grasslands, the second most extensive community after the arid mulga, it is assumed that carbon storage characteristics have not changed significantly following the introduction of pastoral grazing.

The development of a state and transition model for each community was completed to indicate transitions and drivers of change. The proportion of rangeland communities in different states was based on the results of the Rangeland Condition Survey Reports conducted in Western Australia by the Department of Agriculture. State 1 related to rangelands in good or very good condition, state 2 to rangeland in fair condition, and state 3 to rangeland in poor or very poor condition. Analysis of the model required subjective decisions regarding relativities of the carbon state with an undisturbed ecosystem assumed to have a carbon stock index of 1.0. Changes in the state result from the level of impact from a range of drivers with the time required for change in state defined as: two years for degradation and fifty years for full recovery (Hill *et al.* 2002).

Estimates of current carbon stocks have been generated using the VAST 1.0 (Vegetative And Soil carbon Transfer) (Barrett 1999) model which predicts the magnitude and uncertainty of steady state primary production, biomass, litter mass, soil carbon, and mean residence time of carbon for the continental terrestrial biosphere of Australia.

While acknowledging the limited credibility of information, Hill *et al.* (2002) describe a case study estimate of total carbon for the arid mulga community. In this community the major drivers for change are grazing and drought. Four scenarios are presented with the two drivers for change varied and carbon gains and losses modeled over 50 years. The final scenario assumes no change to climatic variability (frequency of drought occurrence) and the removal of all stock, and shows a potential for an increase in net carbon sequestration equal to 6.4 percent of the present carbon stock, and that total carbon of 23.3 tonnes per hectare or 1.47 giga tones for this vegetation type, is sequestered. Scenario one is related to business as usual – climatic and stocking variables based on current data – and shows total carbon as 22.7 tonnes per hectare and 1.43 giga tones for the vegetation type.

The authors of this work (Hill *et al.* 2002) conclude that the case study illustrates the difficulties associated with using imperfect knowledge, arbitrary thresholds and timing of events not well captured. The results of the case study indicate that further work in refining the model will be necessary. The scenarios used in the case studies indicate that the climate-grazing pressure interaction is an important determinant of carbon sequestration in rangeland soils and that even with moderate stocking rates, there would be a risk of soil carbon loss in a long drought period.

Although (at the time of writing) Australia does not have a carbon trading program, if there is a carbon credit remaining once reliable estimates of total carbon sequestered are compared to total carbon emissions in Australia, it may be possible to trade this credit with a country with a carbon deficit. At the estimated value of carbon credits by Australia's commitment period (2008-2012) the sale value of credits may be significant to the State's economy. As pastoral activities occur on Crown land, the plants and carbon sequestered belongs to the Crown and not individuals residing there. The value of the sale of carbon credits should be compared with the economic, social and environmental costs and benefits of the pastoral industry. Given that much of the pastoral industry is considered to be unviable and unlikely to survive in the long term, the alternative of destocking parts of the pastoral zone and increasing carbon storage may well be a better land use.

13.5 Tourism

The increasing interest by the traveling public in Australia's unique and isolated landscape provide significant opportunities for the development of the tourist industry, with the potential to increase the economic return to the State, while at the same time providing regional employment. While much of the pastoral rangelands within the Gascoyne-Murchison Strategy region have been modified by grazing activities, the area still contains landscapes that capture public interest. Most people appreciate the landscape as a result of what they are able to see from the window of their vehicle, or from a particular point in the landscape. For most, the landscape's visual characteristics are the most direct way they will experience the area (Revell 1994).

Tourism tends to focus on patches of natural vegetation, concentrations of native animal populations, areas of striking geological / geomorphic significance, or coastlines and coral reefs. These factors occur in isolation or in combination and occur both within the conservation reserve system, national parks for example, and on pastoral leasehold land within the Strategy region. Coastlines have a particular attraction for both international visitors and Australians alike. For example, the coastline from Carnarvon to Exmouth attracts visitors who are primarily interested in the natural environment and participating in activities associated with observing the coral reef and marine environment (Wood and Dowling 2002). Carlson and Wood (undated) estimate that tourist expenditure in the Gascoyne coast region is greater than that expended in the south-west forests of Western Australia and comparable to the Kakadu World Heritage Area. Tourism is estimated to contribute about $80 million to the local economy (Wood 2003).

The hinterland to the Gascoyne coast contains significant attractions for tourists particularly the Kennedy Ranges and Mount Augustus National Parks. Both destinations are well serviced with airstrips capable of landing twin engine planes; however, neither destination has well developed accommodation nor hire-vehicle facilities. The lack of these developments could be seen as a disincentive to many tourists. The Gascoyne-Murchison Strategy encourages diversification in land use including the development of tourism opportunities on pastoral leases. There are a number of highly successful tourism enterprises conducted by pastoralists as part of their business and based primarily on accommodation and outback experiences. The amount of tourism development of this nature is limited by a number of geographic, social and infrastructure factors including distance from major centers, road condition / all weather access, availability of suitable labour force capable of addressing the needs of tourists, the business and personal abilities of individual pastoralists, and the attractions available on any pastoral lease.

Tourism based on aircraft as a means of transport with good standard accommodation and suitable guided tours in the Gascoyne coast hinterland has not been developed to any great extent.

The Strategy region is large and contains a number of significant landscapes of great interest to tourists wishing to visit and interact with. Much of the region is serviced by dirt roads and long distances must be traveled. It is recognized that many people do not have the time nor confidence in outback travel to cover the huge distances involved. In 1992 an ambitious plan was put forward to promote the Kimberley region of Western Australia utilizing air travel and ground tours once tourists arrived at their destination (Landscope 1994). This plan became known as the Ibis Aerial Highway allowing visitors to enjoy a wide range of remote features without having to travel long distances over often quite rough roads. This plan also linked together tour operators who provide package deals allowing visitors to choose where to go, where to stay and which pre-paid ground tours to join. The plan offered the opportunity to increase the prosperity of local economies, increase awareness of the natural environment with an emphasis on conserving the State's unique places. Tour operators provide visitors with high quality environmental interpretation and information aimed at engendering an understanding of the natural features of the region. Some of the destinations include former pastoral leasehold land acquired by the Department of Conservation and Land Management now managed for the conservation of biodiversity with Departmental staff attending when tours are operating to provide interpretive information.

The Gascoyne-Murchison Strategy region offers an opportunity to establish an aerial highway of its own, involving a range of tourist interests, or development by individuals. Contained within the region are a number of significant natural landscape features including the Kennedy Ranges (see Figure 21), Wooramel River Gorges, Mount Augustus and the surrounding ranges, Kalbarri National Park, historic towns such as Mount Magnet, Meekatharra, Gascoyne Junction and Sandstone, and significant pristine coastal areas such as at Peron Peninsula and Shark Bay.

