Report to the
Department of Conservation and Land Management
Western Australia

Management Planning for Ramsar Sites in the Kimberley Region of Western Australia

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Credits

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Executive Summary

1. In mid-1996, the Western Australian Department of Conservation and Land Management, using funds from the National Wetlands Program of Environment Australia (Biodiversity Group), engaged Wetlands International - Oceania to undertake a project on Management Planning for Ramsar sites in the Kimberley region.

2. The Department has responsibility for implementing the Convention on Wetlands (Ramsar Convention) in Western Australia. Four wetland sites in the Kimberley are listed under the Convention: Lakes Argyle and Kununurra; the Ord River Floodplain; Roebuck Bay; and Eighty Mile Beach. The project work specifications also called for investigations at Lake Gregory, a potential Ramsar site.

3. A team comprising Wetlands International - Oceania, the Environmental Research Institute of the Supervising Scientist, a consultant on Aboriginal issues and Department officers conducted site visits and consultations during June-July 1996.

4. This report presents information on the Ramsar Convention, including wise use principles, management planning, designing a monitoring program and change in ecological character. Comprehensive descriptions are provided for each Ramsar site: for management purposes Lakes Argyle and Kununurra, and Eighty Mile Beach and Mandora Marshes (part of the Eighty Mile Beach Ramsar site), are treated separately. Information for each site covers biological attributes, cultural values, tenure and management regime, threats to the site and detailed recommendations for the site.

5. Site-specific recommendations are grouped into sets of actions proposed for the Kimberley Ramsar sites and Lake Gregory, in line with obligations under the Ramsar Convention: description of ecological character of sites; monitoring changes in ecological character; and management to minimise adverse impacts caused by human activities. The actions are addressed to the Department's Kimberley Regional Manager, District Managers and/or Regional Ecologist.

6. The need to clarify planning and management responsibilities at all sites is paramount. In particular, cooperative arrangements should be established with the WA Water and Rivers Commission in regard to Lakes Argyle and Kununurra.

7. Marine Park proposals are relevant to management planning at Ord River Floodplain, Roebuck Bay and Eighty Mile Beach. Proposed actions cover linkage of the two processes, inter-departmental communication, clarification of site boundaries, and contingency plans.

8. Urgent management action is needed at the springs within Mandora Marshes to reduce degradation caused by domestic cattle. This action includes consultations with pastoralists, site mapping, fencing, and procedure for advising Environment Australia of changes in ecological character of the site.

9. In regard to Lakes Argyle and Kununurra, which are artificial waterbodies, the Department is urged to undertake long-term research, especially on the relationship of water-levels, biota and impact of cattle grazing at Lake Argyle. The

Ramsar Information Sheet for Lake Kununurra should be updated in view of changes that have occurred in the biota.

10. At regional level, specialist advice is needed to develop a program to monitor changes in the ecological character of all Kimberley Ramsar sites.

11. In regard to the interests of Aboriginal people in the Ramsar sites, which include Native Title claims over most of the sites, it is proposed that the Regional Manager ensure inclusion of those interests in discussions on management planning.

12. It will be necessary to clarify the boundaries of each Ramsar site and make adequate maps available to site managers and Environment Australia.

13. In terms of short-term implementation of proposed actions, it is suggested that the Department use the Kimberley Regional Management Plan as a means to progressing some of the actions. Meanwhile, the Department could seek support through State/Commonwealth consultations on the Natural Heritage Trust and through the National Wetlands Program, for implementation of obligations under the Ramsar Convention.

1.0 Introduction

The Western Australian Department of Conservation and Land Management has initiated management planning exercises for Internationally Important Wetlands (known as Ramsar sites) in the Kimberley region of Western Australia. The provision of management plans for Ramsar sites is a national obligation under the Ramsar Convention for Internationally Important Wetlands[1]. The Department of Conservation and Land Management is working towards fulfilling this obligation with support from the National Wetlands Program which is administered by the Wetlands, Waterways and Waterbirds Unit of Environment Australia (Biodiversity Group).

A summary of the work specifications and approach taken is presented below. This is followed by a summary of key aspects of the Ramsar Convention and an overview of the current Ramsar sites in the Kimberley.

1.1 Work Specifications

The initial phase of the management planning process has involved the collection and assessment of data and information on the management status of four existing Ramsar sites in the Kimberley (Lakes Argyle and Kununurra, Ord River Floodplain, Roebuck Bay, Eighty Mile Beach). The consultants were also requested to prepare information on Lake Gregory which is not at present a Ramsar site. The ecological tasks were undertaken by personnel from Wetlands International - Oceania and from the Environmental Research Institute of the Supervising Scientist under contract to the Department of Conservation and Land Management. A specialist consultant also formed part of the team to address issues for Aboriginal people. An abbreviated form of the work specifications is presented below (see Appendix 1 for the complete version).

A thorough assessment of the management status of the five sites was required, taking into account the Ramsar Convention guidelines on management planning and recommendations on the essential character of wetlands and the need for zonation within wetland reserves. To achieve this goal the following process was agreed with the Department in regard to the work specifications:

- Advise and consult with relevant landholders and Aboriginal groups regarding the management planning study and the implications under the Ramsar Convention for these areas.
- Undertake a thorough analysis of existing and potential threats to the ecological character of these sites from activities occurring, or proposed, at or near the site and within the surrounding catchment.
- Assess the cultural heritage significance of each of the wetlands.
- Assemble information needed as background for the preparation of management plans for these sites.
- Identify critically important investigations or other actions required prior to preparation of plans for these sites.

[1] Official title: Convention on Wetlands of International Importance Especially As Waterfowl Habitat

Much of the information for this analysis was derived from a thorough search of the literature backed by consultation with landholders, Aboriginal groups and technical experts. This included information previously collated for the nomination of the four Ramsar sites in 1990 (Department of Conservation and Land Management 1990) and from the Directory of Important Wetlands in Australia (Australian Nature Conservation Agency 1996). Information on the Ramsar Convention was also available from published sources (e.g. Davis 1993, 1994; Finlayson 1996a, 1997; Dugan 1990) and liaison with personnel familiar with the operation of the Convention and the development of various guidelines and procedures for promoting the conservation and wise use of wetlands at a global scale.

The potentially contentious issue of land ownership and access was handled by prior consultation and in collaboration with the Department of Conservation and Land Management personnel in the field. Great effort was taken to contact local communities and address the work specification covering consultation and the provision of advice. This was regarded as a two-way process and the results have been incorporated in the analysis presented below.

Ecological Fieldwork

The fieldwork component of the investigations was undertaken in June and July 1996. It was divided into East and West Kimberley components. The East Kimberley wetlands (Ord River Floodplain, Lake Kununurra, Lake Argyle) were visited during 25 June to 2 July. Fieldwork was conducted at the West Kimberley wetlands (Roebuck Bay, Eighty Mile Beach, Mandora Marshes) during 4-9 July. Lake Gregory was not visited.

The Department's Kimberley Regional Ecologist (Gordon Graham) and Principle Research Scientist with wetland responsibilities (Jim Lane) accompanied the two consultant ecologists to meetings and during the fieldwork. At Broome the Department's Conservation Officer (Tim Willing) also accompanied the team and contributed extensive local knowledge.

Fieldwork on Issues for Aboriginal People

This preliminary investigation covered the following issues:

- Native Title claims over or adjacent to the wetlands
- Documented sites of cultural significance for Aboriginal people
- Issues of importance for Aboriginal people associated with the management of the wetlands
- Investigations required prior to the preparation of management plans for the wetlands
- Recommendations for appropriate procedures for future consultations with Aboriginal people related to the development of management plans
- Recommendations for appropriate strategies for the resolution of possible conflicts.

Preliminary research was undertaken in Perth to identify areas under claim through the National Native Title Tribunal, cultural sites registered with the Heritage and Culture Division of the Aboriginal Affairs Department and information from the Heritage Commission on the Register of the National Estate.

Field consultations took place during 1-3 July in Kununurra and 4-9 July in Broome.

The information gained from the combined ecological and cultural investigations is presented below in the form of an analysis of each site and then specific recommendations.

1.2 The Ramsar Convention

The conservation and wise use of wetlands has received considerable attention in recent years. The Ramsar Convention for Internationally Important Wetlands[2] has been at the forefront of this effort. The Convention was formulated at a meeting in the Iranian city of Ramsar in February 1971 and came into force in December 1975. As such, it is the first of the modern global inter-governmental treaties on conservation and wise use of natural resources. Australia was the first Contracting Party to the Convention and in 1996 hosted the Sixth Conference of the Contracting Parties in Brisbane.

The official contact point for the Ramsar Convention within Australia is the Wetlands, Waterways and Waterbirds Unit of Environment Australia (Biodiversity Group) which maintains links with State/Territory governmental agencies with specific responsibilities for wetland management. Environment Australia only exercises direct control over Ramsar matters on Commonwealth land. In Western Australia the responsible agency is the Department of Conservation and Land Management which joins other States and Territories in regular informal and formal discussions on the Ramsar Convention.

Contracting Parties to the Convention have an obligation to promote the conservation of all wetlands within their territory through a range of actions (Davis 1994):

- Completing wetland policies and promoting the wise use of wetlands
- Nominating specific sites to the List of Wetlands of International Importance and continually monitoring them to ensure that they retain their special ecological characteristics
- Promoting capacity building and technology transfer through the training of wetland managers
- Consulting with each other, particularly in the case of shared wetlands, water systems or resources such as migratory birds.

To assist Contracting Parties to meet this obligation the Convention has approved resolutions and recommendations and provided guidelines on specific subjects such as wetland policies and planning, criteria for listing wetlands of international importance, an information sheet for listing a site, monitoring and change in the ecological character of important sites. These are briefly described below with much of the information available in The Ramsar Convention Manual (Davis 1994).

1.2.1 Wise Use

A major feature of the Ramsar Convention is the promotion of the wise use of wetlands. Guidelines to assist Contracting Parties in making wise use of their wetlands have been prepared (Davis 1993) and a definition of Wise Use was adopted in 1987:

> *The wise use of wetlands is their sustainable utilisation for the benefit of humankind in a way compatible with the maintenance of the natural properties of the ecosystem.*

[2] Official title: Convention on Wetlands of International Importance Especially As Waterfowl Habitat

In the Australian context, land use (including wetlands) is conducted under a National Strategy for Ecologically Sustainable Development (Commonwealth of Australia 1992) that aims to meet the needs of people today whilst also conserving the ecosystems for the benefit of future generations. Thus, land use must effectively integrate economic, environmental, and social considerations and link these to inter-generational equity and adopt a precautionary approach for preventing environmental degradation. Intricately linked with the National Strategy for Ecologically Sustainable Development is the National Strategy for the Conservation of Australia's Biological Diversity (Anon. 1994). In line with the Convention on Biological Diversity this strategy aims to *"protect biological diversity and maintain ecological processes and systems"*.

The guidelines for the implementation of wise use are found in Davis (1993) and were summarised by Finlayson (1996a) and are shown in Table 1. The guidelines provide underlying principles.

Table 1 Summary of the key issues contained within the Ramsar Convention guidelines for the wise use of wetlands (based on Finlayson 1996a).

Establishment of national wetland policies
• Establish and/or develop institutional and organisational arrangements
• Develop a coordinated national approach
• Establish working groups or advisory boards
• Develop and implement policy/legislation and other appropriate measures
• Periodically review existing legislation
• Develop and implement general wise use legislation
• Develop and implement legislation for specific wetland sites
• Periodically review judicial arrangements
• Develop cross-border cooperation and management arrangements
Improved knowledge of wetlands and their values
• Undertake and maintain an inventory of wetlands and their values
• Monitor changes in the ecological character of wetlands
• Support research in areas of management priority
• Undertake training for implementing wise use of wetlands
• Develop education and public awareness programs to promote the wise use of wetlands
Action at particular sites
• Incorporate an inter-disciplinary approach
• Consider human activities under local circumstances
• Integrate management planning at a catchment level
• Adopt or refine technologies to ensure wise use

1.2.2 Wetland Policies

Implementation of wise use requires the development of a coordinated approach on a national or regional scale. This can be done with the establishment of wetland policies and appropriate institutional and administrative arrangements. Of considerable importance is the involvement of local people in the decision making process related to wetland use.

Legislation can be used to promote policies that aid the implementation of wise use. It may also be necessary to undertake periodic reviews of existing legislation before developing new pieces. Legislation could cover general issues such as a permit system for activities affecting wetlands, zoning for particular uses, environmental impact assessment and monitoring, management agreements and financial incentives. It could also cover specific sites such as ecologically sensitive areas or reserves.

1.2.3 Management Planning

A management plan or agreement provides the basis for maintaining the ecological character of a wetland and to allow wise use of the resources by various owners, occupiers and interested parties. The management planning process provides this overall agreement and is underpinned by a number of considerations:

- It is a way of thinking which involves recording, evaluating and planning and is subject to constant review and revision and is therefore flexible and dynamic
- It involves the three basic steps of describing, defining objectives and taking necessary actions
- Preparation of an elaborate plan is not an excuse for inaction or delay
- Review of the plan may lead to revision of the site description and operational objectives
- It should be a technical, not a legal document, although it may be supported by appropriate legislation.

Although conditions vary at individual sites the general considerations may be applied worldwide.

The format of a plan may need to meet various legislative requirements, but it will generally contain a preamble and three major sections: description of the site; evaluation and objectives; and action plan/prescriptions. Technical staff will normally participate in all three stages with policy staff reviewing the first two stages before approving finance and implementation of the third stage. A summary of the recommended components of each stage is given in Table 2.

1.2.4 Criteria for Listing Wetlands of International Importance

When joining the Convention a Contracting Party is obliged to designate at least one site for inclusion in the List of Wetlands of International Importance. At any time a Contracting Party may add wetlands to the List, or extend the boundaries of those already listed. Under urgent national interests the boundaries may also be restricted or the site removed from the List. However, restrictions or deletions should be compensated for by the creation of additional sites or the protection of an equivalent area of similar habitat.

To assist Contracting Parties to designate sites of international importance a set of criteria have been drawn up. The current criteria are presented in Table 3. The last change to the criteria was in 1996 with the inclusion of specific criteria based on fish. At the same time it was arranged for the entire set of criteria to be reviewed.

A wetland can be listed as internationally important if it meets one of the criteria. Guidelines for assessing the suitability of wetlands against the criteria have also been prepared.

Table 2 Recommended components of a management plan for a Ramsar site (Davis 1994).

Preamble

- Concise statement of broad governmental policies concerned with production and implementation of the plan.
- Statement of the broad Ramsar obligations of maintaining the ecological character of a listed sites, making wise use of all wetlands, and establishing nature reserves at wetlands.

Description

- Establishes the basis for monitoring to identify any subsequent changes at the site

Evaluation and Objectives

- Evaluation
  - Assessment of the major features of the sites including its biological diversity, naturalness, history, social and economic value, recreational uses and potential for improvement.
- Long-term management objectives
  - Concise expression of intent and derived from the evaluation process.
- Factors influencing achievement of long-term objectives
  - Internal natural factors such as vegetation succession and variations in water level
  - Internal human-induced factors such as spread of invasive alien species, erosion, disturbance and pollution
  - External natural factors such as climate change, variations in currents and sea level
  - External human-induced factors such as diversion of water, increased sedimentation and pollution
  - Factors arising from legislation or tradition such as treaties or access rights
  - Physical considerations such as inaccessibility
  - Available resources such as finance and a skilled workforce
- Identification of operational objectives
  - Taking into account the influence of factors that affect the achievement of long-term objectives
  - Establishment of the limits of acceptable change

Action Plan/Prescriptions

- Workplan
  - Provides management options derived from the operational objectives
- Projects
  - Provides prescriptions to achieve the individual tasks to achieve the operational objectives
  - Establishes record keeping and administrative processes
- Work programs
  - Derived from the individual projects
- Reviews
  - Assessment of the success of the workplan, projects and work program

Table 3 Criteria for identifying wetlands of international importance (Davis 1994).

1. Criteria for representative or unique wetlands

A wetland should be considered internationally important if:

- it is a particularly good representative example of a natural or near-natural wetland, characteristic of the appropriate biogeographical region;
- it is a particularly good representative example of a natural or near-natural wetland, common to more than one biogeographical region;
- it is a particularly good representative example of a wetland, which plays a substantial hydrological, biological or ecological role in the natural functioning of a major river basin or coastal system, especially where it is located in a transborder position;
- it is an example of a specific type of wetland, rare or unusual in the appropriate biogeographical region.

2. General criteria based on plants or animals

A wetland should be considered internationally important if:

- it supports an appreciable assemblage of rare, vulnerable, or endangered species or subspecies of plants or animals, or an appreciable number of individuals of any or more of these species;
- it is of special value for maintaining the genetic and ecological diversity of a region because of the quality and peculiarities of its flora and fauna;
- it is of special value as the habitat of plants or animals at a critical stage of their biological cycle;
- it is of special value for one or more endemic plant or animal species or communities.

3. Specific criteria based on waterfowl

A wetland should be considered internationally important if:

- it regularly supports 20,000 waterfowl;
- it regularly supports substantial numbers of individuals from particular groups of waterfowl, indicative of wetland values, productivity or diversity;
- where data on populations are available, it regularly supports 1% of the individuals in a population of one species or subspecies of waterfowl.

4. Specific criteria based on fish

A wetland should be considered internationally important if:

- it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity;
- it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend.

1.2.5 Information Sheet for Listing a Site

The Information Sheet on Ramsar Sites is the means by which Contracting Parties present information for the list of important sites. It provides an internationally standardised format for describing wetlands and is accompanied by an explanatory note, guidelines for completing the sheet and the Ramsar classification system for wetland types. Where the sheet can not be completed it is requested that particular attention is given to the sections on conservation measures, functions and values and criteria for designation. A detailed map, preferably at 1:25 000 or 1:50 000 scale is also requested with the sheet.

The sheet requests the following information:

- name of the wetland
- location coordinates
- area
- wetland type
- physical and ecological features
- protection status
- ownership
- conservation measures
- land use in and around the wetland
- threats and disturbances in and around the wetland
- physical and social values
- noteworthy fauna and flora
- research and educational information

Contracting Parties are requested to update the information sheet every six years for monitoring purposes. The sheet is now also being used as the basis for describing the baseline ecological character of a site. It is recognised that the sheets will only provide a snap-shot in time, but they contain the minimum level of information necessary for determining management steps to maintain the ecological character of a listed site.