There are major airstrips at Geraldton, Carnarvon, Monkey Mia, Meekatharra, Mount Magnet, with other Royal Flying Doctor rated strips at Gascoyne Junction, Mount Augustus, Wiluna and Cue (see Figure 22). Opportunities for the development of partnerships between different groups, including Aboriginal people, to provide accommodation facilities, and ground tours focused on some of these areas already exist, but require a catalyst to get started. Careful planning is an important prerequisite in the development of tourist facilities and in coordination of on-ground activities ensuring both visitor satisfaction and protection of the environment.

Figure 21. Kennedy Ranges National Park

Photo © Bill Bachman. Used with permission

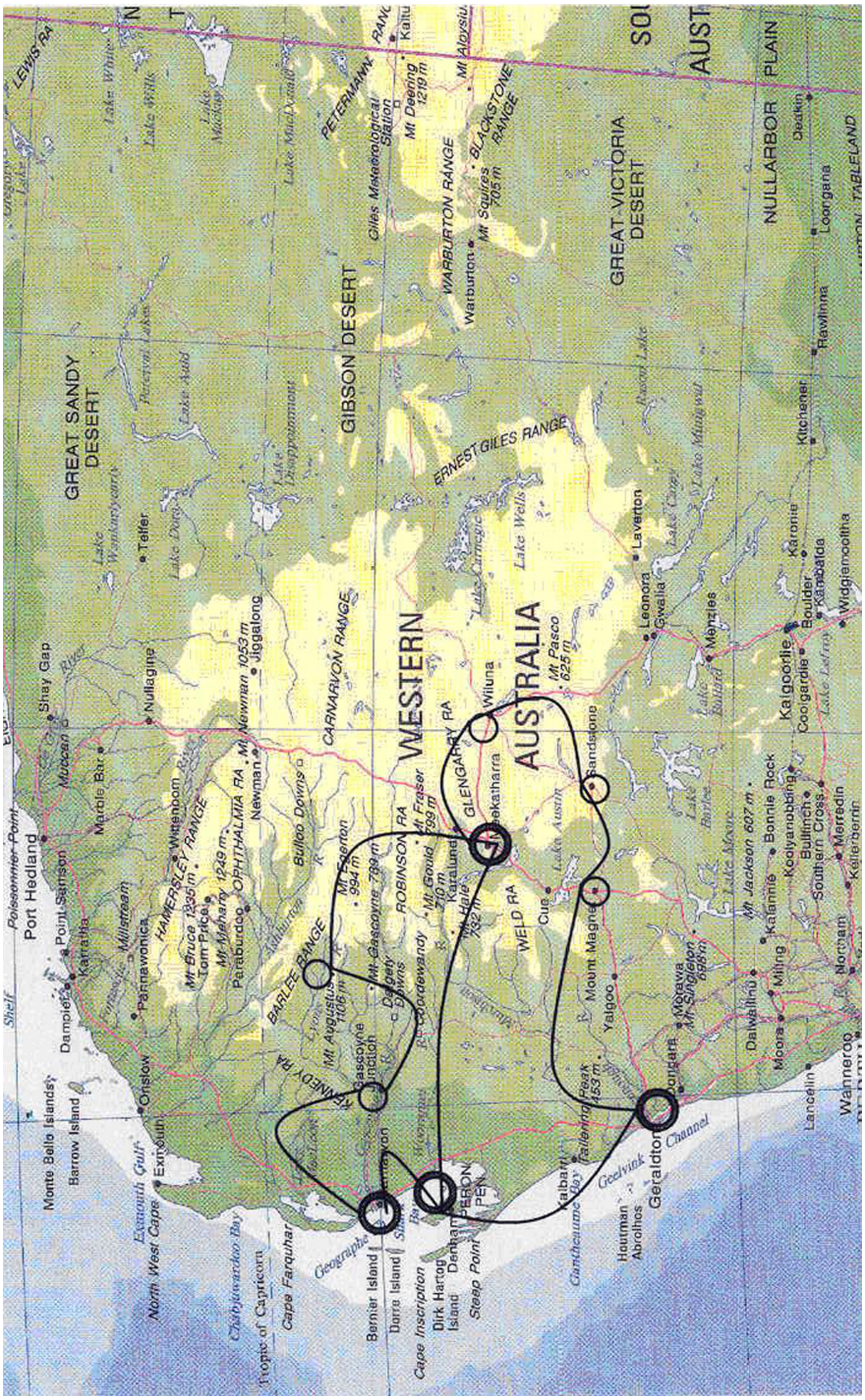


Figure 22. Map of Strategy region showing potential linkages for an aerial highway. Major regional airstrip; Minor airstrip

13.6 Conclusion

Two key management issues remain critical to the responsible and sustainable use of the pastoral rangelands across Western Australia – sustainability and conservation of biodiversity.

Other management and administrative issues such as the size of leases and their carrying capacity, declining terms of trade, land degradation, land tenure, pest animals and plants impact on the sustainability of the pastoral industry. These issues have been addressed in a number of wide-ranging publicly funded inquiries since 1940, all of which have made consistent recommendations that appear not to have made much difference to the way the pastoral industry is administered, nor how individuals plan to manage their lease. More recently, the Gascoyne-Murchison Strategy has identified a range of critical issues needing resolution to ensure the sustainable future of the industry in the region. With the support of the Western Australian government, funding has been made available to progress a range of strategic actions, and considerable progress has been made with a number of the key issues. However, restructuring leases with insufficient area to remain economically viable has not progressed to the same degree. Government appears reluctant to resolve this issue, such that industry continues to apply pressure for economic support, while at the same time environmental degradation and feral animal control issues continue.

A number of opportunities to address sustainable production, while at the same time recognizing the need to maintain diversity, have been developed and are being progressively introduced to pastoralists. Adequate resourcing of these projects is required to ensure that pastoralists in other parts of the state take up the opportunity for improved land management. This has a twofold advantage to pastoralists; firstly, the natural resource on which they depend will recover with a greater level of vegetative diversity providing greater reserves for grazing, and secondly, pastoralists may be able to take advantage of their environmental credentials in the market. Carbon credit trading offers an alternative use of the rangeland's natural resources that could have benefits for conserving biodiversity while at same time allowing recovery of land that has undergone often quite dramatic alteration as a result of continued grazing impacts from a range of mammalian herbivores introduced over the last 150 years. Recent government initiatives to establish a number of working groups made up of industry, community and agency personnel may also result in new approaches to the administration and management of the pastoral rangelands.