1.2.6 Designing a Monitoring Program

In order to detect actual or potential change in ecological character, regular monitoring is required. For the purpose of the Convention monitoring has been defined as:

> *"the process of measuring change in ecological character in any wetland over a period of time."*

Monitoring differs from general surveillance in that there is a specific reason and method for collecting particular data or information. Whilst monitoring is considered necessary it does not need to be overly sophisticated or expensive. Many monitoring techniques are available and the emphasis should be placed on relevance and applicability to the site concerned. Ideally, the relevance to the site would be contained within a plan of management that provides the institutional means of responding to any adverse change detected by the monitoring program.

1.2.7 Change in Ecological Character

Integral to the conservation and wise use of wetlands is the maintenance of the ecological character of the wetland. A working definition of ecological character was adopted in 1996.

> *The ecological character is the structure and inter-relationship between the biological, chemical, and physical components of the wetland. These derive from the interactions of individual processes, functions, attributes and values of the ecosystem(s).*

As mentioned above, the ecological character of a site is described using the Information Sheet on Ramsar sites and every six years the information is verified. Assessment of the ecological character should be linked to the criterion or criteria fulfilled by the site at the time of designation as internationally important. This indicates certain values of the wetland which might be lost as a result of an adverse change in the ecological character. Changes in the ecological character should be assessed against the baseline status presented in the information sheet, together with any information which has been received subsequently. A working definition of change in ecological character was also adopted in 1996.

> *Change in ecological character of a wetland is the impairment or imbalance in any of those processes and functions which maintain the wetland and its products, attributes and values.*

The Montreux Record is the principal tool of the Convention for highlighting those sites where an adverse change in ecological character has occurred, is occurring, or is likely to occur, and which are therefore in need of priority conservation attention. This information is maintained as part of the Ramsar database and is subject to continuous review.

Placement of a site on the Montreux Record is done at the behest of the Contracting Party concerned. Information may be derived from non-governmental sources, but this is then passed to the Contracting Party for assessment. To assist Contracting Parties in making this assessment a voluntary questionnaire (Appendix 2) has been prepared. The questionnaire contains a basic set of information for assisting the Contracting Party to assess whether or not a site should be placed on this Record. Once a site is placed on the Record the Contracting Party is requested to take remedial action, noting that in some instances, this may take a number of years to achieve. At any stage the Contracting Party can remove the site from the Record.

1.3 Overview of Ramsar Sites in the Kimberley

The four Ramsar sites in the Kimberley were added to the List of Wetlands of International Importance in June 1990. Table 4 presents a summary of the information provided in the description of the sites in 1990 (Department of Conservation and Land Management 1990) and reproduced for the Fifth Conference of the Contracting Parties (Jones 1993). A thorough description of each site was not undertaken as a part of this investigation, but specific features with management relevance have been identified in each of the site assessments.

The four sites were nominated to be designated on the List of Wetlands of International Importance on the basis that they meet a number of criteria (Table 5). The habitats of these wetlands vary from the mangroves and freshwater seasonally flooded lagoons on the Ord River Floodplain, the sandy beach and the Mandora Marsh palaeo-drainage system of the Eighty Mile Beach listing, and the tropical marine embayment of Roebuck Bay.

Table 4 Summary description of the four Ramsar sites in the Kimberley region (information from Department of Conservation and Land Management 1990, Jones 1993).

Site	Description	Location	Area (ha)
Ord River Floodplain	Mangroves and saltflats, seasonally flooding plains and permanent freshwater lagoons.	50 km NW of Kununurra Eastern Cambridge Gulf 15° 15'S 128° 22'E	130 000
Lakes Argyle & Kununurra	Deep lakes and fringing inundated grassland and emergent macrophytes and trees.	Near Kununurra 16° 20'S 128° 42'E	150 000
Roebuck Bay	Sand beach, shrubland, mudflats and mangroves, and grass plains.	Near Broome North-west coast of WA 18° 07'S 122° 16'E	50 000
Eighty Mile Beach	White sand beach fringed by sand dunes and mudflats, and salt marshes.	Between Cape Missiessy and Cape Keraudren North-west coast of WA 19° 31'S 120° 48'E	125 000

The Ord River Floodplain and Lakes Argyle and Kununurra also met the general criteria based on plants and animals, especially that for supporting an appreciable assemblage of species with the mangroves of the former being a particular feature. Roebuck Bay and Eighty Mile Beach are also very important sites for shorebirds, including many that migrate to the Northern Hemisphere, and thus meet both the general criterion of being of special value for waterbirds at a critical stage of their biological cycle and the specific criteria for waterfowl numbers. (This area regularly supports over 500 000 birds, most of them migratory.) Thus overall the Kimberley Ramsar sites are considered internationally important on the basis of all three criteria in use at the time of nomination (the fish criteria were not used before March 1996).

For the purposes of this report the "Lake Argyle and Kununurra" site has been considered as two sub-sites. Lake Argyle and Lake Kununurra are two permanent wetlands that have been formed by dams across the Ord River. Lake Argyle is the main catchment dam while Lake Kununurra is a downstream diversion dam to direct water on to the irrigation areas around Kununurra. As such, when considering management of these wetlands it is appropriate to consider them separately.

The "Eighty Mile Beach" site has also been divided into two sub-sites: Eighty Mile Beach and the geographically separated Mandora Marshes.

Separate treatment of these four wetlands in this report was discussed and agreed with the Department of Conservation and Land Management during the fieldwork phase.

Table 5 Nominations details for the Ramsar-listed Wetlands in the Kimberley

Ramsar Criteria	Ord River Floodplain	Lakes Argyle and Kununurra	Roebuck Bay	Eighty Mile Beach
Criteria for representative or unique wetlands: Good example of specific type of wetland characteristic of its region	Yes		Yes	Yes
General criteria based on plants or animals:				
2(a) Assemblage of rare, vulnerable or endangered species or appreciable numbers	Estuarine crocodile Zitting Cisticola	Freshwater Crocodile		
2(b) Special value for maintaining the genetic and ecological diversity of a region	Mangrove habitat			
2(c) Habitat at critical stage of biological cycle			Shorebird migration	Shorebird migration
Specific Criteria based on Waterfowl:				
3(a) Regularly supports 20 000+ waterfowl		Waterfowl	Shorebirds	Shorebirds
3(b) Substantial numbers indicative of wetland values, productivity or diversity	Waterfowl			
3(c) more than 1% of waterfowl population			Shorebirds	Shorebirds

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Lake Argyle

2.0 Lake Argyle

Located at 16° 15' S, 128° 45' E, Lake Argyle lies in the north Australian monsoon tropics (Fig.1). The mean annual rainfall throughout the catchment, ranging from 439 mm to 720 mm (Ruprecht 1995), is essentially restricted to a very hot, humid 'wet' season from December to March. Wet season rainfall is rarely uniform throughout the season or across the landscape. It is characterised by a predominance of temporally irregular, spatially restricted, high intensity convection storms to which are added annually unpredictable but more extensive rainfall events from tropical depressions associated with decaying cyclones. The weather during the middle of the dry season is desert-influenced, being very dry and cool and dominated by persistent south-easterly trade winds. Overall, potential evaporation is over four times the mean annual rainfall thus highlighting the net aridity of the region.

2.1 Physical Attributes

Lake Argyle is an artificial lake formed by a dam across the Ord River. It was created in 1972 as the storage reservoir for the Ord River Irrigation Area downstream (Western Australia Department of Agriculture 1995). Lake Argyle is the largest freshwater body in northern Australia, with depths up to 45 m. It is a unique freshwater resource in a region where the majority of waterbodies either dry out or become much diminished during the long dry season each year.

The lake has a spillway located 7 km north-east of the dam. Up till 1995 spillway overflow occurred when the lake height was above 86.7 m AHD (Australian Height Datum). During the 20 years prior to 1995 the lake only fell below the level of the spillway on 4 occasions (Water Authority data). In late 1994 the spillway overflow level was increased by 6 m to accommodate increased water use for hydro-electric power generation (Western Australian Department of Agriculture 1995). This is expected to raise the average lake height by about 1 m (Western Australian Department of Agriculture 1995). The lake has only achieved a flood height greater than the new spillway overflow height on about four occasions in the last 20 years. Unlike the old spillway the new one has a foot valve which releases a small flow down Spillway Creek when the lake is below the overflow height.

The mean annual flood height of the lake throughout the 20 year period prior to 1995 was almost 90 m AHD (Water Authority data). However given the highly variable annual rainfall there was considerable variation about this mean. The maximum flood height recorded during this time was 97.3 m AHD in 1982 while a minimum flood height of 83 m AHD occurred in 1990. The constancy of annual flood heights from year to year is possibly an important determinant of aquatic plant life in the lake. During the 20 year period from 1976 to 1996 the flood height of one year has been within 1 m of the flood height of the succeeding year on only eight occasions. Furthermore the difference between maximum flood heights in successive years has been greater than 5 m on five occasions.

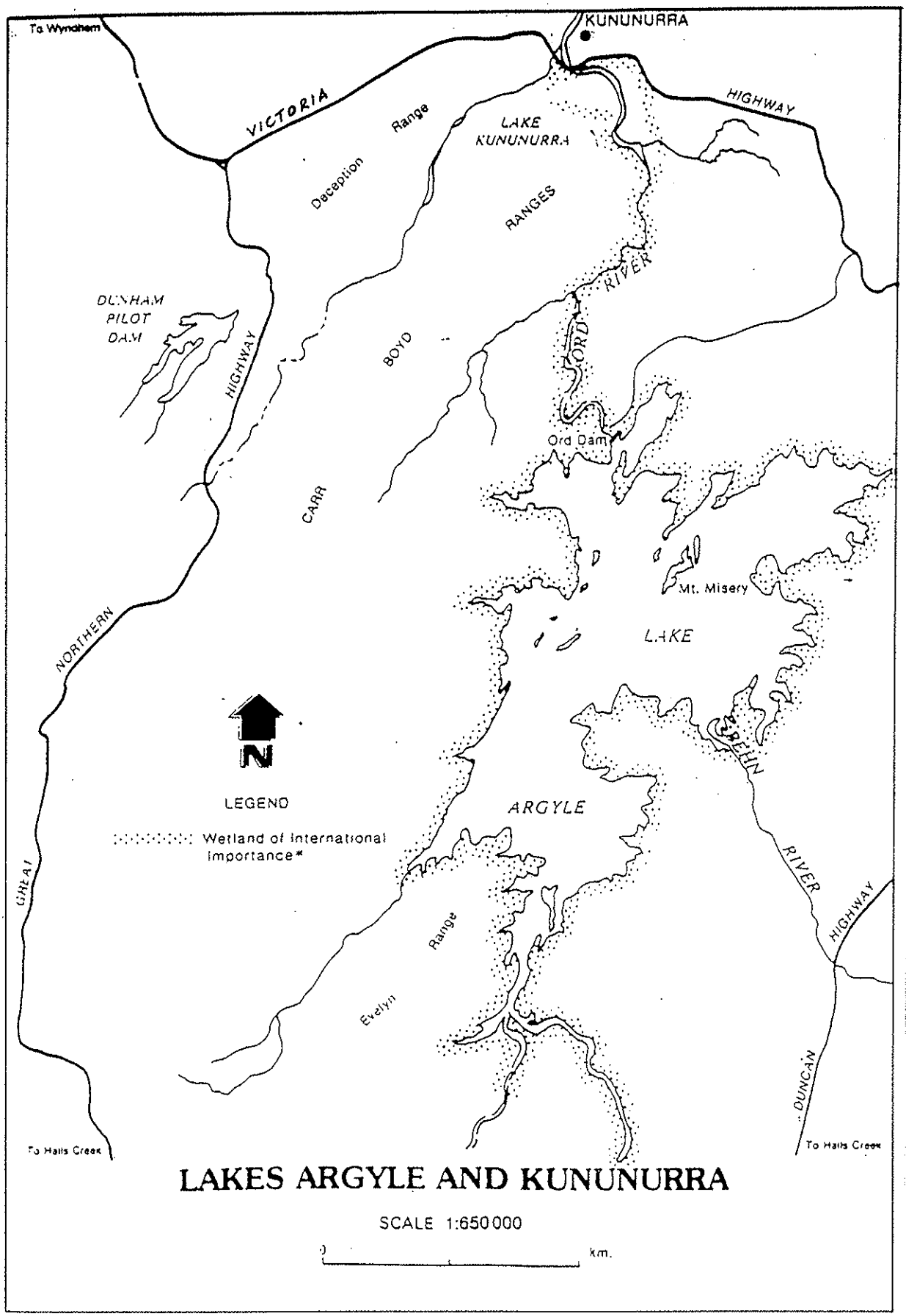


Figure 1. Lakes Argyle and Kununurra
(Department of Conservation and Land Management 1990)

In a seasonal context the annual total drawdown of water from Lake Argyle prior to 1995 has been around 4-5 m/year (Water Authority data). This draw-down comprises water used for irrigation, evaporative loss and runoff down the spillway. With increased water use arising from expansion of the Ord Irrigation Area the annual seasonal fluctuation of the lake may increase.

The surface area of Lake Argyle changes dramatically within and between years. This is due as much to variation in annual rainfall as it is to the characteristics of the hinterland. While the western shores of the lake are dominated by the steep, rocky slopes of the Carr Boyd ranges, the landscape along the eastern and southern shores is very flat with extensive areas having slopes of less than 1 in 500. Relatively small changes in the lake water level can thus cause large changes in the area flooded. At the new spillway height the lake covers some 980 km^2 while at its maximum flood height this could increase to around 2 072 km^2 (Western Australia Department of Agriculture 1995).

The catchment of Lake Argyle has an area of around 46 000 km^2 (de Salis 1993). Steep dissected ranges of sandstone, metamorphosed sandstone, quartzites and schist characterise the upper reaches of the catchment while along the expansive Ord river valley, upstream of the lake, highly erosion-prone mudstones and limestones occur (de Salis 1993, Traves 1955, Stewart *et al.* 1970).

The major rivers draining into the lake are the Ord, the Bow and the Behn. Contemporary (post-European settlement) sediment levels (Kata 1978) in the discharge from these rivers are high due to extensive soil disturbance throughout the catchment from pastoral use. Sediment yields are greatest during the early half of each wet season when unprotected dry surface soils are exposed to sudden, intensely erosive, deluges of rain associated with thunderstorms. Sediment discharge into Lake Argyle is at present estimated to be 24 million tonnes/year (Ruprecht 1995). At the pre-1995 spillway height 30 per cent of the storage volume of Lake Argyle was expected to be filled with alluvium within 100 years. With the new spillway 33 per cent of the lake is expected to be filled by sediment in around 184 years (Ruprecht 1995). Water of the lake, particularly in the southern regions, in the vicinity of riverine discharge is highly turbid throughout the wet season. During the dry season water clarity improves greatly. Deltas are forming wherever riverine discharge occurs around the margin of the lake.

2.2 Biological Attributes

2.2.1 Flora

The process of establishment of aquatic and riparian plant communities in and around Lake Argyle throughout its (brief) 25 year history has not been documented.

An immediate consequence of the creation of the lake was large scale flooding of dry land environments which were formerly vegetated mostly by semi-arid open woodland and grassland plant communities (Gardiner 1945, Perry 1970). Flooded areas that previously supported woodland communities provide a legacy of dead emergent trees in shallower parts of the lake (Photograph 8). While these continue to offer breeding and roosting opportunities for semi-aquatic fauna, in the long term this resource will decline.

Photograph 1 Aerial view of islands in Lake Argyle
(28 June 1996, Doug Watkins)

Photograph 2 Aerial view N across Lake Argyle from above Lily Spit.
Note limited growth of shrubs and trees along the shoreline.
(28 July 1996, Doug Watkins)

Photograph 3 Boat launching area near the Lake Argyle dam wall.
(1 June 1996, Doug Watkins)

Photograph 4 Aerial view of aquaculture enclosures,
adjacent to the Lake Argyle Tourist Village.
(28 June 1996, Doug Watkins)

Photograph 5 Small island near Djibigam Gorge.
Note no development of fringing vegetation.
(1 July 1996, Doug Watkins)

Photograph 6 Bullanyin Island, showing the wash zone caused by wave action and changes in water levels.
(1 July 1996, Doug Watkins)

Photograph 7 Extensive mats mainly of *Potamogeton tricarinatus* and *Vallisneria spiralis* near Lily Spit.
(1 July 1996, Doug Watkins)

Photograph 8 Shallow water on western shore near Flying Fox Creek. Note dead eucalypts in the water, mats of *Pseudoraphis spinescens* and fringing acacia stands. (2 July 1996, Doug Watkins)

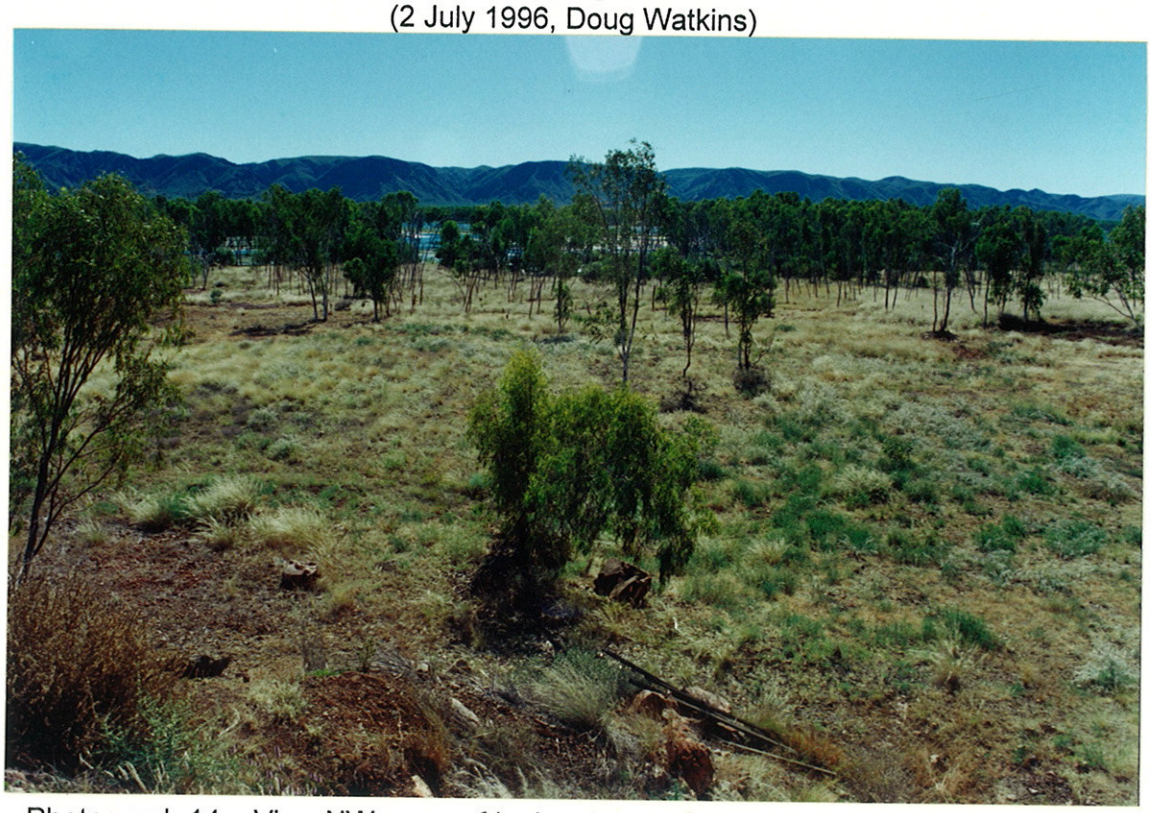
Photograph 9 Western shore near Flying Fox Creek.
(9 July 1996, Doug Watkins).