Chapter 14: Conclusion

The overarching goal for natural resource use in Australia is ecologically sustainable development. The challenge is to develop approaches, practical actions and to provide direction for those engaged in land management, so that they can take into account environmental, economic and social factors. The need for the integration of land management planning is important and successful outcomes require cooperation among all land users. The extensive use of land for pastoralism has implications for the loss of biodiversity in the rangelands, and this environmental loss impacts on other land use programs, which may be carried out within the matrix of all land uses, such as conservation of biodiversity.

Biodiversity loss cannot be resolved through the establishment and management of a conservation reserve system alone, and the issue of broader land use must be addressed in the context of ensuring sustainable management objectives across all land tenures. The mapping of conservation reserve areas across the Strategy region may look impressive, but what is important is the area of land not within reserves containing biodiversity values, left to fend for itself in the face of unrelenting grazing pressure, and often-inappropriate management practices. Government needs to show that it is making progress in protecting biodiversity values outside the reserve system, particularly those values known to be under threat and needing priority protection from threatening processes.

The early enthusiasm to develop rangeland-grazing enterprises saw the introduction of a range of domesticated stock that would utilize the natural capital available as its primary food source. There was neither appreciation of the climate, nor the capacity of the native vegetation to support the unrelenting pressure placed upon it by introduced domesticated animals. Initially, impacts on the vegetation were restricted to land in close proximity to water, either along the major river systems and tributaries, natural springs or soaks, or around wells dug to access water that was then raised to the surface. As the number of stock increased more developments, particularly wells and windmills, were necessary. This saw the development of leases containing many more artificial water points around which introduced stock concentrated, eventually degrading the vegetation.

This was the beginning of a trend in vegetation decline and loss of diversity often leading to increased soil loss – though many pastoralists are now conscious of the need to make changes to the way they manage stock grazing pressure to allow recovery of the natural pasture, particularly the perennial plants, as well as protecting soil from erosion forces by maintaining vegetative cover.

It is this modified landscape that has become the setting for the program of extending the system of conservation reserves, recognized as being inadequate for the long-term conservation of the full array of ecosystems and species, and which is highly biased towards land that is of low pastoral value.

A number of key issues confront the reviewer of rangeland condition reports, including the legislation underpinning pastoral land administration, the range of public inquiries into the economic viability of the pastoral industry, government policy, and the number of associated papers and documents addressing the need for a strategic approach to the sustainability of the industry, including the need to conserve our unique biodiversity. Perhaps the central question to the current debate over the need for sustainability and the prevention of further loss of biodiversity over an extensive area of the state is: why have successive governments not addressed the issues of environmental degradation, economic viability and social issues facing the pastoral industry? More importantly, what actions are necessary to resolve these pressing issues? An approach involving strict regulation and positive support of good land management would provide the best outcome. The facts indicate that successive governments have been reluctant to act upon the advice provided as recommendations for action arising from the many inquiries into the industry.

Only with strong commitment and leadership in the area of land administration and management can governments begin to influence the industry to change from an economically driven pastoral production system that is in many instances marginally viable, or wholly unviable, to a land management system that strives for a balance between economic, environmental, and social factors. When administrative and land management planning policies and practices aimed at achieving ecologically sustainability are addressed it will be possible to assess and evaluate the range of adverse environmental, economic and social issues that are inevitably self-destructive. A sustainable and viable pastoral industry would be ecologically compatible, produce positive economic outcomes, and drive future employment opportunities thus addressing social issues. Future land management must include a greater range of land use options, including traditional grazing practices as just one of these.

The progressive decline of certain components of native vegetation is the result of inappropriate stocking levels that is not in equilibrium with the recuperative capacity of plants periodically overgrazed. These cumulative impacts have led to extensive areas of once highly productive land being degraded to the point where they are now unproductive, with little chance of rehabilitation given the costs involved.

The reluctance to adjust stocking levels rapidly in periods of drought results in further deterioration of native vegetation. In the semi-arid and arid environment that pastoralism is practiced, the only management factor that can be altered is the stocking level; influencing climate and plant growth are not options.

The continued acceptance by government of the existing lease system, with recommended carrying capacities prescribed that are clearly below the accepted

level for economic viability, can only result in the need for continued subsidies, tax relief or debt write off, and financial assistance with new developments. This will continue until government acts to restructure the industry to provide leases of sufficient size that generate real economic return throughout the range of good and bad seasons, while at the same time ensuring that the natural resource is utilized on a sustainable basis. Lease restructuring must consider pastoral productive capacity in the long term, the current state of the environment, and the likely impact of continued activities on the conservation of biodiversity.

The legislative and administrative requirements imposed on lessees are directed primarily at addressing land uses rather than the natural resource base. There are requirements to ensure that leases are managed on an ecologically sustainable basis, so that the natural resource is allowed to recover, but these are not defined more specifically. Furthermore, there are no specific performance goals or outcomes in relation to natural resource management. The reluctance by government to address issues of enterprise viability, lease size, land degradation, and population decline – that is the environmental, economic and social dimensions of the industry - has had the effect that traditional management customs are seen to be unacceptable by a growing number of interested stakeholders.

The establishment of a comprehensive, adequate and representative conservation reserve system as part of the National Reserve System Program, with input from all States and Territories, the Commonwealth, non-government organizations and indigenous landholders, will make a major contribution to the conservation of indigenous biodiversity. A key objective is to have a reserve system that contains examples of all regional ecosystems. It is recognized that a conservation reserve system alone will not guarantee that biodiversity conservation objectives will be met, and the ecologically sustainable management of the broader landscape is necessary. Conservative pastoralism must complement biodiversity conservation objectives.

The sustainable management of the natural resource within the broader landscape will require understanding of how different landscapes function, with the aim of adjusting stocking levels according to seasonal and climatic variations, and the condition and productive capacity of the vegetation. However, it may not be possible for many pastoralists, to easily adjust stocking levels due to economic imperatives, or market inflexibility. Without Government support to pastoralists in the form of economic incentives to reduce or remove livestock grazing from degraded parts of the landscape, it is unlikely that off-reserve conservation initiatives will be taken up.

The continued threat to many native animals inhabiting the rangelands from introduced predators requires sustained and focused feral animal control measures. A number of native animals are now locally extinct, or extinct on the mainland where they were once known to occur. Reintroduction programs can only succeed

if feral predators are eradicated or controlled to the extent that predation pressure does not exceed native animal survival rates.

Excessive numbers of feral goats, particularly in key habitats, in the Strategy region are contributing to the continued decline of native vegetation, significantly in drought periods, and threaten the regeneration of plants preferentially grazed by domestic stock.

The control of introduced plants and animals that impact on biodiversity requires economic commitment and political will. Where there are statutory control requirements for land managers, government will need to develop realistic monitoring procedures and insist on compliance by all parties. Self regulation opportunities may be encouraged by the development of procedures, including the need for compliance issues to be dealt with as part of the lease renewal process, which recognizes commitment to responsible land management including introduced plant and animal control.

Monitoring programs directed towards determining trends in biodiversity over time have not been established in the rangelands, including in the conservation reserve system. The lack of extensive biodiversity monitoring programs is recognized, and governments are now moving to resolve this issue.

The most recent approach to understanding landscape function and the introduction of flexible grazing regimes aimed at allowing country to recover as part of the EMU program, will also require targeted monitoring to show changes in rangeland condition that result. Without this feedback, changes to the program will not be possible, nor will the overall assessment of the value of this investment be possible.

Monitoring changes to vegetative cover and diversity, recovery of degraded and eroded country, and changes in native animal population density and distribution on pastoral land acquired for inclusion in the conservation reserve system is an important management objective. The assumption that land will return to a different, perhaps natural state, following destocking, removal of artificial water resources, and control of feral animals, is untested. Changing land tenure from grazing lease to conservation reserve will not result in an improvement in the conservation of biodiversity of its own. Informed strategic planning based on the outcomes of rigorous monitoring programs, sound science, and management activities directed at achieving conservation goals that are adequately resourced by government, will be necessary.

Continued efforts in participatory research aimed at understanding the ecological functioning of rangelands at both the landscape and species level, is required if sustainable land management activities are to be achieved. Identifying the causes of biodiversity loss as a result of inappropriate fire regimes, total grazing pressure, or changing climate, is a complex issue likely to involve many

different industry and community sectors and interests. Perhaps unfortunately, biodiversity has little economic value or meaning, resulting in many industry and community sectors questioning the need for further research into alternative land use management practices that impose greater costs on society. However, to ignore the ecological requirements of our natural heritage, and blindly pursue unfettered and degrading land management practices, has resulted in loss of species and ecological function on land used for agriculture, with extraordinary implications for loss of production and rehabilitation costs. Already there are signs that extensive areas of the pastoral rangelands have undergone significant ecological change resulting in loss of natural resources, biodiversity, production, and associated high costs of rehabilitation.

The development of effective land use management plans based on the results of research findings provides a basis for monitoring programs aimed at evaluating and improving land management practices. Adjusting management activities based on the results of strategic planning and monitoring is a necessary requirement if the rangeland environment is to be managed sustainably. However, it may not always be possible, nor prudent, to await the results of monitoring or research before beginning the process of management planning. Therefore the reliance on the best advice at the time, combined with a precautionary approach to land management, is most likely the way forward. Planners must also recognize the need for prioritization in allocating scarce resources so that species or ecosystems that are most likely to persist are targeted, rather than those natural features unlikely to persist in the long term.

Educational programs aimed at providing knowledge and understanding within the community about environmental impacts, the need to conserve biodiversity, and ecologically sustainable development are necessary. The delivery of educational material can be achieved through a combination of the formal education system, a range of media opportunities involving television, the internet, radio, and press, and one to one discussion with pastoralists and others involved in rangeland management activities. Recent developments in preparing nationally recognized student-learning outcomes have resulted in the inclusion of a range of relevant topics in the curricula of many teaching programs in schools. Universities have also reacted to community and industry requirements for well-trained environmental science graduates, and developed a range of environmental and natural resource management courses in response. In the end, changing attitudes and behaviour towards the environment will take considerable time. Education is the key to sustainability, and it is only when all stakeholders understand the causes of environmental decline, including the loss of biodiversity, and the need for sustainable rangeland management practices, that society will appreciate the need for greater responsibility in the way natural resources in the rangelands are managed.

This study has provided a summary of the environmental impacts and economic viability of the pastoral industry, as well as land administration, legislation and procedures. It outlines a procedure developed to provide consistency in the way conservation and other values on pastoral leases are assessed in the context of other theoretical approaches developed in Australia.

The results of the land acquisition program indicate that it is possible to improve the level of comprehensiveness, adequacy and representativeness of the network of conservation reserves in the Strategy region, based on pastoral leases containing high conservation values that are generally in better condition than regional averages, as determined by the Western Australian Department of Agriculture. Inevitably parts of these leases have been impacted from historic grazing pressure, and will require considerable time for vegetation to recover and for plants to regenerate, particularly those favoured by grazing animals. There is significant improvement in the level of representation of the major ecosystems of the Strategy region and a number of the bioregions now have greater than 15% of their area within the reserve system. The land acquisition program has made a substantial contribution to the establishment of a comprehensive, adequate and representative conservation reserve system. However, despite the significant achievements made, many gaps remain and areas containing important conservation values remain outside the conservation reserve system.

Using vegetation types having restricted distribution and information about areas of the Strategy region containing high biodiversity, a number of pastoral leases have been identified as important for conservation. Further investigations will be necessary prior to considering these leases for inclusion in the conservation reserve system.

Most of the acquired land has now been destocked, and the process of closing down artificial water points has begun. Initial management planning has been completed for much of this land and this work is continuing. There is anecdotal evidence of improvement in vegetation cover on leases that have been destocked for several years, but the development of effective monitoring programs is still necessary to quantify recovery trends. The need for baseline environmental condition studies on pastoral leases acquired for conservation management has not been adequately addressed, and the opportunities to gather this information, in many instances, is now less than optimal. Fortunately, historic aerial photography and Landsat imagery may provide some of this information particularly in relation to vegetative cover. It is extremely important to maintain momentum in addressing these issues, regardless of which particular activities are the focus of management agencies.

There has been considerable improvement to the comprehensiveness, adequacy and representativeness of the conservation reserve system in the Gascoyne-

Murchison Strategy region, and now is not the time to stop this work because of insufficient provision of resources from governments to adequately address the full range of land management issues. Inadequate resources will perpetuate the implementation gap and result in skepticism about such programs, unfair criticism of agency personnel, and a time lag that, for some species of plants or animals, may inhibit recovery programs and severely compromises their survival status. Progressing with this important work of establishing and managing a world-class reserve system needs continued community and government support and resources, and they are required now.

It is clear that the pastoral wool industry is no longer a major contributor to the State's economy. However, the industry remains well supported and has retained its ability to effectively lobby governments of all persuasions. Future governments will have to take a firm, but informed stance on the administration of pastoral leasehold land that, in ecological terms, is now in a much-altered state. Alternative uses of the land, including destocking to allow recovery of the vegetation, will enhance the sequestration of carbon and may provide opportunities for economic benefit to the state through carbon trading opportunities.