Photograph 10 Jim Lane, Gordon Graham and Kym Brennan on the eastern shoreline near Grass Castle Plains.
(9 July 1996, Doug Watkins).

Photograph 11 'Island" of river redgum *Eucalyptus camaldulensis* and mat of *Pseudoraphis spinescens* in the mouth of Flying Fox Creek.
(2 July 1996, Doug Watkins)

Photograph 12 Jim Lane standing in the 'island ' of river redgum at the mouth of Flying Fox Creek.
(2 July 1996, Doug Watkins)

Photograph 13 Margin of Flying Fox Creek showing range of tree age and dead saplings.
(2 July 1996, Doug Watkins)



Photograph 14 View NW across fringing river redgum stands in Flying Fox Creek
(2 July 1996, Doug Watkins)

Present-day aquatic macrophyte vegetation in Lake Argyle mostly grows in water less than 5 m deep. The broad, low gradient margins along the eastern side of the lake are thus much more extensively vegetated than the western margins with their steep rocky banks. Though lacking any detailed survey data the overwhelming first impression is that the species richness of aquatic macrophytes is very low. Floating surface mats of the substrate-attached species *Potamogeton tricarinatus* (Photograph 7) and spiny mud-grass *Pseudoraphis spinescens* (Photographs 8, 11) are common as are two other substrate-attached species *Myriophyllum verrucosum* and *Vallisneria spiralis* (Department of Conservation and Land Management 1990). Apart from these only *Sesbania cannabina*, an annual (wet season) emergent shrub which grows in a variety of habitats but most often in seasonally waterlogged soils, seems widespread. Such apparent low species diversity could be symptomatic of the short history of the lake in relation to slow natural rates of seed dispersal and establishment from elsewhere. Species richness could thus slowly increase through time. Alternatively the net effect of the current hydro-pedological regime (i.e. the type of waterbody, its flooded sedentary soils and the overall impact of large annual, and enhanced seasonal variations in water level) could be prohibitive to all but a few plant species with exceptionally broad environmental tolerances. With this, the current macrophyte assemblage might not alter to any great extent in the near future. Compared to other permanent tropical freshwater wetlands in northern Australia (further north than the latitude of Lake Argyle), emergent sedges (Cyperaceae) and grasses (Poaceae), free floating plants and the range of 'waterlily' type plants are scarce or absent. This assessment is however based on extremely limited data.

The development of riparian woodlands and forest around the margin of Lake Argyle is very patchy and is most conspicuous at points where major rivers discharge into the lake. Here, dense stands of river redgum *Eucalyptus camaldulensis* have established on levees and 'islands' associated with deltas (Photograph 11 - 14). These stands appear to be located on the shoreline at about 90 m AHD, i.e. at the mean flood height of the last 20 years. If the long term mean flood height of the lake increases then these populations may gradually die out and be replaced by new stands at the new mean level. Current populations of *E. camaldulensis* are composed of dense, relatively young, un-hollowed, slender trees (<0.5 m diameter at breast height) to less than 10 m tall.

Elsewhere around the edge of the lake there is little in the way of riparian tree or shrub development apart from occasional stands of *Acacia holosericea*. These seem to be associated with sand deposits above 90 m AHD. Consisting almost entirely of over-mature plants it is probable they arose from mass germination events caused by abrasive wave-on-sand action during storms in a year of above average flood height (Photograph 8 - 9). In general the striking absence of development of fringing riparian woodland and forest along much of the margin of the lake suggests either that the hydro-pedological characteristics of sedentary soils are unfavourable and/or that grazing pressure from cattle is prohibitively high (Photograph 2).

No plant species are considered to be notably rare, threatened or endemic at Lake Argyle (Australian Nature Conservation Agency 1996). No aquatic weeds have been recorded, however the exotic woody weeds *Parkinsonia aculeata*, *Calotropis procera* and *Jatropha gossypifolia* could eventually form dense contiguous thickets along the riparian zone. Their infestations at present appear to be patchy though widespread. Past and current rates of weed colonisation and spread around the margin of the lake have not been documented and there is currently no weed control.

2.2.2 Fauna

Animal life other than vertebrates appears to have been little studied in Lake Argyle. The histories of demise or colonisation of substrates by invertebrate species, either annually since the lake was formed or in a seasonal context have not been documented. The relative productivity of invertebrates on flooded sedentary soils and alluvial soils is unknown. From our brief inspection of a sandy alluvial deposit along the south-west shoreline dense accumulations of shells of a small bivalve were observed. These could potentially form the basis of a significant food resource for a number of species of wading birds and dabbling ducks.

Around 15 species of fish are known from the lake (Allen and Leggett 1990; Australian Nature Conservation Agency 1996). The northern barramundi *Lates calcarifer*, a popular sport and table species, has persisted though numbers have probably dwindled in the lake since the dam was built because they are now isolated from the coastal estuaries where they normally breed. However, there are plans to periodically restock the lake with fingerlings (Neville Stuart, Lake Argyle Fisheries, pers. comm.). In contrast, populations of catfish appear to have 'exploded' since formation of the lake. One species *Arius midgleyi*, traded as 'Silver Cobbler', forms the basis of a local fishery. The giant glassfish *Parambassis gulliveri*, believed to be restricted to the Ord River basin, has also been recorded from Lake Argyle. No other endemic fish species are known from the lake.

Both species of Australian crocodile have been recorded from Lake Argyle. Estuarine crocodile *Crocodylus porosus* numbers are low and probably always were along the upper reaches of the Ord River prior to damming. The current population is isolated from the tidal estuarine environments where most breeding usually occurs. In contrast numbers of freshwater crocodiles *Crocodylus johnstoni* are high though estimates vary considerably from 10,000 to 20,000 individuals (Gordon Graham, Conservation and Land Management, pers. comm.). Freshwater crocodiles are seldom seen in open water and their numbers are low where there are steep shores. Numbers are greatest where some protection is afforded and slopes are gentle. These areas occur around the mouths of creeks and rivers and the throughout north-eastern embayments (Gordon Graham, Conservation and Land Management pers. comm.).

It was predominantly on the basis of its waterbird populations that Lake Argyle was nominated for Ramsar listing (Department of Conservation and Land Management 1990). The first waterbird censuses of the lake were undertaken in 1979 and 1980 (Gowland 1983) by staff of Agriculture WA investigating the impacts of birds on commercial agriculture in the Ord River Irrigation Area. Since 1981 only one waterbird survey has been conducted by the Royal Australasian Ornithologists Union in August 1986 (Jaensch and Vervest 1990).

Up to 74 waterbird species have been recorded on Lake Argyle including 22 listed under international conservation treaties (Australian Nature Conservation Agency 1996). A count of 181 400 birds was recorded in August 1986 (Gowland 1983) and it was estimated that > 100 000 birds probably use the lake annually. Common species include Eurasian Coot *Fulica atra*, Hardhead *Aythya australis*, Grey Teal *Anas gracilis*, Pacific Black Duck *Anas superciliosa*, Wandering Whistling-Duck *Dendrocygna arcuata* and Magpie Goose *Anseranus semipalmata* while numbers of Oriental Pratincole *Glareola maldivarum*, Wood Sandpiper *Tringa glareola*, Radjah Shelduck *Tadorna*

radjah, Green Pygmy-Goose *Nettapus pulchellus*, Comb-crested Jacana *Irediparra gallinacea*, Yellow Chat *Ephthianura crocea* and Glossy Ibis *Plegadis falcinellus* are significant either State-wise or nationally. The shoreline of the lake attracts up to 15 species of migratory wading birds. Oriental Pratincole is abundant throughout the wet season while others such as Little Curlew *Numenius minutus* probably only stage during the September to December period before dispersing elsewhere as the wet season develops. The overall level of use of the lake by migratory shorebirds, particularly as a staging site, is probably underestimated given that the only ground counts to have been conducted have been outside the main staging period. The highest concentrations of waterfowl in the lake are associated with shallow water along the eastern shores. Bird numbers tend to rise throughout the dry season suggesting that the lake acts as refuge as waterbodies elsewhere in the region begin to dry up. The overall importance of Lake Argyle in the greater regional setting as a refuge for waterfowl has never been determined but, given its permanency it is likely to be substantial.

Twelve species of waterbird have been recorded breeding on the lake. These have included large populations of Pied Cormorants *Phalacrocorax varius* nesting in several colonies in dead trees along the eastern margin of the lake.

There has only been a single assessment of the mammal fauna in and around Lake Argyle since it was created (Kitchener 1978). The only 'aquatic' mammal is the water rat *Hydromys chrysogaster* but present day numbers and distribution are unknown. On the margins of the lake the most visually conspicuous mammals are introduced cattle. The boundaries of adjacent pastoral properties are poorly fenced and cattle densities appear to be high around substantial sections of the low gradient southern and eastern shorelines. The shoreline of the lake has probably been highly impacted by cattle throughout its history and the role cattle play in habitat maintenance, weed dispersal and perhaps even weed suppression has not been investigated.

2.3 Cultural Values

2.3.1 Aboriginal Cultural Values

The major cultural issues for Aboriginal people in the Kununurra area relate to the current Native Title claims. Lake Argyle and Lake Kununurra form part of the Miriuwung Gajerrong Native Title Claim No 1. The claim was lodged by the Aboriginal Legal Service of Western Australia on behalf of the claimants in April 1994 and was accepted by the National Native Title Tribunal in May 1994 (Appendix 3). The majority of the claimants are represented by the Aboriginal Legal Service and the Northern Land Council. A number of Kija people, who live in the Turkey Creek area, are joint claimants and they are represented by the Kimberley Land Council.

The application is for land and water in and around Kununurra, Wyndham, Cambridge Gulf and Turkey Creek in Western Australia and the Keep River National Park in the Northern Territory. The area includes Lake Kununurra and Lake Argyle and Lacrosse, Kanggurrya, Pelican, Monsmont and Guy Reid Islands (Appendix 3). The same claimants have lodged a further Native Title claim that includes Ord River Floodplain (Miriuwung Gajerrong No. 2) (Appendix 4).

In respect of the above there are 133 interested persons registered with the National Native Title Tribunal including the Commonwealth and the Western Australian

Governments. The Native Title Tribunal referred the claim to the Federal Court in February 1996 after preliminary mediation between the interested parties because it was felt there was no possibility of an agreement between all the parties. This move was supported by the claimants and the State Government. The case is set down for hearing in March 1997.

There was little interest in discussing issues related to Lake Argyle during the field work because:

- the Federal Court hearing on this claim was pending, and
- the claimants were involved in intensive negotiations with the State Government and the East Kimberley Shire in relation to their Miriuwung Gajerrong No. 2 claim (Appendix 4) and the Ord Stage 2 Project.

A number of parties were contacted including:

- Aboriginal Legal Service, Kununurra
- Bob Hannan, Miriuwung Gudjerrong Families Land Council
- Ben Ward, Warringarri Aboriginal Corporation
- David Neary, Mirima Dawang Worlab-gerring Language Centre
- Ray Blackwood, Aboriginal Affairs Department
- Project Officer, Aboriginal and Torres Strait Islander Commission

Correspondence relating to the project was forwarded to each organisation and a meeting was requested. Meetings to discuss the Ramsar status and proposed management planning process were held with representatives from the Mirima Language Centre, Aboriginal Affairs Department and the Aboriginal and Torres Strait Islander Commission. The representative from the Mirima Language Centre emphasised the importance of the areas to Mirima people and the importance of including these people in any discussions about management.

Although Mr Hannan was not in Kununurra at the time of the field work he advised that he would like to be kept informed of what was happening. He also requested that representation be made through the Native Title Tribunal or that the Minister should approach him directly [sic]. He expressed the opinion that once the Native Title issue was resolved this would clarify future management issues. His view was that extensive damage had already been done to the site by pastoral activity.

As mentioned above, over the past 12 months the claimants have been focusing on negotiations relating to the Ord Stage 2 Project. A number of agreements have been negotiated by the Working Party, which includes representatives from Aboriginal groups, the State Government and the Shire. The success of these negotiations indicates that despite conflicting interests related to the area under claim, properly structured consultation and negotiation processes can yield positive results.

The site register held by the Heritage and Culture Division of the Aboriginal Affairs Department lists a number of ethnographic and archaeological sites within and adjacent to Lake Argyle and Lake Kununurra wetland sites.

2.3.2 Other Cultural Values

Lake Argyle is listed on the Register of the National Estate.

2.4 Tenure and Management Regime

2.4.1 Tenure

Tenure under the Land Act

Ownership and management of water in Lake Argyle is vested with the Western Australian Water and Rivers Commission. Engineering assets however, such as the dam wall and associated hardware are owned and managed by another WA Government agency, the Water Corporation.

The boundary of the Ramsar-listed area is poorly defined due to the scale of the map in the nomination documents (Department of Conservation and Land Management 1990). This issue is currently being addressed by the Department of Conservation and Land Management. The 95 m AHD contour, as shown on P.W.D. W.A. 53375, has been recommended as providing an official boundary.

Native Title

Lake Argyle and Lake Kununurra form part of the Miriuwung Gajerrong Native Title Claim No 1. The claim was lodged by the Aboriginal Legal Service of Western Australia on behalf of the claimants. This application was referred to the Federal Court in February 1995 and has been set down for hearing in March 1997.

Proposed Lake Argyle and Carr Boyd Range National Park

The Department of Conservation and Land Management has proposed that a 125 000 ha National Park be gazetted covering the Carr Boyd Range and the islands of Lake Argyle (Burbidge *et al.* 1991). This proposal supports those made by the Conservation Through Reserves Committee (1977) and the Environmental Protection Authority (1980). The Carr Boyd Range section would include all of western shoreline of the lake from the dam wall south to Flying Fox Creek.

2.4.2 Site Management

Access to the site is limited. A 50 km, all-weather, sealed spur-road from the Victoria Highway provides access to the Dam and all tourist facilities at the northern end of the lake. Vehicle access to other sections of the lake is only via non-gazetted 4WD station or mining exploration tracks. The level of public use of these roads is not documented though probably low.

The primary historical aim of the Water and Rivers Commission was to manage Lake Argyle to ensure that water quality and quantity requirements for irrigation were satisfied. Water supply for power production is now also an important consideration with the commissioning of a hydro-power station on the dam.

Other recent additional aims relate to increasing flows to Lake Kununurra and along the Ord River below the Lake Kununurra diversion dam to satisfy the needs of tour operators and cattle stations (Sinclair-Knight-Merz 1995). The Water and Rivers Commission currently has no objectives dealing with management of the lake for its wildlife values.

The Water and Rivers Commission authorises a range of commercial and recreational activities on the lake. These include commercial fishing, tourism and private recreational use. In addition to these water is also sold to two diamond mining projects located upstream of the southern limit of the lake.

The catfish *Arius midgleyi* has been fished commercially in Lake Argyle since 1974. There are at present seven licensed operators but only two of them are active. They use gill net techniques to collectively harvest some 180 tonnes of fish per year. This level of harvest has more or less remained constant for several years and is believed to be sustainable. The size of the net mesh used, 180 mm, captures fish greater than 3 kg in weight. The fish are traded in Perth as 'Silver Cobbler'. All net-based fisheries invariably catch a variety of non-target species and the fishery on Lake Argyle is no exception. The dominant non-target species in the lake are freshwater crocodiles and hair-backed herring with numbers of turtles and cormorants also taken. The Department of Conservation and Land Management has attempted in the past to have captured non-target species reported but this has not been done in a consistent manner (Gordon Graham, pers. comm.). Current licences allow operators unrestricted access to all areas of the lake. The catfish industry on Lake Argyle is regulated by the Fisheries Department but is self managed with Fisheries Department representatives attending periodic meetings of the group of fishery operators (Neville Stuart, Argyle Fisheries pers. comm.)

More recently a pilot barramundi *Lates calcarifer* fish farming industry has been developed in the lake. This is based at Bamboo Cove, near the Argyle Dam wall. Eyed-ova eggs are obtained from hatcheries in Darwin and reared in land-based tanks to fingerling stage. These are transferred to cages in pontoons in the lake and raised to marketable sizes from 500 g to 3 kg in weight. The growing, caged fish are fed pelletised food imported from Queensland. The present operation aims to achieve an annual commercial harvest of around 100 tonnes (Neville Stuart, Lake Argyle Fisheries. pers. comm.).

Tourism on Lake Argyle is based around scheduled boat tours. There is a single licensed operator who conducts daily tours using two boats. Two hour cruises operate within 10 km of the dam wall while more extensive half day trips, using a high speed boat, complete a 120 km return trip from the Argyle Dam to Ord River 'mouth' at the southern end of the lake. During the high season from June to September the current tour schedule potentially caters for around 120 people per day. During other months a reduced schedule can cater for around 80 people per day.

Lake Argyle is used for a range of private recreational activities including boating, fishing, swimming and a very small amount of SCUBA diving. The levels of these activities are not monitored. Extended trips to more remote sections of the lake would generally be restricted to a small number of residents in the region. Marine safety and navigation laws apply and thus affect the type of craft that can be used.

Two diamond mining companies, Argyle Diamond Mines and Poseidon Bow River Diamond Mines operate in the catchment of Lake Argyle upstream of its southern limit. Each of these draws water for their processing plants via pontoon-based pump stations. The pump stations are located at the mouth of Flying Fox Creek.

2.4.3 Catchment Management

The adjacent hinterland and greater catchment of Lake Argyle are managed for nature conservation, tourism, cattle production and mineral production.

The steep rocky terrain of the Carr Boyd ranges along the western shores of the lake, and some islands within the lake, form part of the proposed Carr Boyd National Park. This will be managed by the Department of Conservation and Land Management.

The Lake Argyle tourist village is located at the northern end of the lake above Bamboo Cove near the Argyle Dam. This offers tourist services including accommodation ranging from demountable units (12 units) to caravan sites (42 sites) and camping facilities (48 sites). Its total accommodation capacity is around 200 persons. Waste water and sewage treatment from the village is managed by the Western Australian Government Water Corporation. There is no effluent disposal into the lake.

The southern and eastern shores of the lake are abutted by the Lissadel and Argyle Downs pastoral leases. These leases are theoretically isolated from the lake by a buffer zone of vacant crown land which is completely fenced. From our brief aerial inspection of the lake margin it was clear that cattle numbers in the buffer zone are relatively high with evidence suggesting a long (probably continuous) history of use as de-facto pastoral land. The legal status of grazing within the Water Reserves along the eastern shores of Lake Argyle is not known.

The catchment of the Ord River above Lake Argyle at present contains 17 pastoral leases which support around 160 000 head of stock (Paul Novelly, Agriculture WA, pers. comm.). The history of the pastoral industry throughout the catchment of the lake was characterised initially by extensive overstocking which led to severe land degradation and erosion (de Salis 1993). When the Ord River Irrigation Project was established a large tract of land, comprising 10 000 km^2 along the Ord River immediately upstream from Lake Argyle was destocked for rehabilitation as part of an effort to reduce the amount of sediment transported into the lake. While some of this area has stabilised other parts continue to sustain very high rates of erosion (Ryan 1981, de Salis 1993).

Considerable effort has been put into improving the management of pastoral lands in the Lake Argyle catchment over that past three decades. Initiatives of Agriculture WA have encouraged land holders to establish systems of photograph-based rangeland monitoring sites on their stations as a means of assessing cattle impact and developing more sustainable management options. These, backed by more detailed studies by Departmental staff and further supported by landscape level monitoring using remote sensing techniques form part of a State-wide rangeland program: the Western Australian Rangeland Monitoring System (Western Australia Department of Agriculture 1992). Periodic meetings of the East Kimberley Land Conservation District provide a venue where pastoral managers can exchange or receive information concerning environmentally sustainable practice. In spite of these initiatives however it is notable that annual sediment loads into Lake Argyle (24 million tonnes/annum) have not changed since the dam was built (Ruprecht 1995).

There are two diamond mines in the Ord river catchment immediately upstream of the southern end of the lake on Lissadel Station. The Argyle diamond mine began operations in 1985 and is located on Smoke Creek at a point around 20 km upstream

from Lake Argyle. The Bow River diamond mine commenced in 1988 and is situated on Limestone Creek near the junction of the Bow and Ord Rivers. With the new spillway it is possible that in some years mined areas at Bow River will be flooded. Compared to many other mineral extraction processes diamond recovery is fairly environmentally benign. At the Argyle mine diamond-bearing rock is first crushed then washed and screened while at Bow River alluvial deposits are washed and screened directly without crushing. In both operations small amounts of acid are used to wash extracted diamonds and spent acid is stored with waste water in tailings dams. Dilutions of 1 litre of acid to tens of thousands of litres of waste water occur. Apart from dilute acid, tailings also consist of fine sediments from the washing and screening process. The Western Australian Department of Mines assumes the prime supervisory role in relation to environmental issues arising at both mines.

Quality of water flowing from the Ord catchment into Lake Argyle is monitored by the Water and Rivers Commission by way of a network of five automatic gauging stations which provide continuous records of flow rates and rainfall. Water samples from each gauge site are analysed for major ions three times during each wet season corresponding to first flow, peak flood and last flow conditions.

2.5 Potential Threats to the Site and its Values

Having only had a short history of development Lake Argyle is probably still actively evolving toward an optimal ecological configuration. Thus it is important to recognise that certain changes to its ecological character may be inevitable and natural and should therefore be considered a feature of the ecological character of the site. In this context changes to ecological character related to natural successional development of soils and native plant and animal communities within the current water management regime are not considered further.

Any alteration to the water management regime that changes either the mean annual flood height or the seasonal drawdown in the lake could cause changes to the ecological character of the lake. The recent 6 m increase to the height of the spillway is expected to increase the average height of the lake rise by about 1 m. Average flood heights will also change and this may disrupt processes of establishment and development of present day riparian vegetation. These increases combined with increased seasonal drawdown arising from increased water use over the next 20 years or so as the Ord River Irrigation Area expands, may also affect the distribution and abundance of some aquatic plant species. Incremental changes to seasonal drawdown are likely to have de-stabilising effects on aquatic vegetation communities and management options to counter these to maintain the ecological character of the lake may be very limited.

Weed populations pose a considerable potential threat to the ecological character of Lake Argyle. Whilst there are currently no aquatic weeds, the mat-forming species *Salvinia molesta* could have a devastating impact if introduced from the Northern Territory. Three currently widespread riparian woody weeds are possibly poised to have a major impact around the margin of the lake. *Parkinsonia aculeata*, *Calotropis procera* and *Jatropha gossypifolia* can each form impenetrable thickets in riparian zones and are difficult to control once they 'get away'. Other serious weeds with potential to colonise the riparian zone include the giant sensitive plant *Mimosa pigra* which is widespread across floodplains in the Northern Territory, and noogoora burr *Xanthium pungens* and leucaena *Leucaena leucocephala,* already established

downstream on the Ord River below Kununurra. However before any weed control measures are implemented, other possible consequences need to be appraised. For example populations of the rare Purple-crowned Fairy-wren *Malurus coronatus* have been seen in thickets of mature Parkinsonia upstream of where the Ord River meets Lake Argyle (Gordon Graham, pers. comm.).

The overall ecological impact of feral animals, particularly cattle, on the shores of Lake Argyle is undoubtedly complex. The eastern and southern margins of the lake have probably had a long history of relatively intensive impact. With highly visible disturbance from trampling and grazing the overall effect of cattle ecologically has probably been to retard development of woody riparian vegetation. The resulting low, cropped riparian habitat could be critically important to many of the waterbird species now abundant on the lake. The role of cattle in restricting or promoting woody weed establishment around the margin of the lake is also unclear. While cattle may act as dispersal agents for some exotic plant species it is also possible that rates of infestation could accelerate if cattle are removed from the system. Cattle trampling around the margins of the lake may reduce the nesting success of freshwater crocodiles and turtles though the high population size of freshwater crocodiles suggests this impact could be low.

Commercial barramundi farming on Lake Argyle could cause local water quality deterioration through accumulation on the lake bed of nutrient-enriched waste from fish and the food they are fed. Although the Bamboo Cove site is in a deepwater environment surrounded by steep-sided rocky banks any upwelling of sediments from the bottom could arouse public health concerns because the boat launching area, which is also used for swimming, is located in the same embayment. There is not enough information to determine the ecological and/or heath impacts of fish farming effluent in Bamboo Cove or to other adjacent areas of the lake.

The potential for tourism and recreation, at their current levels, to affect the ecological character of the lake is probably low but could be manifest through general disturbance to waterfowl or more particularly to breeding colonies. The amount of disturbance to waterfowl at Lake Argyle from these activities is not known.

The current diamond mining activity around the southern end of the lake probably constitutes a relatively low threat to biological integrity. At worst a breached tailings dam would release a pulse of fine sediment and dilute acid into the river. The particular conditions under which this might occur would probably be characterised by exceptionally high wet season rainfall and runoff. Acids already very dilute would become much more diluted while the sediment pulse would barely be detectable against the high 'natural' levels of sediment normally transported. However, studies to confirm the outcome of this and other possible scenarios are justified.

In the very long term a large permanent inland waterbody such as Lake Argyle could become an extremely important refuge for waterfowl conservation in northern Australia. If the current prognosis for climate change eventuates (CSIRO 1994) then many of the freshwater wetland resources associated with sub-coastal floodplains across northern Australia could be substantially diminished within 100 years, transformed into estuarine environments as a result of sea level rises. Permanent inland lakes such as Lake Argyle may then provide crucial habitat for a number of species. The overall importance of the lake however may well be judged in terms of the amount of suitable breeding habitat available. The present status of the lake as a breeding ground is not fully known. From our brief observations around the lake a pair

of Magpie Geese with unfledged young was noted. This species could be highly affected by loss of breeding habitat in coastal areas caused by rising sea levels. In view of the impending potential threat to the ecological character of a very large number of wetlands across northern Australia it might be prudent now to assess the vulnerability of northern Australian waterfowl to climate change, determine the current status of Lake Argyle as a breeding venue for vulnerable species, then begin to develop long term research and management strategies to attempt to increase breeding opportunities for them.

2.6 Conclusions

2.6.1 Urgent Management Actions

Lake Argyle is a man-made wetland that was created 25 years ago. The nomination of the site for the List of Wetlands of International Importance recognised that the primary management purpose of the wetland was water supply (Department of Conservation and Land Management 1990). The release of water from Lake Argyle is managed by the Water and Rivers Commission.

No urgent management concerns were identified during the fieldwork that require follow-up by the Department of Conservation and Land Management with the Water and Rivers Commission.

2.6.2 Necessary Ecological Investigations

As a man-made wetland Lake Argyle has the potential to be managed for ecological goals without the usual constraints of seeking to mimic a "pre-European settlement" state. However, ecological goals will only be accommodated within the primary management objectives of water supply.

There is a clear need for a greater understanding of the ecology of the lake and how management of water levels and grazing of the margins could be optimised for ecological goals. A detailed scientific case will need to be presented if trade-offs are to be obtained with water supply and cattle production. An understanding of the response of introduced plant species would be an important component of this research.

Recommendation 1: The Regional Ecologist encourage the researchers within the Department and the Water and Rivers Commission to assist to develop long term research programs on the relationship between water levels and the biota of Lake Argyle. A pilot study of the impact of grazing on fringing vegetation should be an important component of this work.

Implementation of a monitoring program is one of the core obligations of management of Ramsar sites. It is needed to "test" if ecological change is occurring and to develop appropriate management responses. Important attributes to monitor are aquatic and fringing vegetation, aquatic fauna and waterbird numbers.

Recommendation 2: The Kimberley Regional Ecologist, in consultation with the East Kimberley Office, develop a program to monitor for changes in the ecological character of Lake Argyle. This should be developed as part of a regional program for Ramsar sites (see Section 9.3).

2.6.3 Management Planning

An important issue related to management and management planning is to establish a clear understanding of the boundary of the Ramsar-listed area of Lake Argyle. Detailed maps showing the boundary should be made available at the East Kimberley Office for staff and the public. A copy of these maps should be supplied to the Water and Rivers Commission.

Consideration could be given to having Lake Argyle and Lake Kununurra listed individually as Internationally Important Wetlands. However this should be discussed with the Principal Research Scientist responsible for wetlands because there may be some question of the merit of an individual listing for Lake Kununurra (see Section 3.6.2).

Recommendation 3: The Kimberley Regional Ecologist, in consultation with the East Kimberley Office, work with the Department's wetland research officers to define in detail the boundaries of the Ramsar-listed area of Lake Argyle.

Recommendation 4: The Regional Manager ensure that detailed maps are available at the East Kimberley Office that show the boundary of the Ramsar-listed area of Lake Argyle. Also that a copy of these maps be supplied to the Water and Rivers Commission Office in Kununurra.

Recommendation 5: The Regional Manager take the necessary steps to ensure that the Department forward a copy of the detailed maps to Environment Australia.

Lake Argyle is vested in the Water and Rivers Commission. As such the management plan that is developed for Lake Argyle should have, as a minimum, a statutory basis under legislation administered by the Commission.

The Department of Conservation and Land Management should have a formal role in the development of the management plan because of its responsibility for implementation of the Ramsar Convention in Western Australia. A mechanism to develop this cooperative approach is the establishment of a consultative committee involving the Kununurra Office of the Water and Rivers Commission and the Department of Conservation and Land Management. Initially this committee could discuss the Ramsar Convention and the obligations for the management of listed wetlands. These consultative arrangements could pick up issues associated with the proposed Carr Boyd Range and Lake Argyle National Park. The committee could also consider including other agencies and stakeholders in the consultations (especially Aboriginal Traditional Owners).

Recommendation 6: The Regional Manager establish a consultative committee with the Kununurra Office of the Water and Rivers Commission to discuss Ramsar issues related to the management of Lake Argyle (also see Section 9.1.2).

Recommendation 7: The Regional Manager use the consultative committee to discuss the joint development of a management plan to be implemented under legislation administered by the Water and Rivers Commission (also see Section 9.1.2).

In addition to giving attention to the development of a management plan for Lake Argyle it is also important that the Department of Conservation and Land Management actively participate in other planning and management processes for the lake and adjacent areas.

Recommendation 8: The Regional and District Managers continue to support staff involvement in government and community planning for Lake Argyle and adjacent areas.

In establishing a consultative committee to discuss management issues related to Lake Argyle recognition should be given to the special interests of Aboriginal people. A current Native Title claim has been made over the area by the Miriuwung Gajerrong Traditional Owners. This is to go before the Federal Court in March 1997 where the Aboriginal Legal Service will represent the Native Title interests of the claimants.

Recommendation 9: The Regional Manager note the special interest that Aboriginal people have in Lake Argyle and seek to ensure that:

- **these interests are included in any future discussions about the management of Lake Argyle**
- **necessary steps are taken to advise the State Government's Native Title Unit of the Ramsar-listed status of Lake Argyle and the interests of the Department**
- **full recognition is given to the current legal proceedings in any decisions made relating to Lake Argyle.**

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Lake Kununurra

3.0 Lake Kununurra

Lake Kununurra is located at 15° 48' S, 128° 43' E. Being directly downstream from Lake Argyle it has essentially the same monsoon influenced climate; hot, humid and relatively wet from December to March and cooler and very dry from June to October. The annual average rainfall at the township of Kununurra, located adjacent to the lake, is 787 mm but annual variations are great (Western Australia Department of Agriculture 1995).

3.1 Physical Attributes

The lake is an artificial waterbody formed by a dam (the Diversion Dam) across the Ord River at a place known as Bandicoot Bar (Photograph 15). It was created in 1963 to supply water to the Ord River Irrigation Area (Western Australia Department of Agriculture 1995). The Lake Kununurra site extends from the Diversion Dam to the base of the wall of the Argyle Dam about 53 km upstream along the Ord River (Fig. 2)and has an area of around 60 km^2. It includes a flowing 15 km section of river at the upstream end, an impounded 40 km length of flooded river bed (the lake) up to about 500 m wide (Photograph 16), and several adjoining swamps (Packsaddle Swamp (Photograph 19, 20), Lily Creek Swamp (Photograph 17, 18), Emu Creek Swamp and 'The Everglades') that were created when the lower reaches of tributary creeks were inundated. For its first 10 years, prior to the Argyle Dam being built, Lake Kununurra filled annually and slowly drained during each dry season. Since the Argyle Dam became operational in 1972 the lake has been maintained at a more or less constant level (41.3 m AHD to 41.6 m AHD) to allow a permanent gravity fed supply to the M1 canal of the Ord River Irrigation Area. Throughout the period 1977 to 1980 though, the lake was drained for one to two weeks each year for weed control (Sinclair-Knight-Merz 1995).

Conditions in the lake are characterised by high water temperatures, an intense sunlight regime, high water clarity, relatively high concentrations of total nitrogen (208 - 240 µg/l) and phosphorus (17.8 - 18 µg/l) (Departments of Agriculture, Water Resources and the North-west 1990, Rosich and Partridge 1988) and fertile sediments and levee soils. These conditions are ideal for growth of aquatic plants and the lake becomes eutrophic at various times in the year.

While the catchment of Lake Kununurra consists technically of the Ord River above the Diversion Dam it is effectively truncated where the Argyle Dam blocks the river 53 km upstream. There are no major rivers or creeks draining into Lake Kununurra between the Diversion Dam and the Argyle Dam. The lake is supplied from Lake Argyle from discharge at the base of the Argyle Dam wall and over a spillway located 7 km north-east of the Argyle Dam. A minimum discharge of 60 m^3/sec is released from the base of Argyle Dam (Wark undated). Flow down the spillway creek, which enters Lake Kununurra about 29 km downstream from the Argyle Dam, is currently permanent though highly variable both seasonally and from year to year; depending on height of Lake Argyle.