The condition and plight of the pastoral rangelands in Western Australia is not often the subject of headline news, despite much of the information about extensive land degradation being in the public arena. Even though the damage to our native plants, animals and soils is significant, there has never been a significant informed public debate about the state of the rangelands environment, nor the economic and social situation in which the industry finds itself. In overall economic terms the industry's contribution to the state's gross domestic product is small, yet its environmental footprint is massive. One may well ask about the wisdom of continuing with this industry in its present form: much of it is in a desperate economic position, and its activities result in continued environmental degradation and loss of biodiversity.

Unfortunately, the author's conclusion is that, without effective leadership and without a change of government priorities and community understanding, more time looks set to pass before the need for urgent action to overcome the non-sustainable treatment of our natural heritage is recognised. On the other hand, if there were a public debate, on a scale similar to the 'save old-growth forests', or 'protect the Daintree from further development', or 'saving the Frankland River', then perhaps the significance of the issue would clarify for the broader community. Such a debate would draw attention to the range of issues besetting the industry that have been described repeatedly in the numerous outcomes and recommendations of the publicly-funded enquiries into the viability and environmental impact of the pastoral industry. It may be that the public debate would question the apparent inactivity – even maladministration – of successive governments and

their advisory bodies, who have continually avoided taking appropriate action based on the recommendations and outcomes of these enquiries.

Conditions in the pastoral rangelands have reached a tipping point. Strong and decisive action by government, based on good science, management plans and informed public discussion, is urgently needed to turn around the plight of the rangelands. At the very least, it is our responsibility to present and future generations of Australians.

Rescuing the rangelands should be the concern of all West Australians. Based on my years of research and experience, I believe this book provides enough facts about the environmental impacts from the activities of the pastoral industry to substantiate the need for action, and enough detailed description of corrective management strategies for conservation and representative protection of the rangelands to indicate the path by which the rangelands can be saved.

Surely it is worth rescuing what remains of our natural heritage, and attending to the rehabilitation of the already significantly modified and damaged rangelands?

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Appendix 1

Criteria for Establishing a Conservation and Representative Reserve System in the Pastoral Rangelands of Western Australia

A. Brandis
Environmental Protection Branch

Goal And Background

Establish a comprehensive, adequate and representative reserve system for the long term conservation of biodiversity.

The reserve system should ideally encompass examples of all ecosystems within the rangelands. A range of conservation management options exist including outright purchase of (all or part of) pastoral leases, voluntary agreements with land managers (pastoralists, mining companies, Aboriginal people, other Govt. agencies), and by influencing broader land management practices through forums such as Land Care District Committees and the Soil and Land Conservation Council.

CALM will assess and evaluate a range of ecological and other values, using the best available data, across the rangelands of WA to develop a set of priorities for land acquisition or other management options. It is recognized that there are deficiencies in detailed biological survey information in the rangelands. Therefore CALM will rely heavily upon the limited information available, primarily broadscale vegetation and geological mapping, and combine this with more detailed biological survey information where it exists. Other data, such as that relating to rangeland condition prepared by the Department of Agriculture Western Australia will also be used. These data can be utilized to provide an overview of the gaps in the rangelands conservation estate or it may be used to evaluate conservation values at the pastoral lease scale. Both approaches will be followed.

Due to the limited funds available for land acquisition and ongoing management, a set of criteria has been developed which will allow the consideration of the full range of land management options ensuring the most effective use of financial and other resources. The outcome of this process will be the establishment of state-wide priorities which will focus the Department's activities in the rangelands to ensure the establishment of a comprehensive, adequate and representative reserve system.

Criteria for Setting Priorities

1. Reservation Status of the (IBRA) Bioregion

- based on the percentage of the region already reserved (area, no. subtypes, specific targets), condition and bias.

2. Scientific Criteria (based in the Interim Scientific Guidelines for Establishing the National Reserve System)

- habitat condition - current state of the ecosystem compared to what would be considered pristine
- habitat quality - is this a measure of diversity?
- threatening processes - the dominant limiting factors and constraints to the on going conservation of biodiversity - e.g. fire, overgrazing, foxes/cats, weeds etc.
- adequacy, including replication - the maintenance of the ecological viability and integrity of populations species and communities
- representativeness - areas selected for reserves should reasonably reflect the biotic diversity of the ecosystems
- complementarity - the need for individual protected areas to complement, rather than duplicate, one another in terms of the features they contain. This leads to representation targets for the features in a region being more efficiently achieved in terms of the number or extent of protected areas, thereby increasing the likelihood of those targets being implemented on the ground.
- threatened species and ecological communities - a species or ecological community that is vulnerable, endangered or presumed extinct.

In addition to the above information there may be relevant information about :

- geology/geological surveys
- other significant geomorghological features e.g. particular landforms or examples of landforming processes

3. Regional Management Plans (CALM and State/C'wlth planning bodies)

Areas referred to in Regional Management Plans as worthy for inclusion in the conservation estate, or reference to areas with high conservation value which are intended for further investigation.

4. Other Management Attributes/Issues

A range of additional management issues need also to be considered, viz.

- area fenced/fencing requirements - new or upgrading
- rehabilitation of degraded areas - costs/timeframes - likelihood of natural recovery?
- artificial and natural waters
- total projected ongoing management costs
- sandalwood resource status (if appropriate)/value
- adjoins other conservation estate/adjacent land tenure
- linkages with areas of conservation value - corridors
- boundary: area ratio
- level of mineral prospectivity
- historical/cultural values (Aboriginal and European)
- heritage values/registration
- national/international agreements (wetlands)
- special features - e.g. coastline, wilderness
- geo/political sensitivity
- market price vs. market value - Valuer General's Office.

5. Implementation of compatible scientific operations

- other scientific studies, operations and facilities of significant national, state or regional importance which are compatible with the major management objectives, e.g. radio telescope facilities.

Process

The information required for this priority setting procedure will be gathered from a range of sources including existing data bases, reports by science and information division staff, regional staff and staff from other government agencies where appropriate.

The development of the process to allow a ranking (say High, Medium, Low) for each criterion/issue will be considered.

The outcome of the process will be the provision of a recommendation for corporate decisions to be made which will provide the most effective expenditure of funds for the acquisition of lands encompassing ecosystems most in need of protection.

Appendix 2

Department of Conservation and Land Management
Environmental Protection Branch

Communications Strategy (Rangelands)

Prepared By A. J. Brandis

Calm's Mission and Goals

Background

The rangelands of Western Australia make up about 85 per cent of the land area of the state of which approximately half is managed for wool and beef production on pastoral leases. Nearly all land utilized for pastoral production now suffer from degradation and loss of biodiversity.