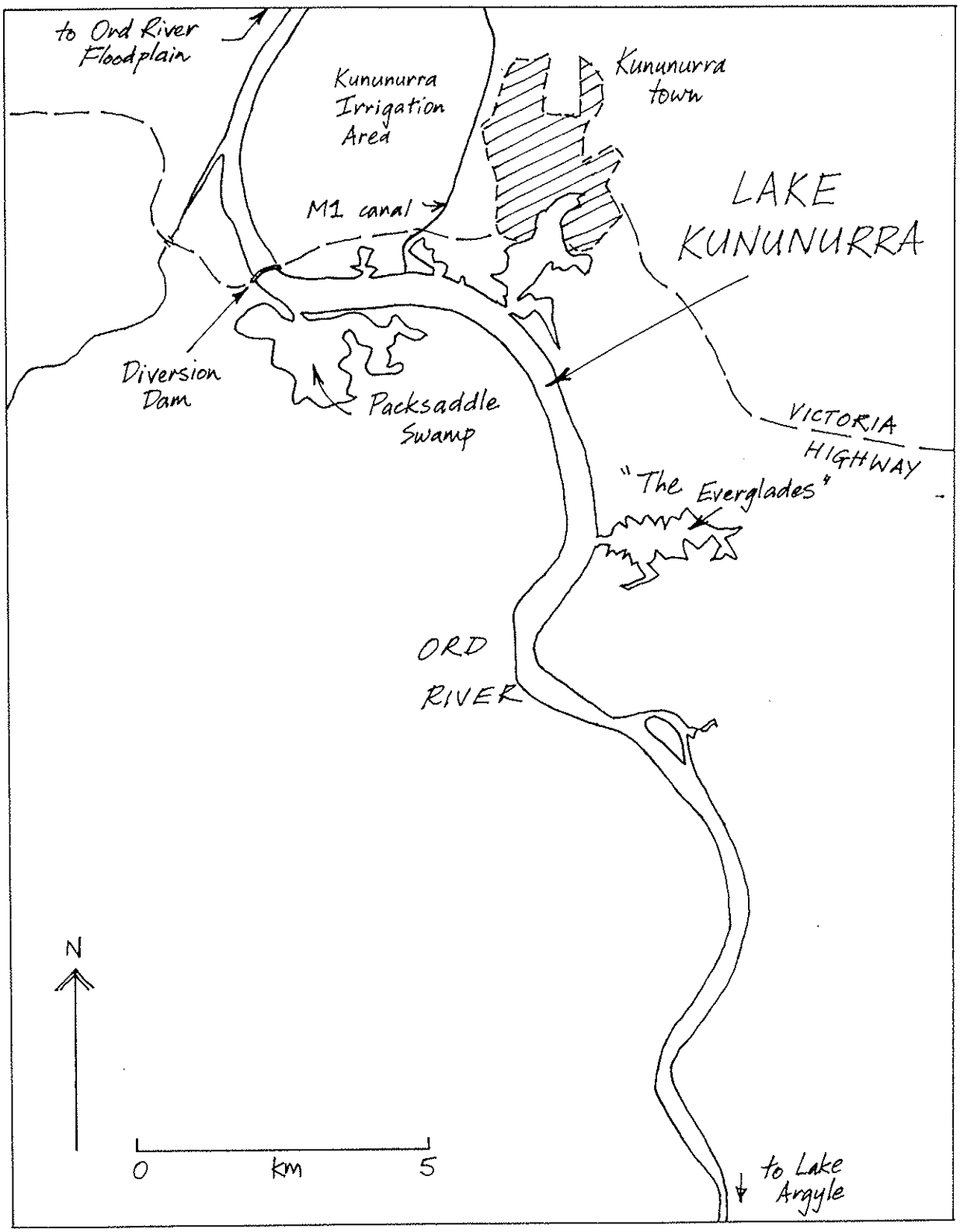

Figure 2. Lake Kununurra (northern part)

Photograph 15 Lake Kununurra, aerial view SE over the Diversion Dam
(28 June 1996, Doug Watkins)

Photograph 16 Lake Kununurra, aerial view N down the upper section of the lake.
(28 June 1996, Doug Watkins)

Photograph 17 Kununurra, aerial view SE across Lily Creek and Lake Kununurra. Irrigated crop and M1 Channel in foreground. Sewage treatment ponds between the M1 and the Kununurra townsite. Note residential development around Lily Creek. (1 July 1996, Doug Watkins)

Photograph 18 Kununurra, aerial view E across the M1 Channel and Lily Creek. (28 June 1996, Doug Watkins)

Photograph 19 Aerial view NE across the northern section of Packsaddle Swamp and over Lake Kununurra to the Kununurra townsite. Extensive stands of cumbungi growing across the swamp. (28 June 1996, Doug Watkins)

Photograph 20 Aerial view S across Lake Kununurra and Packsaddle Swamp. (1 July 1996, Doug Watkins)

The upstream (southern) half of the river/lake (known as Carlton Gorge) is particularly spectacular, passing through a rugged, deep, sandstone gorge of the Carr Boyd Ranges (Traves 1955, Stewart *et al.* 1970). In the lower (northern) half the surrounding terrain is comparatively flat with sandy to loamy soils, interspersed with occasional steep rocky hills and outliers (Traves 1955; Stewart *et al.* 1970; Riley, McGhie and Sherrard 1993).

Sediment inputs to Lake Kununurra are relatively low. Lake Argyle effectively insulates Lake Kununurra from the high seasonal sediment loads that were delivered to Lake Kununurra by the Ord River prior to construction of the Argyle Dam (Kata 1978).

3.2 Biological Attributes

3.2.1 Flora

An immediate impact of the creation of Lake Kununurra was permanent flooding of low lying areas of seasonally dry riparian woodland and adjacent sclerophyllous woodland habitats. This killed many trees, particularly along the channel and in swamps associated with tributary creeks. Most of these swamps still support an abundance of dead emergent trees which offer a variety of roosting and breeding sites for fauna (Photograph 20).

While riparian woodland has successfully re-established along the banks of the lake on old levees, the level of establishment on the margins of swamps appears less dramatic, possibly related to less suitable sedentary soil types. Typical fringing and riparian woodland species include *Melaleuca leucadendra, M. argentea*, *Pandanus aquaticus*, *Eucalyptus microtheca*, *E. camaldulensis*, *Sesbania formosa*, *Nauclea orientalis* and *Lophostemon grandiflorus.*

The establishment and proliferation of submerged aquatic plants in Lake Kununurra has been spectacular. The seasonally dry Ord River, which existed prior to the construction of the Diversion Dam, probably supported very little submerged aquatic vegetation along the sections now covered by the lake. Present conditions offer an ideal regime for growth of submerged aquatic plants. Although there has been no monitoring to describe the establishment of aquatic plants in the lake is was clear after the first five years of stable water levels in Lake Kununurra (1972-1977) that the amount of submerged and floating aquatic plant growth was becoming a problem and in 1977 the lake was drained for two weeks as a control measure. This was repeated annually till 1980. Aquatic vegetation communities in Lake Kununurra were mapped in 1981 (Gowland 1981) and there is evidence today that the composition of some submerged plant assemblages has changed quite substantially since then (Sinclair-Knight-Merz 1995). Common submerged or floating aquatic plants in the lake include floating pond weed *Potamogeton tricarinatus*, ribbon weed *Vallisneria spiralis*, hydrilla *Hydrilla verticellata*, *Najas graminea, Myriophyllum verrucosum*, *Chara* spp., white snow-flake lily *Nymphoides indica* and blue waterlily *Nymphaea gigantea.*

Almost all areas of the lake or in swamps less than 5 m deep usually support dense growths of aquatic plant communities. However, at the end of the wet season a period of widespread senescence may occur. To date there have been no algal blooms on the lake associated with nutrient release during periods of water plant senescence.

One of the most successful aquatic plants associated with the Lake Kununurra wetlands has been the tall emergent cumbungi *Typha domingensis* (Photograph 19). From relative obscurity it now occupies broad tracts around the margins of the lake and its swamps. It has highly efficient, wind dispersed seed and readily colonises situations with stable water levels. Cumbungi was initially somewhat slower to proliferate than the submerged and floating aquatic weeds. It was certainly established by the late 1970s when the last map of aquatic vegetation on the lake was compiled (Gowland 1981) but at this time most of the swamps around the lake still had substantial lengths of cumbungi-free margin. The perimeter of Lily Creek Swamp, for example, was over 75 per cent cumbungi-free in 1978 but by 1993 almost the entire margin was colonised (maps in Sinclair-Knight-Merz 1995). This process was been repeated in all the swamps and cumbungi is continuing to expand into open water to depths of around 2 m. Cumbungi can also form free-floating rafts in open water and survives well in the nutrient rich waters of the lake. These rafts can quickly clog up previously navigable waterways and cause problems for shore frontages such as swimming and skiing beaches.

None of the wetland plants recorded in Lake Kununurra are considered to be rare, threatened or endangered (Australian Nature Conservation Agency 1996). No exotic water weeds are known to occur in Lake Kununurra though this should be qualified by the fact that there have not been any recent surveys. The riparian zone however, probably supports an extensive array of introduced species, especially in the northern half of the lake where the banks adjoin horticultural and residential developments. Amongst the most conspicuous such weeds are tree and shrub species which include leucaena *Leucaena leucocephala*, date palms including *Phoenix dactylifera*, rubber tree *Calotropis procera,* and parkinsonia *Parkinsonia aculeata.* The distribution of date palms around the shores of the lake has been surveyed and mapped by the Department of Conservation and Land Management (Gordon Graham pers. comm.) An introduced climbing vine *Clitoria ternatea* is also prominent amongst riparian vegetation in some areas.

3.2.2 Fauna

With few exceptions there has been very little quantitative documentation of the fauna associated with Lake Kununurra since the early 1980s when Agriculture WA employed staff to investigate problematic interactions between wildlife, principally birds, and agricultural crops in the Ord River Irrigation Area (Gowland 1980 a, b, c, 1981, 1983).

Data and knowledge concerning invertebrate fauna in the lake is sparse. There have been reports to assess mosquito occurrence in relation to public health risks (Wright 1991); a mosquito monitoring program, operated by the University of WA, Department of Microbiology, has been active in the Kununurra region since 1972. Freshwater prawn (cherrabun *Macrobrachium rosenbergii*) populations are well known to local fishing enthusiasts. A collection of land snails was taken from a riparian site on the Ord River near the Diversion Dam (Solem 1991, Solem and McKenzie 1991). From this the presence of an introduced snail species *Lamellaxis gracilis* was noted but no details concerning its potential ecological impact were given. The most intensive invertebrate studies around the lake have focussed more on suites of insects directly associated with agricultural activities in the region (Richards 1968).

The fish in Lake Kununurra include the popular sport/table fish sooty grunter *Hephaestus fuliginosus* and the barramundi *Lates calcarifer.* Several species of catfish

including the shovel-nosed catfish *Arius midgleyi* and eel-tailed catfish *Porochilus* spp. are also abundant but information concerning other fish is generally poor with no published checklist available that relates specifically to the lake (Allen and Leggett 1990). The giant glassfish *Parambassis gulliveri*, believed to be endemic to the Ord River basin could be present. The lake is not known to support populations of any exotic fish species.

Freshwater crocodiles *Crocodylus johnstoni* are abundant in Lake Kununurra and estuarine crocodiles *Crocodylus porosus* have occasionally been seen and removed. Lake Kununurra is a designated crocodile control zone which means that immediate action is taken by the Department of Conservation and Land Management to remove any estuarine crocodiles that are confirmed to be present through trapping, harpooning and shooting. Freshwater crocodiles that might be considered a problem may also be removed. The Department of Conservation and Land Management is unable to give a guarantee to people who use the lake that saltwater crocodiles are not present due to the possibility of them moving from below the Diversion Dam wall into the lake.

Freshwater crocodiles *Crocodylus johnstoni* are abundant and estimates from survey data collected in 1988, 1989 and 1994 indicate a population from 3 000 to 5 000 individuals (Gueho 1995). In a survey in 1979 (Brennan unpublished data) over 1 000 animals were counted between the Diversion Dam and 'The Everglades' (13 km upstream) at a time when the lake (and all the swamps) was drained for weed control. When this survey was repeated one month later, after the lake had filled, only 330 animals were detected. The main breeding areas for freshwater crocodiles in the lake are probably in the upstream (southern) half of the lake where there are sandy bars beside the river. The level of use of the downstream end of the lake and adjacent swamps as a breeding area has not been determined though it is probably low due to the infrequent occurrence of soft sandy substrates for nest excavation. The dense stands of emergent and floating vegetation in swamps around the lake could provide suitable nesting habitat for estuarine crocodiles.

There are three species of freshwater turtle known from the lake. One of these, *Emydura australis* is restricted to the Kimberley-Victoria River region.

Around 160 species of birds have been recorded from the Lake Kununurra wetland system. Records from the late 1970s and early 1980s showed large, late dry season aggregations of ducks and geese in the Packsaddle Swamps (12 000 birds, Sept 1978 (Gowland 1981, 1983)). Although there have been no recent surveys it would appear that such aggregations no longer occur or are smaller; probably related to infestation by cumbungi of essential shallow water and swamp-margin roosting habitat. While the habitat loss from expanding populations of cumbungi may clearly have displaced some species others have benefited. These would include regionally significant breeding populations of the Little Grassbird *Megalurus gramineus*, Little Bittern *Ixobrychus minutus* (the only breeding site in northern Australia) and the Spotless Crake *Porzana tabuensis* as well as a non-breeding migrant population of the Oriental Reed-Warbler *Acrocephalus orientalis* (Australian Nature Conservation Agency 1996, Blakers *et al.* 1984, Brennan 1983, Jaensch 1988). Comb-crested Jacana *Irediparra gallinacea* is abundant on weed mats fringing the lake and in the extensive lily beds in Lily Creek swamp. The riparian vegetation around the lake includes one of the few regularly used breeding colonies of herons and egrets in the Kimberley region (Jaensch and Vervest 1989).

Of the native mammals on the lake (Gowland 1980b), the most visually conspicuous are flying foxes which form dense, diurnal roosting colonies in riparian trees. Two species occur. The black flying fox *Pteropus alecto* is resident with a population of 3 000 to 5 000 individuals often located at the entrance to the Packsaddle Swamps or further upstream in 'The Everglades'. The little red flying fox *Pteropus scapulatus* is only present in the wet season with congregations of up 30 000 individuals (Russell Gueho pers. comm.). Records from the WA Museum list eight other species of bat, and 11 other native mammal species for the Kununurra area. Of these only the Water Rat *Hydromys chrysogaster* is highly aquatic and little is known of its current status.

Feral animals associated with the lake include cats, cattle, pigs and donkeys. Donkeys are primarily associated with rocky terrain in the upstream sections.

3.3 Cultural Values

3.3.1 Aboriginal Cultural Values

The major cultural issues for Aboriginal people in the Kununurra area relate to the current Native Title claims. Lake Argyle and Lake Kununurra form part of the Miriuwung Gajerrong Native Title Claim No 1 (Appendix 3). The claim was lodged by the Aboriginal Legal Service of Western Australia on behalf of the claimants in April 1994 and was accepted by the National Native Title Tribunal in May 1994. The majority of the claimants are represented by the Aboriginal Legal Service and the Northern Land Council. A number of Kija people, who live in the Turkey Creek area, are joint claimants and they are represented by the Kimberley Land Council.

The application is for land and water in and around Kununurra, Wyndham, Cambridge Gulf and Turkey Creek in Western Australia and the Keep River National Park in the Northern Territory. The area includes Lake Kununurra and Lake Argyle and Lacrosse, Kanggurrya, Pelican, Monsmont and Guy Reid Islands (Appendix 3). The same claimants have lodged a further Native Title claim that includes areas adjacent to the Ord River Floodplain (Miriuwung Gajerrong No. 2) (Appendix 4).

There are over 100 interested persons registered with the National Native Title Tribunal including the Commonwealth and Western Australian Governments. The Native Title Tribunal referred the claim to the Federal Court after preliminary mediation between the interested parties because it was felt there was no possibility of an agreement between all the parties being reached. This move was supported by the claimants and the State Government. The case has been set down for hearing in March 1997.

There was little interest in discussing issues related to Lake Argyle during the field visit because:

- the Federal Court hearing on this claim was pending, and
- the claimants were involved in intensive negotiations with the State Government and the East Kimberley Shire in relation to their Miriuwung Gajerrong No. 2 claim (Appendix 4) and the Ord Stage 2 Project.

A number of parties were contacted including:

- Aboriginal Legal Service, Kununurra
- Bob Hannan, Miriuwung Gudjerrong Families Land Council
- Ben Ward, Warringarri Aboriginal Corporation

- David Neary, Mirima Dawang Worlab-gerring Language Centre
- Ray Blackwood, Aboriginal Affairs Department
- Project Officer, Aboriginal and Torres Strait Islander Commission

Correspondence relating to the project was forwarded to each organisation and a meeting was requested. Meetings to discuss the Ramsar status and proposed management planning process were held with representatives from the Mirima Language Centre, Aboriginal Affairs Department and the Aboriginal and Torres Strait Islander Commission. The representative from the Mirima Language Centre emphasised the importance of the areas to Mirima people and the importance of including them in any discussions about management.

Although Mr Hannan was not in Kununurra at the time of the field trip he advised that he would like to be kept informed of what was happening. He also requested that representation be made through the Native Title Tribunal or that the Minister should approach him directly [sic]. He expressed the opinion that once the Native Title issue was resolved this would clarify future management issues.

As mentioned above, over the past 12 months the claimants have been focusing on negotiations relating to the Ord Stage 2 Project. A number of agreements have been negotiated by the Working Party, which includes representatives from Aboriginal groups the State Government and the Shire. The success of these negotiations indicates that despite conflicting interests related to the area under claim, properly structured consultation and negotiation processes can yield positive results.

The site register held by the Heritage and Culture Division of the Aboriginal Affairs Department lists a number of ethnographic and archaeological sites within and adjacent to Lake Argyle and Lake Kununurra wetland sites.

3.3.2 Other Cultural Values

Lake Kununurra is listed on the Register of the National Estate.

3.4 Tenure and Management Regime

3.4.1 Tenure

Tenure under the Land Act

Ownership and management of the water in Lake Kununurra is vested with the Western Australian Water and Rivers Commission. Engineering assets however, such as the dam wall and associated hardware are managed by another WA Government agency, the Water Corporation. The foreshores along the northern half of lake between Palm Spring and the Diversion Dam comprise a complex of Vacant Crown Land and Shire and Government reserves (Wyndham East Kimberley Shire (undated)).

The boundary of the Ramsar listing area is poorly defined due to the scale of the map in the nomination documents (Department of Conservation and Land Management 1990).

Native Title

Lake Kununurra forms part of the Miriuwung Gajerrong Native Title Claim No 1. The claim was lodged by the Aboriginal Legal Service of Western Australia on behalf of the claimants. This application has been referred to the Federal Court and is set down for hearing in March 1997.

Nature Conservation Proposals

Packsaddle Swamp has been proposed as a Nature Reserve (Burbidge *et al.* 1991). When declared it will be administered by the Department of Conservation and Land Management. It has been proposed that a management program will be developed in agreement with the Water and Rivers Commission.

The Department of Conservation and Land Management has proposed that a 125 000 ha National Park be gazetted covering the Carr Boyd Range and the islands of Lake Argyle (Burbidge *et al.* 1991). This proposal supports those made previously by the Conservation Through Reserves Committee (1977) and the Environmental Protection Authority (1980). The National Park would include the western shoreline of Lake Kununurra from the Lake Argyle Dam north to the Packsaddle Irrigation Area.

3.4.2 Site Management

The primary aim of water management on Lake Kununurra is to supply water for irrigation to the Ord River Irrigation Area, though a flow of 21 m^3/sec is released from the Diversion Dam to allow year round boating downstream (Wark undated).

The Lake is managed by the Water Corporation which controls and regulates the supply of water for irrigation. Water quality aspects are handled by the Water and Rivers Commission however there is no routine monitoring of the water quality in the lake. The Water and Rivers Commission also determines other uses of the lake. The range of activities permitted on the lake includes tourism, commercial fishing, recreation, nature conservation and irrigation waste water treatment.

Four tour operators conduct scheduled trips on or from the lake. While one uses the lake as a base for aerial tours using two float planes, the other three conduct boat-based tours. Of these, one uses two high powered boats to offer full day and half day trips from Kununurra to the Argyle Dam and the other two operate solely on the 40 km lake section. One of the lake-based operators specialises in relatively short 'eco-tours' throughout Lily Creek and the Packsaddle Swamps.

There is a single licensed commercial fishing operator on the lake. Target species include the shovel-nosed catfish and the sooty grunter or black bream though some eel-tail catfish may also be taken. Fish are caught using set gill net techniques. Details on the non-target catch are not available though freshwater crocodiles and turtles are known to be involved.

The lake is popular for a range of water sports. Activities include swimming, fishing, skiing, sailing, wildlife appreciation and canoeing. No records are kept of the level of the recreational fish catch or the amount of boating on the lake. Approval to operate ten houseboats on the lake has been granted. An application for an additional ten houseboats is currently being assessed.

While it has been proposed that the Packsaddle Swamps become a Nature Reserve it is important to note that these swamps are at present functioning as a wetland filter for the irrigation tail water from the Packsaddle Irrigation Area. There is no routine monitoring of the quality of tail water as it flows from the Packsaddle Irrigation Area.

One of the consequences of using the lake for tourism and recreation has been increased public pressure to manage the growth of wetland plants. Submerged and floating plants interfere with power boat and swimming activities while the tall emergent cumbungi restricts access to, and views across, the lake. Plant control has been recommended for the Lily Creek Swamp to enhance views, improve boating, to 'beautify' the shoreline and protect commercial enterprises. Proposed control measures include mechanical cutting of submerged plants, and for cumbungi, a combination of physical removal, chemical spraying and burning is suggested (Sinclair-Knight-Merz 1995). Each year during the dry season a number of unplanned cumbungi fires occur around the lake. These fires have a detrimental effect on other fringing vegetation which is less tolerant to hot repeated burning.

3.4.3 Catchment Management

The upstream (southern) half of the river/lake between the Argyle Dam and Palm Spring passes through part of the proposed Carr Boyd Range National Park and is at present Vacant Crown Land. When declared the park will be vested in the National Parks and Nature Conservation Authority and administered by the Department of Conservation and Land Management.

The foreshores along the northern half of lake between the Palm Spring and the Diversion Dam include horticultural farms, small settlements at Crossing Falls and Packsaddle, parts of the Kununurra township and facilities for recreation clubs and tourists. There are two foreshore-located caravan parks, a ski club, a rowing club and a sailing club. All the recreation reserves on the eastern (Kununurra township) side of the lake are managed by the Shire while other reserves are managed by the Department of Land Administration. A picnic area and facilities just below the Argyle Dam wall is managed by the Water Corporation.

Beyond the immediate lake foreshore, the hinterland of the northern half of the lake is dominated by the township of Kununurra and the Ord River Irrigation Area. The pastoral property, Ivanhoe Station backs onto the lake in the vicinity of 'The Everglades' swamp.

Kununurra township supports a population of just over 4 000 people and is a service centre for the Ord River Irrigation Area as well as a major tourist destination. The national highway from the Northern Territory to Western Australia runs through the town (and crosses the Ord River at the Diversion Dam) delivering some 100 000 visitors annually. The town thus consists of residential, commercial and light industrial areas and has a range of tourist facilities. Storm water runoff from the town is discharged into the Lily Creek swamp. There is no routine monitoring of the water quality of storm water runoff. Sewage effluent is treated in ponds on the western side of the town. Any water released from the treatment ponds is discharged into the M1 canal of the Ord River Irrigation Area (Ivanhoe plain) and does not enter the lake.

The Ord River Irrigation Area contains over 135 km of irrigation channels (WA/NT Governments 1994) and comprises two main irrigation areas; Packsaddle Plain and Ivanhoe Plain. Water for the Packsaddle Plain is pumped from Lake Kununurra while that for Ivanhoe Plain is gravity fed from the M1 canal about 2.5 km upstream from the Diversion Dam. Irrigation tail water from the Packsaddle Plain is returned to the lake through the Packsaddle Swamps. Any irrigation water entering the M1 canal to the Ivanhoe Plain can be regarded as having moved downstream from the Lake Kununurra wetlands. Tail water from the Ivanhoe Plain is discharged into the Ord River at various points below the Diversion Dam. Of the 116 466 megalitres of water supplied annually for irrigation about 12 per cent is 'wasted' as consequence of the need to keep the system full to deliver supply within 24 hours of notification from users.

Intensive broad-acre horticulture and irrigated cropping necessarily involves the use of a range of pesticides and fertilisers. From the 1960s when control of pests in cotton crops led to massive applications of DDT the general trend these days is to reduce insecticide use or to use chemicals with a short residual life. Some areas in the Ord River Irrigation Area still contain residues of DDT high enough to preclude their use for dairy farming and beef production (Departments of Agriculture, Water Resources and the North-west 1990). Today, pesticides including Paraquat, Diquat and Glysophate which are de-activated by clay particles and Simazine, Surflan, Treflan, Prefar and Alanap which are biologically deactivated in soil, are the main chemicals used for insect control. All fungicides used in the Ord River Irrigation Area are believed to rapidly decompose in the soil. (Departments of Agriculture, Water Resources and the North-west 1990). Pesticides are frequently applied by aerial spraying.

The incidence of nutrient enrichment of ground water from fertiliser applications throughout the irrigation area is considered to be low. The dominant soil type, Cununurra [sic] Clay (Riley, McGhie and Sherrard 1993) has a high affinity for most minerals including P, N, K and Zn.

Some areas in the north and north-east Ivanhoe Plain area had problems with rising ground water and increased soil salinity during the mid 1980s and these were linked to soil types lacking an underlying gravel bed. By using more efficient irrigation practices and reducing the number of flood irrigated crops in these areas the problems now seem to have stabilised (Departments of Agriculture, Water Resources and the North-west 1990).

The irrigation canals of the Ord River Irrigation Area, like the Lake Kununurra wetlands, are also prone to infestation by aquatic water plants. Periodically they become choked and are treated with the chemical herbicide Acrolein. In some canals nutrient releases from plant debris following chemical treatment have caused algal blooms (Departments of Agriculture, Water Resources and the North-west 1990).

The current irrigation scheme services a total area of around 15 000 ha (Packsaddle Plain 2 400 ha, Ivanhoe Plain 11 794 ha) but this is only a relatively small part of the total potential development plan. Future extensions, which will require construction of another major supply canal (the M2) from Lake Kununurra, could service another 64 276 ha (Keep River 26 000 ha, Weaber Plain 13 722 ha, Knox Creek 5 263 ha, Carlton Plain 9 150 ha and Manitea Flats 2 996 ha). All planned extensions to the irrigation scheme lie downstream of Lake Kununurra.

3.5 Potential Threats to the Site and its Values

The relatively short history of Lake Kununurra has been characterised by continuing changes of ecological character. The aquatic vegetation of the site has provided a visually conspicuous example. From an open, mostly unvegetated waterbody in its early years the lake and its associated swamps rapidly became densely colonised by submerged plants. This was accompanied by slower infestation of the margins by cumbungi, a tall emergent rush. Recent inspections compared with survey data from the early 1980s suggest evidence of ongoing succession amongst aquatic plants in the swamps and that cumbungi may continue to consolidate its position by encroaching into open water up to 2 m deep (Kym Brennan pers. obs.).

These 'natural' changes may already have altered some of the ecological values for which the site was originally nominated for the List of Wetland of International Importance. For example, the large numbers of waterfowl that congregated on the Packsaddle Swamps during the dry season probably no longer occur or are reduced because the shallow water and short-grass swamp margins are now covered with cumbungi. In a case such as this, where one or more of the original ecological values of the site are clearly related to a 'fleeting' successional state, the only practical option may be to re-appraise the ecological character of the site, preferably in terms of likely or favoured end-points of succession and to use these to develop future management strategies.

It seems likely that the current water management regime on Lake Kununurra will be continued. The lake needs to be maintained at a more or less constant level to meet irrigation requirements. However with the development of future extensions to the irrigation scheme the amount of water cycled through the lake should increase. This could be beneficial in the sense that any surficial pollutants that enter the main body of the lake could have shorter residence times.

If the current status of a few of the native aquatic plants in Lake Kununurra is perceived to be a problem then the threat posed by the introduction of some exotic water plants is potentially devastating. The floating aquatic fern *Salvinia molesta*, now present in wetlands in the Top End of the Northern Territory, has the potential to cover the entire surface of the lake and severely restrict recreational and commercial water use. Although a biological control agent, a weevil *Crytobagus salvinnae*, exists for this species, it is known to be periodically ineffective (Storrs and Julien 1996). Water hyacinth *Eichhornia crassipes*, another floating aquatic plant would be equally devastating. The potential for exotic plant introductions into Lake Kununurra is high. There are several sources for these introductions including escape from aquaria (which is known to have occurred in Derby, Gordon Graham pers. comm.) and plant material from boats and boat trailers being brought from other locations, particularly the Northern Territory. This threat emphasises the importance of the quarantine service in Western Australia. Dealings in the aquarium trade in the township of Kununurra are not restricted to native plant and fish species.

The close proximity of a major township and agricultural area to the lake greatly increases the risk of introduction of a range problem riparian plants. A least two tall woody species now well established along the lake, the tall shrub, leucaena *Leucaena leucocephala* and the raintree *Samanea saman* have escaped from agricultural or urban settings respectively. There are potentially many others in garden situations in the Kununurra township; the noxious, often riparian weed, candel bush *Senna alata* is

an alarmingly common garden plant and is apparently freely available from nurseries in the town. Another noxious weed with high potential to establish around the margin of the lake is noogoora burr *Xanthium pungens*, currently restricted to a quarantine area downstream of the Diversion Dam. Present infestations of the thorny shrub, *Parkinsonia aculeata,* along the upstream sections of the lake should be targeted for eradication before they are able to form contiguous belts, displacing native species and severely limiting access. A thorough analysis of the status of populations of introduced plants along the margin of the lake is needed. This should include a review of the weed potential of garden plants in the township of Kununurra.

The long term prediction for the township of Kununurra will probably be for continued population growth and development. This will be led by expansion of the irrigation scheme and possibly tourism, each of which will generate demand for facilities and services. It is thus likely that the lake will be exposed to increased pressure from recreation, tourism and urban and industrial expansion.

Increased power boat activities on the lake will lead to greater inputs of oil and fuel residues. These may not cause problems on the main body of the lake due to the relatively high throughput of water, which will only increase when the irrigation scheme expands. In the swamps however, where mixing and throughput is much reduced, accumulated petrochemical residues could affect water quality and cause undesirable changes to the fauna and flora. If plans to accommodate increased levels of boating in the Lily Creek Swamp come to fruition (Sinclair-Knight-Merz 1995) then accumulated petrochemical residues and physical disturbance from boats could be of concern, especially in terms of the need to conserve the significant population of Comb-crested Jacana in this system. Apart from use by tour operators, the level of power boat use in swamps on Lake Kununurra is currently unknown. Furthermore the absence of regular monitoring of water quality or the fauna and flora in the swamps prevents any assessment of the impact of current levels of use.

Increases in boating activities, involving overnight camping between the Argyle Dam and the Diversion Dam, could cause disturbance to wildlife breeding sites and also health problems in the lake. Canoeists are likely to be the biggest group of lake users who would tend to camp and favoured sites will probably be sandbars beside the river above the spillway creek confluence. These same situations are also likely to be favoured breeding sites for freshwater crocodiles, turtles and water monitors. Current levels of use of sand bars along the upper reaches of the lake by either campers or wildlife and the amount of breeding disturbance occurring is unknown. Long term intensive use of sandbars without adequate toilet facilities has resulted in water contamination with micro-organisms causing giardia in other nearby parts of tropical Australia e.g. in Nitmiluk (Katherine Gorge) National Park.

At least one of the commercially targeted fish species, the sooty grunter probably undertakes seasonal upstream migrations to flowing riverine sections of the lake to spawn. In this respect the impact of commercial net fishing activities in upstream areas should be determined. Both impacts on migrating fish as well as on non-target species (turtles and crocodiles) in the vicinity of prime upstream breeding habitat would need to be addressed.

Industrial and urban expansion in the Kununurra township or along the foreshore of the lake will create greater stormwater discharge into swamps and losses of riparian habitat. The Lily Creek Swamp will almost certainly be the main recipient of any increase in stormwater runoff. There is currently no routine monitoring of the quality of

stormwater runoff entering Lily Creek (or any other) Swamp. Without efficient throughput, any pulses of nutrient enriched runoff from stormwater discharge could generate prolonged periods of eutrophic conditions.

The riparian zone potentially supplies a number of resources to aquatic and semi-aquatic animals. The range may include food (flowers, fruits, leaves or invertebrate life from overhanging riparian plants), shelter (shaded margins or protected pockets amongst submerged fallen branches or root masses of overhanging trees) and breeding sites (amongst submerged fallen branches or root masses from trees, in holes in the substrate or amongst leaf litter on banks or in riparian vegetation itself). Current evidence from along the foreshore of Lake Kununurra strongly suggests that development precipitates a large reduction in habitat complexity of riparian vegetation. The lakeside hobby-farm blocks and foreshores associated with sporting facilities, residential areas and lakeside tourist services are often substantially cleared to the water's edge. The extent to which clearing and development of riparian habitat can continue before ecological change amongst aquatic organisms becomes noticeable is unknown. There needs to be some assessment of the use of riparian habitat by aquatic and semi-aquatic organisms and identification of key zones or regions.

One of the more obvious effects of increased population pressure on the lake is increased fire frequency in aquatic and riparian environments. While part of the current management strategy to control infestations of cumbungi includes controlled burning there has also been an increase in the number of unplanned burns; deliberately lit by townspeople with their own plans of cumbungi reduction in mind. Cumbungi burning affects not just the cumbungi but also riparian woodlands and stands of dead trees in swamps. With repeated long term burning it is possible that riparian woodlands could be dramatically thinned or eliminated; the result of progressive deaths of trees from fire with very low levels of recruitment because of competition from re-invading cumbungi. Riparian woodland habitats supporting flying fox colonies along the lake could be at risk. This is particularly evident in the Packsaddle Swamp. In other swamps, accelerated losses from burning stands of dead trees will reduce the number of roosting and nesting opportunities of a range of water birds including cormorants, egrets and herons.

With the current arrangement of the Ord River Irrigation Area, a predominantly gravity fed canal system running directly from the lake, once water leaves the lake any subsequent deterioration in quality is effectively passed downstream. It is only from the Packsaddle irrigation area, an area supplied by pumping from the lake, that any water initially removed for irrigation is returned to the lake. Irrigation tail water from the Packsaddle area is discharged into the Packsaddle Swamps. This water may pick up a variety of pesticide and herbicide residues during its passage around the irrigation network. There is currently no routine monitoring of its quality or of what impacts it may be having. Of particular concern would be impacts on invertebrates, fish and frogs and ultimately species higher up the food chain such as heron and egrets.

Without any current knowledge of the status of feral animals along the foreshores of the lake or in swamps the extent of the ecological impact is unknown. Populations of cattle, donkeys and pigs in upstream areas could, through trampling, interfere with the breeding sites of crocodiles and turtles. Pigs would also be capable of preying on the eggs of these species. The foraging impacts of cattle, pigs and donkeys could enhance the opportunity for weed establishment along the lake by disturbing and selectively grazing native species. They may also however maintain some level of suppression of the potential growth capability of these weed species.

3.6 Conclusions

3.6.1 Urgent Management Actions

Lake Kununurra is an man-made wetland that was created over 30 years ago. The nomination of the site for the List of Wetlands of International Importance recognised that the primary management purpose of the lake was water supply (Department of Conservation and Land Management 1990). The water level in Lake Kununurra is managed by the Water Corporation.

No urgent management concerns were identified during the fieldwork, which require follow-up by the Department of Conservation and Land Management with the Water and Rivers Commission.

3.6.2 Necessary Ecological Investigations

Implementation of a monitoring program is one of the core obligations of management of Ramsar-listed wetlands. Monitoring is needed to test if ecological change is occurring and to develop appropriate management responses. Important attributes to monitor at Lake Kununurra are water quality, aquatic and fringing vegetation, aquatic fauna (e.g. native fishes) and waterbird numbers.

The monitoring should consider including periodic assessment and mapping of wetland plant communities to determine the future course of cumbungi infestations, changes in aquatic macrophyte composition, changes in riparian woodlands, the presence or extent of invasions by introduced plants and the impact of fire on communities and on stands of emergent dead trees. It should include periodic routine monitoring of waterbird populations with an emphasis on seasonal usage of the range of wetland habitats and clarification of the importance of the site for breeding.

Recommendation 10: The Kimberley Regional Ecologist, in consultation with the East Kimberley Office, develop a program to monitor for changes in the ecological character of Lake Kununurra. This should be developed as part of a regional program for Ramsar sites (see Section 9.3.2).

It is important to ensure that commercial fishing occurring in the lake is being conducted at a sustainable level and that all measures are being taken to minimise the catch of non-target species. Additional studies or data collection by the fishery operators may be needed.

Recommendation 11: The Regional Manager correspond with the regional office of the Department of Fisheries providing details on the Ramsar Convention and seeking information on the management of the fishery in Lake Kununurra.

It was clear from the brief fieldwork that the ecological attributes of the lake have changed considerably since the nomination information was prepared in 1989. These changes have been underpinned by the massive proliferation of cumbungi which has caused structural habitat modification characterised by infestation of margins and shallow water by tall dense aquatic vegetation. Some of the fauna values for which the

lake was originally noted (e.g. concentrations of waterfowl) have probably been much reduced.

However the change in the ecological attributes of the lake is still essentially a part of the ecological character of the site. This is because a protracted period of succession can be anticipated in man-made ecosystems. There is a need to update the Information Sheet for Lake Kununurra and in this recognise that there will continue to be significant changes in the ecological attributes until the lake reaches a dynamic equilibrium.

Recommendation 12: The Regional Ecologist update the Ramsar Information Sheet for Lake Kununurra and include revised information on the ecological attributes and incorporate a recognition of the dynamic changes that will continue to occur at the lake.

3.6.3 Management Planning

An important issue related to management and management planning is to establish a clear understanding of the boundary of the Ramsar-listed area of Lake Kununurra. Detailed maps showing the boundary should be available at the East Kimberley Office for staff and the public. A copy of these maps should be supplied to the Water and Rivers Commission.

Consideration could be given through discussion with the Department's Principal Research Scientist responsible for wetlands to having Lake Argyle and Lake Kununurra listed individually as Wetlands of International Importance.

Recommendation 13: The Kimberley Regional Ecologist, in consultation with the East Kimberley Office, work with the Department's wetland research officers to define in detail the boundaries of the Ramsar-listed area of Lake Kununurra.

Recommendation 14: The Regional Manager ensure that detailed maps are available at the East Kimberley Office that show the boundary of the Ramsar-listed area of Lake Kununurra. Also that a copy of these maps be supplied to the Water and Rivers Commission Office in Kununurra.

Recommendation 15: The Regional Manager take the necessary steps to ensure that the Department forward a copy of the detailed maps of Lake Kununurra to Environment Australia.

Lake Kununurra is vested in the Water and Rivers Commission and managed by the Water Corporation. As such the management plan that is developed for Lake Kununurra should have, as a minimum, a statutory basis under legislation administered by the Commission.