A number of policies and strategies proposing additions to the conservation estate within the rangelands have been released over the last few years. CALM has the responsibility for the conservation of wildlife in Western Australia and has now taken a more proactive position in conservation management in the rangelands given the recognition of the need to acquire additional land for the conservation of biodiversity together with the availability of some financial resources from the Natural Heritage Trust (NHT).There is also a recognized need to restructure the pastoral industry. Although approximately 7 per cent of the rangelands in the State has been reserved for conservation purposes, much more needs to be done to ensure that the reserve system is comprehensive, adequate and representative of the full range of ecosystems and species.

Calm's Mission

To conserve Western Australia's wildlife and to manage land and water entrusted to the Department for the benefit of present and future generations.

The Department of Conservation and Land Management (CALM) manages approximately 20 million hectares of public lands and waters. This land comprises National Parks, Nature Reserves, State Forests, Marine Parks, Marine Nature Reserves, Conservation Parks and other Reserves. CALM also has responsibility for conserving flora and fauna on all other lands and waters outside the conservation estate in Western Australia.

This strategy sets out the overall direction for communicating with stakeholders involved in land management activities within the rangelands. It is designed as a guide for staff members responsible for the implementation of activities aimed at improving land management activities and, in particular, about management for the conservation of biodiversity. It is also a useful guide to stakeholders wishing to understand the basis for communications activities carried out by CALM's staff involved in rangeland management.

This strategy is intended as a dynamic document that will be reviewed and changed as new issues are identified or external factors (economic, social, political) place different pressures on industry and Government agencies.

Vision

Informed community members who are supportive of, and involved in, CALM's conservation and land management activities in the rangelands.

Goals

The following *broad goals* relating to communication with all stakeholders have been identified

1. Provide clear understanding of CALM's position in relation to land management for commercial operations (e.g. timber production, sandalwood production, kangaroo harvesting, seed collection, wildflower picking), mining activities and conservation purposes within the rangelands.
2. Establish a network of contacts and protocols for the interchange of information and ideas related to conservation management.
3. Seek support for CALM's conservation and land management activities in the rangelands.
4. Establish the credibility and legitimacy of CALM's role in conservation and land management within the rangelands.

Part of CALM's role within the rangelands is aimed at achieving a comprehensive, adequate and representative conservation reserve system, while at the same time seeking opportunities for voluntary conservation management arrangements with lease holders or other groups occupying land within the rangelands.

There is a need to generate a positive attitude which will come from knowledge and understanding about CALM's role in land management in the rangelands. This will assist CALM in the enormous task of managing lands in remote areas of the state and in achieving broader community support for its activities.

The key challenge for those charged with implementing the strategy is to develop a range of approaches by which information can be provided to all

stakeholders. This challenge will involve many CALM personnel working within the rangelands of the state. Personnel with appropriate expertise in other agencies can also play a role in providing information to stakeholders.

Issues

- One key aspect of communication will be to overcome the concern within the community about the level of input by State Government in land management affairs in the rangelands.
- CALM needs to be proactive in providing balanced information to the community through a range of media or face to face contacts. Selecting the right media for information release is also of great importance.
- There needs to be a positive climate of awareness about CALM's activities as well as the broad range of initiatives being implemented by other agencies, both State and Federal which have implications for conservation in the rangelands.
- Keeping track of what issues are important to stakeholders will be important, as will the need to maintain a close watch on what information appears in the media.
- The need to create opportunities to inform stakeholders must be considered.

Target Audiences

Government Agencies

State and Federal Government agencies play a vital role in providing services and resources to the community. There is a clear need to maintain good communications between the various agencies with an interest in conservation and land management. The complementary nature of the activities of various agencies needs to be promoted and brought together through cooperative and coordinated efforts.

Strategies

- provide opportunities for collaborative involvement of appropriate agencies
- provide briefings to agency personnel
- encourage an integrated approach to the dissemination of relevant land management material
- assist other agencies with the preparation of communication materials

Outcomes

- high level of understanding of CALM's role in rangeland management

- increased awareness of the Department's nature conservation goals in the context of State and Federal Government statements on the environment and State Government policy.
- increased cooperation between agencies

Contacts

- State and Federal funding agencies
- Agriculture Western Australia (AgWA)
- Department of Land Administration (DoLA)
- Geological Survey / Department of Minerals and Energy (DoME)
- Aboriginal Affairs Department
- Indigenous Land Corporation
- Pastoral Board
- Department of Environmental Protection (DEP)
- Environmental Protection Authority (EPA)

Media

The major source of information about the environment (and many other issues) for most people in Australia is television, through programs which focus on science and nature or news and current affairs. Other sources of information include newspapers, magazines and radio.

These different components of the media have had, and continue to have, a great influence on the community's and individuals' understanding and attitude towards conservation and land management in the rangelands.

Of primary concern to land management agencies is the need to ensure that comprehensive and balanced information is presented.

Strategies

- identify newsworthy items for the media
- promote the reporting of success stories in rangeland management, particularly where cooperative activities are carried out
- encourage the presentation of comprehensive and balanced information
- provide opportunities for media personnel to interact with community members in sharing information about land management

Outcomes

- regular reporting of land management issues in the media
- balanced reporting of rangeland management issues

Contacts

- local, regional and state print media
- Elders Weekly
- Countryman
- West Australian Newspaper
- Kalgoorlie Miner
- TV / radio
- Country hour ABC radio
- Landline ABC TV
- local radio
- Landscope
- AgWA publications

Community

It is important for community members to understand the issues that CALM will be addressing in relation to enlarging the conservation estate and in conservation and land management in general (including commercial activities).

The community includes pastoral lessees, urban residents, special interest groups, (including conservation groups), Aboriginal people, mining company personnel, tourists, students, government agency representatives and politicians.

Politicians, both State and Federal, respond to issues and concerns brought to their attention by the community. In relation to communicating information to rangelands stakeholders, politicians can play an important role by providing leadership and facilitating discussion.

CALM's future activities will be carried out in full recognition of the need to keep community members fully informed.

Strategies

- disseminate information through a range of channels including the print and radio / television media, industry forums and personal contacts.
- respond to requests for information
- provide briefings to community and industry groups

- invite political and civic leaders, and peak bodies to participate in communication opportunities
- compile a database of network contacts

Outcomes

- improved awareness and understanding about the activities of the Department
- increased support for, and involvement in, CALM's activities
- high level of positive interaction between stakeholders and the Department

Contacts

- pastoral leaseholders
- mining companies
- pastoralists (including Aboriginal pastoral lessees)
- industry organizations
- Pastoralists and Graziers Association
- Western Australian Farmers Federation
- National Farmers Federation
- Chamber of Minerals and Energy
- Association of Mining Exploration Companies
- Land Conservation District Committees
- Aboriginal Lands Trust and Corporations
- peak environmental organizations e.g.
- Conservation Council of Western Australia
- tourism associations
- Local Government Authorities
- politicians
- Regional Development Commissions

Implementation And Review

The information in this strategy will be communicated within the Branch and amongst other interested stakeholders. The strategy shows clearly the intended direction of communication activities in the future and allows other people within the organization to see where they might fit into the process.