The Department of Conservation and Land Management should have a formal role in the development of the management plan because of its responsibility for implementation of the Ramsar Convention in Western Australia. A mechanism to develop this cooperative approach is the establishment of a consultative committee involving the Kununurra Office of the Water and Rivers Commission and the Department of Conservation and Land Management. Initially this committee could discuss the Ramsar Convention and the obligations for the management of listed

wetlands. These consultative arrangements could pick up issues associated with the proposed Carr Boyd Range and Lake Argyle National Park and the Packsaddle Swamp Nature Reserve. The committee could also consider including other agencies and stakeholders in the consultations (especially Aboriginal Traditional Owners).

Recommendation 16: The Regional Manager establish a consultative committee with the Kununurra Office of the Water and Rivers Commission and Water Corporation to discuss Ramsar issues related to the management of Lake Kununurra (also see Section 9.1.2).

Recommendation 17: The Regional Manager use the consultative committee to discuss the joint development of a management plan for Lake Kununurra to be implemented under legislation administered by the Water and Rivers Commission (also see Section 9.1.2).

In addition to giving attention to the development of a management plan for Lake Kununurra it is also important that the Department of Conservation and Land Management actively participate in other planning and management process for the lake and adjacent areas.

Recommendation 18: The Regional and District Manager continue to support staff involvement in government and community planning for Lake Kununurra and adjacent areas.

In establishing a consultative committee to discuss management issues related to Lake Kununurra recognition should be given to the special interests of Aboriginal people. A current Native Title claim has been made over the area by the Miriuwung Gajerrong Traditional Owners. This is to go before the Federal Court in March 1997 where the Aboriginal Legal Service will represent the Native Title interests of the claimants.

Recommendation 19: The Regional Manager note the special interest that Aboriginal people have in Lake Kununurra and seek to ensure that:

- **these interests are included in any future discussions about the management of Lake Kununurra**
- **necessary steps are taken to advise the State Government's Native Title Unit of the Ramsar-listed status of Lake Kununurra and the interests of the Department**
- **full recognition is given to the current legal proceedings in any decisions made relating to Lake Kununurra.**

3.7 References

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Ord River Floodplain

4.0 Ord River Floodplain

The Ord River Floodplain is located at latitude 15° 15' S, longitude 128° 15' E. The nearest township, Wyndham, has an annual average rainfall of 695 mm (Bureau of Meteorology data). Rainfall is monsoonal and is thus restricted to a very hot (mean max. about 39° C in December), humid wet season from November to March. The middle of the year is characterised by warm (mean max 30° C in July), dry days with periods of steady south-easterly winds.

4.1 Physical Attributes

The site has an area of around 1100 km^2 and is composed of depositional floodplain and estuarine environments associated with the mouth of the Ord River. There are three relatively distinct wetland units.

The southern part of the site is dominated by Parry Creek. This includes a 20 km length of seasonally-flowing creek channel running through upland environments, and an alluvial floodplain complex. The floodplain is flooded to variable extent in the wet season but after the rains cease, except for a few permanent 'holes' associated with incised channels and claypans, it quickly dries out. The upstream (southern) portion of the floodplain is freshwater while lower (northern) sections, if not inundated by saline water, certainly have salty soils.

Extending north from the floodplain of Parry Creek for some 60 km to the Cambridge Gulf are the lower reaches of the Ord River. Although the upstream end of the site on the Ord River carries a perennial flow of freshwater, the downstream sections, when not in flood, soon start to become saline and are increasingly influenced by tides. The tidal amplitude at the coast can be as much as 8 m. At the upstream end the river channel is around 150 m wide, increasing to over 5 km wide near the mouth. Processes of sediment deposition dominate along the entire length of the river on the site. Broad sandy or gravelly spits and bars occur along upstream reaches while unstable mud bars and islands become common toward the mouth. Burbidge and Messel (1979) reported that *'We found the river had cut new channels upstream of 37 km and that available air photography and maps were of little value when navigating'*. Within the greater alluvial plain through which the river runs there is evidence that the river channel has a long history of instability. The floodplain substrates on either side of the river are predominantly saline.

North-east from the mouth of the Ord River, the site extends for a short distance around the coast to include an estuarine complex known as the 'False Mouths of the Ord'. This consists of a deltaic maze of channel-ridden, tidally inundated coastal mud flats and islands. It is only the northern-most channel in this complex that receives much freshwater input; this from the relatively small and ephemeral Emu, Station and Tanmurra Creeks. A study to investigate geomorphological aspects of this area was completed by Thom *et al.*(1975).

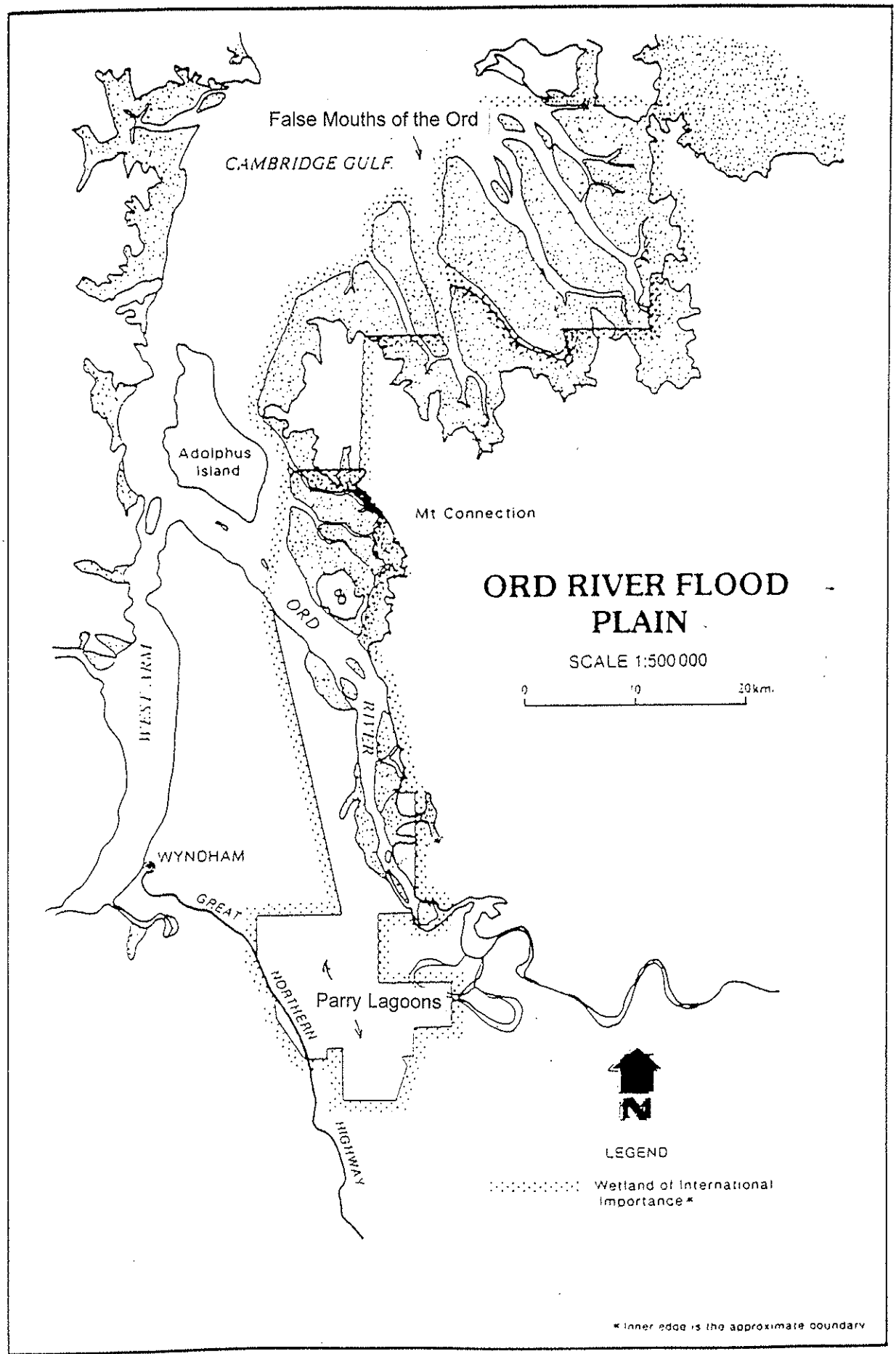

Figure 3. Ord River Floodplain
(Department of Conservation and Land Management 1990)

Photograph 21 Aerial view across the False Mouths of the Ord River (28 June 1996, Doug Watkins)

Photograph 22 View N across Marlgu and lower Parry Lagoons. (25 June 1996, Doug Watkins)

Photograph 23 Ruins of a radio telegraph station on hill overlooking Marlgu Lagoon.
(25 June 1996, Doug Watkins)

Photograph 24 Marlgu.
(29 June 1996, Doug Watkins)

Photograph 25 Goose Hill, view NE across Wild Goose Creek and Ord River to House Roof Hill.
(29 June 1996, Doug Watkins)

Photograph 26 Noogoora burr growing in Wild Goose Creek.
(29 June 1996, Doug Watkins)

The catchments of short creeks entering the site are bounded by the sandstone hills of the Erskine Ranges to the west of Parry Creek and by the Onslow and Hargreave Hills and the limestone Ningbing Range to the east of the False Mouths (Traves 1955). Both Parry Creek and the False Mouths have very small catchments compared to that of the Ord River which has a catchment of 55 300 km^2.

Historically, the flooding and drying cycles, and the massive sediment deposition from the Ord River would have been major determinants of ecological processes on the site. However, with the river now dammed at two points upstream the hydrological and sediment deposition characteristics have changed markedly. Once a river with only seasonal flow, it is now perennial due to constant discharge from the Diversion Dam of the Ord River Irrigation Area some 85 km upstream (Wark undated). The main Argyle Dam on the Ord River, some 140 km upstream from the site, is highly effective at constraining wet season flood peaks and trapping sediment loads from the majority of the catchment. Since the construction of the Argyle Dam the wet season flood peaks and sediment pulses in the lower Ord are almost certainly determined more by the pattern of flooding and sediment yield from the Dunham River. This is a tributary of the Ord River with catchment of less than 4 000 km^2 which flows into the Ord River just below the Diversion Dam.

Compared to pre-dam conditions the Ord River now floods less frequently and/or for shorter periods and, carrying much less sediment, the stream channel of the lower Ord is possibly more stable than in times past.

4.2 Biological Attributes

4.2.1 Flora

The floodplains of the lower Ord are the most extensive in Western Australia (Department of Conservation and Land Management 1990, Burbidge *et al.* 1991) (Photograph 22). They have not been comprehensively mapped and changes that may have occurred, or that are occurring, since the river was dammed have not been documented.

Parts of the Parry Floodplain were part of the Goose Hill Station and the area was also used as a holding area for cattle prior to them being moved to the meatworks at Wyndham. Changes that might have occurred due to these uses have not been documented.

The dominant vegetation type over shallow, freshwater or slightly brackish floodplains is grassland. Beetle grass *Diplachne parviflora* and Wild rice *Oryza australiensis* are amongst the most abundant species. The annual shrubs *Sesbania cannabina* and *Aeschynomene indica* are common and form dense thickets to 2 m high on the central flats.

In deeper, more persistent freshwater billabongs and swamps (primarily associated with Parry Creek) the aquatic vegetation includes fringing *S. erubescens* and sedges (e.g. *Cyperus* spp.), several species of water lily (*Nymphaea* and *Nymphoides* spp.), beds of spike-rush *Eleocharis* spp., bladderworts *Utricularia* spp. and hornwort

Ceratophyllum demersum (Photograph 24). The tall emergent reed *Phragmites karka* is patchily distributed.

As soil salinity increases closer to the mouth of the Ord River, the samphire species *Halosarcia indica* and *Tecticornia verrucosa* and the salt grasses *Sporobolus virginicus* and *Xerochloa* spp. become more common.

Riparian vegetation along freshwater reaches of the Ord River and around deeper billabongs can include *Eucalyptus papuana*, *E. camaldulensis*, *Terminalia platyphylla*, *Barringtonia acutangula*, *Melaleuca argentea*, *Acacia holosericea* and *Excoecaria parvifolia*. Riparian communities along the river seem to have benefited greatly from the effects of upstream damming. Either from reduced scouring during wet season floods or from perennial river flows (or both) many formerly bare sandy banks, bars and islands now appear to becoming densely vegetated. The reed *Typha domingensis*, probably either rare or absent from the lower Ord prior to damming has now established in dense stands along most freshwater reaches of the river.

In tidally-influenced, saline portions of the lower Ord and throughout the False Mouths, mangrove communities occur. Fourteen species of mangrove plant have been recorded with species richness being only slightly less than the 17 species recorded for the whole of the Kimberley (Johnstone 1990, Kenneally 1982, Thom 1975, Wells 1982, Semeniuk 1993). The lower rainfall of the region is thought to be the primary cause of this difference (Wells 1982). Communities are more or less linear and form narrow, relatively low stands along banks (Photograph 21) or broader belts in a few parts of the False Mouths. Common species include *Sonneratia alba*, *Avicennia marina*, *Ceriops tagal*, *Bruguiera parviflora*, *Rhizophora stylosa* and *Aegiceras corniculatum*. Mangrove communities throughout the site frequently exhibit strong patterns of species zonation, reflecting each species' preference for a particular regime of tidal flooding. Due to their occurrence on unstable, soft muddy substrates and the effects of high tidal flows and seasonal scouring from floods, the location of mangrove stands throughout much of the lower Ord River has the potential to change through time. Thom *et al.*(1975) determined that historically mangrove cover throughout the site has been much more extensive.

Weed species on the site are recognised as a significant problem along all freshwater sections of the Ord River. A large portion of the Ord River Floodplain lies within a noogoora burr *Xanthium pungens* quarantine area (APB undated) (Photograph 26). The prickly shrub parkinsonia *Parkinsonia aculeata* has formed extensive thickets in riparian and river levee situations. The banks also support populations of rubber bush *Calotropis procera* and some leucaena *Leucaena leucocephala* which escaped from agricultural areas upstream. The recent discovery of (what is currently) a small patch of bellyache bush *Jatropha gossypiifola* on the reserve adjacent to Parry Creek is of some concern.

4.2.2 Fauna

There are no published data available on the status of the invertebrate fauna of the site. Of the vertebrate fauna only for estuarine crocodile *Crocodylus porosus* and waterbird populations have there been there any quantitative studies (Burbidge and Messel 1979, Messel *et al.* 1987, Gowland 1983, Jaensch and Vervest 1990).

It was on the basis its population of crocodiles that part of the site was originally recommended for protection as a nature reserve (Bustard 1969). Repeated crocodile censuses by Messel *et al.*(1987) showed that crocodile populations in the Ord River were increasing and that the Ord River is the major breeding area in the region. However, the current Ramsar site apparently only contains small areas of favoured crocodile nesting habitat. Most breeding must occur elsewhere on the river. A crocodile count in the Ord River estuary in 1992 showed a non-hatchling crocodile density of 1.5/km (Australian Nature Conservation Agency 1996).

The site supports significant populations of waterbirds though primarily on a seasonal basis (Gowland 1983). From floodplain habitats associated with Parry Creek up to 77 waterbird species have been recorded, including 22 listed under international conservation treaties (Gowland 1983, Jaensch and Vervest 1990). The early part of the dry season, May to July, as the floodplains dry out, appears to be the time when the greatest numbers of waterfowl congregate on the site. The highest count recorded was of 27 000 birds in May 1986 (Jaensch and Vervest 1990) and it is thought that more than 20 000 probably occur annually. Abundant species with State or nationally significant aggregations reported during this period include Plumed Whistling-Duck *Dendrocygna arcuata* and Glossy Ibis *Plegadis falcinellus*.

Parry Lagoons is an important area for shorebirds. The site is considered to be of international importance in terms of populations of Red-kneed Dotterel *Erythrogonys cinctus,* Australian Pratincole *Stiltia isabella,* Oriental Pratincole *Glareola maldivarum* and Little Curlew *Numenius minutus* (Watkins 1993). Recent information suggests the area is also internationally important for Sharp-tailed Sandpiper *Calidris acuminata*, Common Greenshank *Tringa nebularia*, and Marsh Sandpiper *Tringa stagnatilis* (Collins and Jessop *in press*). This information increases the ranking of the site to it being one of the five most important wetlands in Western Australia for migratory shorebirds (in terms of the number of species for which the site is internationally important). It also lifts the national ranking to around the tenth most important site in Australia (based on the data in Watkins 1993).

Rare or threatened species known from the site include Freckled Duck *Stictonetta naevosa*, Garganey *Anas querquedula*, Pectoral Sandpiper *Calidris melanotos*, Long-toed Stint *Calidris subminuta*, Painted Snipe *Rostratula benghalensis* and Zitting Cisticola *Cisticola juncidis*.

Eight waterfowl species are known to breed on the site but no comprehensive breeding surveys have ever been conducted. Of these the most significant are Magpie Goose *Anseranus semipalmata,* having the highest breeding concentration in WA, egrets and herons (colonies in wooded swamp), and Yellow Chat *Ephthianura crocea.*

The mangrove bird fauna on the site includes almost all of the specialist mangrove species occurring in WA (Johnstone 1990; Schodde, Mason and Gill 1982). The site includes part of the only population of Black Butcherbird *Cracticus quoyi* in the State, a morphologically significant variant of the Lemon-breasted Flycatcher *Microeca flavigaster*, and populations of the Collared Kingfisher *Halcyon chloris*, Shining Flycatcher *Myiagra alecto* and Chestnut Rail *Eulabeornis castaneoventris* that are of State significance.

Fish populations on the site have apparently received little attention. Two species of freshwater fish, the catfish *Neosilurus hyrtlii* and a rainbowfish *Melanotaenia splendida*, have been recorded from Parry Lagoons (Allen and Leggett 1990) and the barramundi

Lates calcarifer is the main species targeted by recreational and commercial fishing in estuarine regions. The regional significance of the estuarine environments on the site as breeding and nursery grounds for marine fish and crustaceans is thought to be high but this has yet to be quantified.

The only mammal survey conducted on the site was in mangroves in the False Mouths (McKenzie and Rolfe 1986). This recorded the first known population of Mosaic-tailed Rat *Melomys burtonii* in WA and a rich bat fauna comprising some 17 species.

Introduced fauna on the site includes feral cats and cattle.

4.3 Cultural Values

4.3.1 Aboriginal Cultural Values

The major cultural issue for Aboriginal people in the Kununurra/Wyndham area relates to Native Title Claims.