It should be obvious that it will take some time to develop contacts within the community, other agencies and the media, but a start has been made.

The strategy will be reviewed from time to time to evaluate the progress being made in communicating or making effective links with the media. In evaluating progress, or any gaps in achievement, new insights into the way we are attempting to provide communication links may be developed which will result in the modification of the strategy.

Appendix 3

Example of Interim Management Guidelines

1. Introduction

1.1. Purpose of Interim Management Guidelines

These guidelines are required for planning purposes so that certain operations can be carried out in an orderly fashion in the absence of an approved management plan. The operational activities described in the guidelines are defined as those actions necessary for the preservation or protection of persons, property, land, flora and fauna.

These guidelines, which identify short-term management objectives and actions will be reviewed at least annually and will be put in place for a period not exceeding five years. All work programs emanating from these guidelines will be approved by the Regional Manager.

1.2 . Principal Management Directions

These guidelines cover the major management issues. These are :

- the conservation of biological, physical, cultural and landscape resources.
- the facilitation of recreation in a safe and appropriate form in relation to the physical and climatic conditions of the area and the conservation objectives.
- to seek a better understanding of the natural and cultural environment and the impacts of a range of management activities.
- to promote informed appreciation of natural and cultural values.

1.3. Area Description

Mooloogool pastoral lease comprises and area of about 415,000 hectares and is situated approximately 100 kms to the north - north east of Meekatharra. It is an amalgamation of the former Mooloogool and Diamond Well leases. Earliest available records indicate that both leases were granted in 1918. The property lies within the Murchison IBRA region which is identified as a region lacking in an adequate and representative reserve system. This land lies within the Mid West region of CALM and will be administered through the Geraldton office of the Department.

The lease is situated across the watershed of the Murchison / Gascoyne rivers flowing westwards and water which is shed towards the east into Lake Way /

Lake Nabberu. Seven vegetation units as mapped by Beard occur on this lease. All are poorly represented within the current reserve system, and three are not represented at all. There are 14 different land systems as mapped by AgWA, (most of which are of low pastoral value) suggesting a considerable degree of variation in vegetation over the lease. Although there are obvious impacts from grazing activities there are no areas identified by AgWA as being severely degraded nor eroded.

Published distribution data suggests that the property supports 82 ground dwelling vertebrate taxa. There are two scheduled rare species and two priority species.

There are two large areas which have not been developed for grazing in the north east and southern portions of the lease. However, there is considerable reduction of vegetation cover over the remainder of the lease where grazing has occurred. This impact is most obvious within the piospheres at all watering points though there is a distinct improvement in understorey even at a short distance from water.

2. Interim Management Objectives

The Interim Management Objectives for the Mooloogool area are to :

- complete the removal of all domestic stock from the lease and close artificial waters not required for strategic water supply.
- identify, record and protect the natural and cultural resources of the area.
- identify and maintain strategic access within the area.
- continue to control introduced plants and animals.
- carry out management activities which are sympathetic to the requirements of neighbours including the maintenance of boundary fences in a stock proof condition.
- ensure that future development proposals, particularly for mining, include adequate provision for appropriate rehabilitation.
- protect natural resources, buildings, areas of historic or cultural significance from the impacts of wildfires.
- initiate recreation planning in preparation for future provision of access and visitor facilities.
- liaise with individuals and organizations with regard to the development and implementation of these guidelines.

3. Interim Guidelines

3.1 Management For Conservation

Geomorphology

The property is of fairly uniform topography; mostly a broad plateau of about 600m in elevation. A small part of the Glengarry Range encroaches the south - western corner. Mooloogool is located at a prominent point in the total landscape, being at the top of the Murchison catchment and what is effectively the watershed between the Murchison River, the Gascoyne River and the Lake Way Lake Gregory catchments. The major surfaces are Quaternary sands, alluvium and colluvium, with outcrops of pre-Cambrian sedimentary rocks and some dolerite sills.

A recent publication by J S Beard, 1998 (Journal of the Royal Society of Western Australia 81, 157 - 164) has highlighted the importance of this area, as a place of considerable landscape antiquity that preserves portions of the palaeosurface and its superficial deposits.

Action

- develop greater understanding of the geomorphological units within the lease.
- develop interpretive material on the geology, land forming processes and the descriptions of the land forms.

Vegetation, Flora and Introduced Plant Species

Seven vegetation types are recognized across the lease, at the 1:250,000 map scale. All associations comprise mulga (Acacia aneura) woodland, mulga shrubland or mulga shrub / steppe. Field observations generally confirmed the validity of the vegetation mapping, recognizing the limitations of mapping at this scale. One vegetation type, that is reported to be present in about 1,000 ha, was not located. Other associations were noted that are not recognized at the 1:250,000 scale. Overall, the property incorporates greater environmental variation than is suggested by either geological or vegetation mapping.

Buffel grass, ruby dock and double gee were noted in small, isolated patches. Buffel grass has failed to become broadly established, despite and active introduction programme.

Action

- survey the lease for further occurrences of introduced plants.
- monitor the survival, spread and distribution of all introduced plant species.
- detailed flora surveys are required to determine the occurrence, distribution and abundance of threatened flora.
- protect areas on which threatened flora is known to exist.

Native and Introduced Fauna

Published distribution data suggests that Mooloogool potentially supports 82 ground - dwelling vertebrate taxa. Included in these is the Scheduled Rare Dasycercus cristicauda and Petrogale lateralis and the Priority species Sminthopsis longicaudata. Extinct mounds of Bettongia leseur are common across wide areas of the lease. Extinct nests of Leporillus sp. are common in breakaways.

Feral goats and camels occur on the lease, although none were sighted during the initial inspection of the lease and neither were reported as a significant problem, by the lessee.

Feral cats and foxes also occur on the lease. Foxes have been seldom observed by the pastoralist.

Action

- conduct comprehensive surveys to document the fauna of the area.
- protect significant habitats and monitor changes which may occur following the removal of domestic stock and feral herbivores.
- carry out surveys to determine the level of abundance of foxes and cats.
- investigate the value of broadscale fox and cat baiting programs to control the numbers of foxes and cats on the lease and surrounding areas where they are shown to be impacting on native fauna.

Cultural Resources

Aboriginal people lived throughout the area now known as the Mooloogool pastoral lease, using the land for hunting, gathering and cultural purposes. The lease contains a number of sites where Aboriginal people have gathered and other areas of significance on the lease may also exist.

A disused stock route - Crown reserve number 9699 - runs through the lease. There are a number of Government wells along this stock route which may have some historical value.

The lease was taken up for grazing in about 1918 and has remained an active pastoral lease since then. The two original homesteads - at Diamond Well and at Mooloogool are still in existence along with some original stock yards and water points.

Action

- liaise with the Aboriginal Affairs Department to ensure that any recognized heritage site are registered.
- protect known Aboriginal or European heritage areas.
- conduct survey of the lease to determine areas of cultural or historical significance.

- establish the need to retain existing buildings and structures of significance and demolish those considered unnecessary or unsafe.
- ensure that the knowledge of the lessee related to the natural and cultural history of the area is recorded.

Erosion, Mining and Rehabilitation

There is minimal land degradation on Mooloogool as the property has been conservatively stocked for some time and the lessee ensured that areas of the lease were spelled from grazing from time to time.

There has been some mineral exploration carried out on the lease and cleared grid lines remain in evidence today.

Action

- determine the existing mining tenements which occur over the lease.
- future mining tenements will be granted in accordance with conditions agreed to between CALM and DoME. Prior to any ground disturbing activity a detailed program will be prepared by the proponent and referred to CALM. Rehabilitation requirements will also by addressed as part of this process.

Fire

Fire management considerations include the protection of persons, property and conservation values. Fire is a major ecological process in spinifex communities which burn readily and are adapted to fire. A range of vegetative successional stages following fires is important in providing habitat for native fauna.

The removal of domestic stock and control of feral herbivores and declared animals such as kangaroos will result in a recovery of the native vegetation. This in turn will create a greater risk of damaging wildfires which can destroy (or seriously modify) habitats, buildings, structures of historical significance, fencing and stock and infrastructure on adjoining pastoral leases.

Action

- protect important habitats, buildings and important structures from the impact of uncontrolled fire by creating fuel reduced buffers through prescribed burning activities or the construction of mineral earth fire breaks.
- liaise with local Bushfires Board, local Government and neighbours to determine the requirements for coordinated fire responses.
- develop a fire management plan for the lease.
- provide information to alert visitors to the area about fire risk and safety precaution

Boundary, Land Tenure and Fences

Mooloogool is surrounded by active pastoral leases. The boundary of the lease has been fenced although the fencelines have not been surveyed and are not always on the cadastral boundary. The boundary fences are generally in good order but some will require upgrading to provide a stock proof barrier. A section in the north east corner of the lease has never been fenced. As a result some cattle from the neighbouring lease graze onto Mooloogool when surface water is available.

In the interests of good neighbour relations CALM will maintain boundary fences cooperatively with neighbours.

The lease was purchased in 1999 and held in the name of the Executive Director of CALM. The lease will be converted to a Conservation Park and vested in the Nature Conservation Authority.

Action

- commence process of declaring the lease a protected area under relevant legislation.
- liaise with neighbours over the maintenance of boundary fences.
- remove all vegetation from boundary fence lines to assist with fence maintenance and access
- liaise with neighbours over the control or removal of straying stock.

Artificial Waters

The developed areas of the lease are reasonably well watered from 50 mills. There is one dam near the Mooloogool homestead.

Action

- close down water points not required for the strategic supply of water
- monitor the impacts on native animals (population numbers / mortality)
- fill in or otherwise make secure all wells and bores.
- clean up mill sites by removing unwanted yards, fences, tanks, troughs.

Domestic Animals

Domestic animals (other than guide dogs) will not be permitted in Mooloogool. Pets disturb wildlife, can introduce disease, foul recreation areas and water holes, and can interrupt native fauna activity.

Action

- discourage pet owners from bringing these animals onto Mooloogool.

3.2. Management For Recreation

Mooloogool is accessible by two wheel drive vehicles throughout most of the year. However, as the area has been operated as a pastoral lease or some time the level of visitation has been low and with the permission of the lessee. It is not expected that the level of visitation will increase in the near future without careful planning, the development of facilities and advertisement of the area as a recreational destination. The area offers opportunities for self drive tours, camping and other passive recreational activities based around the natural and historical assets.

Action

- restrict public access to areas that are easy to locate, have ready access to water, are in good condition and have land use capabilities that allow for limited environmental impacts.
- initiate recreation planning to identify future requirements for visitor access and facilities.
- investigate the factors determining land use capability for recreational activities.
- close off sensitive areas and tracks not required for access by CALM or members of the public.
- prepare contingency plans to deal with incidents such as wildfire, vehicle and personal accidents.

3.3. Research And Monitoring

Nature Conservation

Effective conservation management requires adequate knowledge of flora, fauna and natural processes within the landscape, including baseline condition and changes associated with management, natural events and climate. Monitoring is the means by which long term trends can be recorded and interpreted.

Action

- conduct comprehensive flora and fauna surveys to document baseline condition, locate threatened or priority species and document important features.
- monitor populations of introduced animals and plants.
- monitor the recovery and successional trends which will result from the removal of domestic stock and closure of artificial water sources.

Social

Visitor numbers to the area are expected to increase once knowledge of the status and management purpose of the area is promulgated or otherwise becomes more widely known. At present the area, although serviced by reasonably good dry

weather access, does not have high visitation levels due to the pastoral activities being conducted and the distance off the Great Northern Highway.

Once planning for recreation has been addressed the issue of research into visitor needs and expectations, monitoring impacts on visitation areas and their requirements for interpretive information will be reviewed.

3.4. Implementation

The implementation of these guidelines will be undertaken within the annual works program developed by Mid West regional staff. Implementation activities will also be subject to broader regional priorities and will depend on the availability of staff and other resources.

These guidelines may be changed as new information becomes available or policy developments occur.

4. Action Plan.

Mooloogool is in a state of transition from pastoral lease land to conservation reserve and is currently being destocked by the former lessee who has 18mths to complete this activity. The tasks outlined here for action over the next 12mths are considered important in maintaining the integrity of boundary fences, making some of the buildings secure or at least beginning the process of determining which buildings should be demolished and in improving access to the boundary and strategic locations within the lease. None of these activities will interfere with the ongoing pastoral activities but will begin the process of management that will underpin future conservation activities. Some of the waters will be closed down and removed as destocking progresses and following the initial planning required to determine the strategic requirements for future water supplies.

This action plan will be reviewed and amended at least annually and have additional activities included over time as further strategic planning is completed and resources become available.

Action plan details not included here.