The Ord River Floodplain is part of the Miriuwung Gajerrong Native Title Claim No. 1 (Appendix 3). The claim was lodged by the Aboriginal Legal Service of Western Australia on behalf of the claimants in April 1994 and was accepted by the National Native Title Tribunal in May 1994. Lake Kununurra and Lake Argyle are also included in the claim. The majority of the claimants are represented by the Aboriginal Legal Service and the Northern Land Council. A number of Kija people, who live in the Turkey Creek area, are joint claimants and these are represented by the Kimberley Land Council.

The application is for land and water in and around Kununurra, Wyndham, Cambridge Gulf and Turkey Creek in Western Australia and the Keep River National Park in the Northern Territory. The area includes Lacrosse, Kanggurrya, Pelican Monsmont and Guy Reid Islands (Appendix 3). The same claimants have lodged a further Native Title claim that includes areas adjacent to the Ord River Floodplain (Miriuwung Gajerrong No. 2) (Appendix 4).

There are over a hundred interested persons registered with the National Native Title Tribunal including the Commonwealth and Western Australian Governments. The Native Title Tribunal referred the claim to the Federal Court after preliminary mediation between the interested parties because it was felt there was no possibility of an agreement between all the parties being reached. This move was supported by the claimants and the State Government. The case has been set down for hearing in March 1997.

There was little interest in discussing issues related to Ord River Floodplain during the field visit because:

- the Federal Court hearing on this claim was pending, and
- the claimants were involved in intensive negotiations with the State Government and the East Kimberley Shire in relation to their Miriuwung Gajerrong No. 2 claim (Appendix 4) and the Ord Stage 2 Project.

A number of parties were contacted including:

- Aboriginal Legal Service, Kununurra
- Bob Hannan, Miriuwung Gudjerrong Families Land Council

- Ben Ward, Warringarri Aboriginal Corporation
- David Neary, Mirima Dawang Worlab-gerring Language Centre
- Ray Blackwood, Aboriginal Affairs Department
- Project Officer, Aboriginal and Torres Strait Islander Commission

Correspondence relating to the project was forwarded to each organisation and a meeting was requested. Meetings to discuss the Ramsar status and proposed management planning process were held with representatives from the Mirima Language Centre, Aboriginal Affairs Department and the Aboriginal and Torres Strait Islander Commission. The representative from the Mirima Language Centre emphasised the importance of the areas to Mirima people and the importance of including them in any discussions about management.

Although Mr Hannan was not in Kununurra at the time of the field work he advised that he would like to be kept informed of what was happening. He also requested that representation be made through the Native Title Tribunal or that the Minister should approach him directly [*sic*] He expressed the opinion that once the Native Title issue was resolved this would clarify future management issues.

As mentioned above, over the past 12 months the claimants have been focusing on negotiations relating to the Ord Stage 2 Project. A number of agreements have been negotiated by the Working Party, which includes representatives from Aboriginal groups the State Government and the Shire. The success of these negotiations indicates that despite conflicting interests related to the area under claim, properly structured consultation and negotiation processes can yield positive results.

The site register compiled by the Heritage and Culture Division of the Aboriginal Affairs Department lists a number of ethnographic and archaeological sites within the Ord River Floodplain area.

4.3.2 Other Cultural Values

Parry Lagoons Nature Reserve, Ord River Nature Reserve and the Ord River Floodplain are listed on the Register of the National Estate (Natural Values).

The Parry Lagoons area is of historical interest. In 1914 a radio telegraph station was build on the hill overlooking Marlgu Lagoon to assist shipping entering Wyndham. The ruins of these buildings remain clearly visible (Photograph 23). Between 1920 and 1960 the Parry Lagoons were an important watering and holding area for cattle being delivered to the meatworks at Wyndham.

4.4 Tenure and Management Regime

4.4.1 Tenure

Most of the site is made up of Nature Reserves which are vested in the National Parks and Nature Conservation Authority and are managed by the Department of Conservation and Land Management. The southern portion is formally named the Parry Lagoons Nature Reserve. A middle section encompassing most of the lower reaches and mouth of the Ord River is known as the Ord River Nature Reserve while

the northern-most section (the estuarine complex north-east of the Ord River mouth) is called the False Mouths of the Ord Nature Reserve.

Lands adjoining about half of the Ord River Floodplain lies within a noogoora burr Quarantine Area. Access into this area has been restricted to limit the spread of noogoora burr. The quarantine procedures are managed by Resource Protection Officers of Agriculture WA.

There is a freehold block of land of about 45 ha within the Parry Lagoons Nature Reserve for which there are plans to develop low key tourist accommodation. Other small areas north-west of the township of Wyndham and to the far east of the site are also unreserved, being either Vacant Crown Land or part of the Carlton Hill pastoral lease.

Native Title

The Ord River Floodplain is included in the Miriuwung Gajerrong Native Title Claim No. 1. The claim was lodged by the Aboriginal Legal Service of Western Australia on behalf of the claimants. This application has been referred to the Federal Court and is set down for hearing in March 1997.

Marine Park Proposal

The Marine Parks and Reserves Selection Working Group (1994) has recommended that a Marine Park be established for the conservation of marine flora and fauna and protection of mangrove habitats in the eastern half of the Cambridge Gulf. This area includes parts of the Wyndham Port Limits. The proposed area extends up the Ord River to the Parry Lagoons Nature Reserve.

East Asian-Australasian Shorebird Reserve Network

At the Ramsar Conference of Parties in Brisbane in March 1996 the Western Australia Government announced its involvement in a shorebird conservation project called the East Asian-Australasian Shorebird Reserve Network. This project seeks to address the conservation needs of migratory shorebirds on a flyway basis through the development of an international network of sites managed for shorebird conservation. Parry Lagoons was nominated by the Western Australian Government for inclusion in the project. The Shorebird Reserve Network does not have legal implications. Responsibility for the management of sites remains with the nominating agency (Watkins 1995).

4.4.2 Site Management

Access to the site is limited. On the southern side of the Ord River, the Parry Lagoons Nature Reserve is accessible on the Parry Creek road, an unsealed, two-wheel-drive road from the Great Northern Highway about 15 km SE of Wyndham. This provides dry season entry to Marlgu Lagoon, a near-permanent freshwater billabong on the Parry Creek floodplain. Several un-gazetted, four-wheel-drive tracks from the Great Northern Highway, nearer to Wyndham, appear to provide entry to some of the northern parts of the site but these tracks are not sign-posted and are mostly used by small groups of people from Wyndham and Kununurra. The location of these tracks can vary from year to year as old tracks are rediscovered or new tracks created once the soils have dried

out enough following the wet season. The Parry Creek road runs through much of the southern part of the site though access is restricted due to the noogoora burr Quarantine area. Because nearly all of the Ord River on the site falls within the quarantine area there is effectively no public vehicle access to the river. The only vehicle entry to the site on the eastern side of the Ord River is on four-wheel-drive tracks through pastoral properties. None of these tracks are marked on publicly available maps though at least one (off the Ningbing track) is used regularly by residents from Kununurra to enter an area of the False Mouths of the Ord.

Many inappropriate and illegal uses of the site originate as a result of its proximity to the town of Wyndham. These include rubbish and litter, dumping, shooting of wildlife, lighting of fires and off-road-vehicle use.

The level of visitation to the Parry Lagoons Nature Reserve is unknown. Visitor facilities at Marlgu Lagoon are limited. A lookout on a small hill near the lagoon provides views across the floodplain (Photograph 22). The lagoon has an interpretative sign near the carpark and a raised board walk leading from the car park to a viewing platform and bird hide. The Commonwealth Government has provided $ 60 000 for the construction of boardwalks, viewing platforms and hides at this site (Australian Nature Conservation Agency 1996b).

Recreational and commercial fishing is possibly the only other activity that occurs regularly on the site. The reservation status of the site excludes recreational fishing in floodplain lagoons or billabongs but fishing is allowed on the Ord River and in the channels of the False Mouths. However, because of the noogoora burr Quarantine Area, boating activities on the Ord River are restricted to two fishing tour operators and members of the East Kimberley Sport and Game Fishing Club who are issued with special permits. They enter the site from base camps upstream. Recreational fishing also occurs in the False Mouths of the Ord but there is no information available concerning boat numbers or of the amount of fish taken.

A small commercial barramundi fishery operates in the Cambridge Gulf. The size of the catch taken from the lower Ord River is not known.

Management to control or eradicate noogoora burr in the quarantine area has been in progress since 1974. The area of infestation along the Ord River was divided into upstream and downstream management units with the upstream unit first targeted for treatment. This area extended from Buttons Gap to near Wild Goose Creek.
Initial efforts at control involved manual spray applications of the herbicide 2-4-D to break up dense infestations. As plant densities diminished chemical control was phased out and replaced by manual grubbing within systematic search grids. After some 20 years much of the upstream management area is now believed to be free of noogoora burr. Control of noogoora burr in the downstream management area, which includes almost all the infestations on the Ord River Floodplain, began only about two years ago. It is still very much in the 'initial knock-down' phase (Richard Watkins, Agriculture WA, pers. comm.).

4.4.3 Catchment Management

Lands bordering the eastern part of the site, along the Ord River and around the False Mouths, are part of Carlton Hill pastoral lease and managed for beef cattle production. Another pastoral property, Ivanhoe Station, adjoins the south-eastern part of the site.

The boundaries of Ivanhoe Station are fenced while those with Carlton Hill Station are only partially fenced. On nearly all pastoral properties in the region fire is one of the most widely used management tools. During the dry season fire both removes nutritionally deficient stands of dead grass and stimulates production of a 'fresh green pick'. However, burns on pastoral properties are essentially uncontrolled with inadequate fire breaks to prevent escape to neighbouring properties. The Ord River Floodplain thus tends to have a fire regime at least partially imposed by the adjacent stations.

The hinterland to the west of the site includes El Questro Station, areas of Vacant Crown Land and government reserves. The Great Northern Highway, a popular tourist route, runs down part of the western side of the site.

About 85 km upstream from the site along the Ord River is the township of Kununurra and the Ord River Irrigation Area. The Ord River Irrigation Area comprises a storage lake, Lake Kununurra, formed by a dam (the Diversion Dam, Photograph 15) across the Ord River near the township, and the irrigation network which includes over 135 km of channels, servicing an agricultural area of some 15 000 ha (Western Australian/Northern Territory Government 1994). The Water and Rivers Commission is responsible for water quality in Lake Kununurra. Dam operations and hardware are managed by the Water Corporation while distribution of water throughout the irrigation network is administered by a private co-operative, the Ord Irrigation group.

Irrigation tail water from the Ivanhoe Plain section of the Irrigation Area is released into the Ord River at various points downstream between the Diversion Dam and the Ord River Floodplain. Of the 116 466 megalitres of water supplied annually for irrigation, about 12 per cent is considered 'wasted'. It is uncertain how much of this is released as tail water. Neither the quantity nor the quality of this water is routinely monitored. Pesticide applications to the Irrigation Area during its early years of operation occasionally caused fish kills downstream along the Ord River (Departments of Agriculture, Water Resources and the North-west 1990). Pesticide use today is considered to be much more environmentally responsible.

Apart from irrigation supply, the Diversion Dam is also managed to maintain river levels and water quality downstream for use on river-levee horticultural blocks, for cattle on adjoining pastoral properties and for tourist and recreational boating (Wark undated). This is achieved by a minimum release from the dam of 41 m^3/second (1.292 million megalitres/year). Before the Ord River was dammed the river flows stopped each dry season.

The current land use and management regime around the southern part of the site is planned to change in the near future. The Stage 2 extensions to the Ord River Irrigation Area include development of the Carlton Plains and Manitea Flats for broad acre agriculture and horticulture (WA/NT Governments 1994, Kinhill 1995). These developments, with a total planned area of some 12 400 ha, will abut the eastern side of the Parry Lagoons Nature Reserve and extend upstream along both sides of the Ord River for about 36 km. Water will be supplied by pumping from the river. Some of the crops expected to be grown include sugar cane, cotton, leucaena, bananas and mangoes.

Associated with these developments the Parry Creek road may be upgraded, most probably sealed, and is likely to become a significant tourist route (Kinhill 1995). As a

result the Parry Lagoons Nature Reserve would be exposed to a much higher level of tourist visitation.

Wyndham is one of only two operating ports in the Kimberley. The shipping to Wyndham passes in and out of the Cambridge Gulf adjacent to the Ord River Floodplains. In 1994-95, 118 858 tonnes of produce, materials and equipment were imported through Wyndham port and 180 535 tonnes were exported. The major imports were: bulk fuel (102 479 tonnes), building materials (7 989 tonnes), fertiliser (4 196 tonnes) and general (2 447 tonnes). The major exports were: zinc concentrate (130 387 tonnes), lead concentrate (21 500 tonnes), livestock (13 570 tonnes) and, grain and agricultural products (11 049 tonnes) (Department of Transport 1995).

4.5 Potential Threats to the Site and its Values

Events or impacts that could cause change to the ecological character of the site include introductions of exotic plants or feral animals, un-managed visitor impacts, change of water quality, changed fire regimes and change to annual/seasonal hydrology.

Populations of exotic plants are already well established on the site, particularly along the Ord River which is densely infested with noogoora burr and parkinsonia. Although there have been no systematic surveys to monitor the establishment of these species, parkinsonia, at least on the western side of the Ord River at the northern end of the Parry Lagoons Nature Reserve, was observed to have many small satellite infestations that appeared to be continuing active spread across the river levee. The status of noogoora burr on the site has diminished as a result of on-going control and eradication measures. However, with the recent restructure of agriculture-related agencies in Western Australia it can be anticipated that funding for weed eradication will be reviewed and possibly reduced.

The presence of agricultural areas upstream, as a source of potentially invasive non-native plants, will always pose some threat to the site. Furthermore, the level of threat will be heightened when the Carlton Plains and Manitea Flats extensions to the irrigation scheme are developed immediately upstream of the site along the Ord River. The shrub leucaena, grown as a cattle fodder crop, has already escaped from agricultural areas and established along the river. Its rate of spread and establishment downstream may currently be limited by constant exposure to grazing pressure from cattle between the site and agricultural sources. When this pressure is removed when the extensions to the irrigation scheme are developed, and especially if leucaena is cultivated in these new areas, then leucaena could quickly emerge as a significant environmental weed. In this respect the timing of the 'change over' from pastoral to agricultural land use could be important. Ideally any land targeted for re-development should only be de-stocked immediately prior to re-development. An extended period between de-stocking and re-development could allow a significant weed front to develop which could advance onto the site.

In newly-developed agricultural areas the groups of potential weedy species that might escape to establish in wetland situations could include a range of legumes, grass crops such as sorghum and rice, and cotton.

Introduced plants not currently in the region but known to be significant wetland weeds in similar habitats in the Northern Territory, include the thorny shrub *Mimosa pigra* and the floating fern *Salvinia molesta*.

The development of transport corridors on or around the site could prove to be an avenue for weed invasion, and the weed status of land used to supply gravel and fill for road works should be carefully evaluated prior to use.

Visually obvious impacts of feral animals on the site are more or less restricted to the activities of cattle around the margins of the False Mouths of the Ord. Fencing around most sections of the lower Ord River and the Parry Lagoons Nature Reserve seems adequate given that in the near future much of the pastoral land adjoining the site in these regions will be redeveloped for intensive agriculture. At the False Mouths the landward edge and fringing woodlands, especially at the discharge points of small creeks, appears to attract the greatest cattle disturbance. Cattle are probably severely overgrazing the grassy (*Sporobolus virginicus*) saline flats and sheltering in the woodland margins. These habitats may be highly important for survival of a range of small mammals including Mosaic-tailed Rat. Fencing should be considered for this area.

There are undoubtedly feral cat populations in riparian and mangrove environments on the site. Population sizes and the extent of their impacts on assemblages of small mammals, particularly on Mosaic-tailed Rat are unknown. There are currently no feral pigs in the Ord River Floodplain but populations have recently established in upstream locations around Lake Kununurra. The potential for pigs to move downstream to the site through riparian environments should be considered high.

The development of the Carlton Plains and Manitea Flats agricultural areas immediately upstream of the site may cause at least intermittent water quality deterioration on the site. Any runoff into the river of pesticide residues could have potential to kill or alter community assemblages of aquatic fauna including fish and macro-invertebrates. Nutrient flushes may cause algal blooms.

The success of some areas of the new agricultural ventures upstream of the site will hinge on rigorously-managed irrigation practice. Poor practice could raise the water table and cause salinity problems. Whether such problems would be confined to the local situation or whether they would be expressed more extensively and possibly affect the site, is not known.

The current fire regime on the site, which appears to be characterised by extensive annual burning, seems to be largely un-managed. While some fires enter the site from neighbouring pastoral stations many hot, late dry season fires appear to be lit by unknown persons. These fires are a concern for both Reserve and pastoral property managers. It is not known whether the current fire regime is the most appropriate for conservation of the range of fauna and flora on the site. Sensitivity studies to identify how species are affected by different burning regimes could be used to develop burning strategies more in keeping with important conservation values of the site.

The dams along the Ord River have already changed the hydrology of the site substantially. It is thus highly possible that a large section of the Ord River Floodplain is currently in a state of ecological re-adjustment. However, the impact of the Ord River dams on the ecology of the lower Ord wetlands has never been evaluated. In riparian environments along the Ord River ecological shifts related to the change from seasonal flow to permanent flow are conspicuous (e.g. the revegetation of sandy bars and the emergence of infestations of cumbungi *Typha domingensis* along river banks). In floodplain environments however, now inundated less frequently and/or for shorter

periods, the effects are less obvious or more subtle and are probably characterised by slow rates of community turnover. There is at present no monitoring regime to identify the range and rate of community changes in these areas.

With development of new irrigation areas upstream of the site, flow rates down the Ord River will need to be increased for water supply. This could shift the freshwater/saltwater tidal interface in the estuary of the Ord River slightly downstream and cause replacement of some mangrove communities by assemblages of freshwater riparian species.

The Department of Fisheries is present planning to prepare a fisheries management plan for the lower Ord River (Gordon Graham, pers. comm.).

In the longer term the hydrology of the site could be profoundly influenced by rising sea-levels. A sea level rise of just 1 m could cause substantial or total loss of present freshwater wetland habitat on the site but favour expansion of mangroves.

4.6 Conclusions

4.6.1 Urgent Management Actions

No urgent management concerns were identified during the fieldwork that require follow-up by the Department of Conservation and Land Management.

4.6.2 Necessary Ecological Investigations

Implementation of a monitoring program is one of the core obligations of management of Ramsar-listed wetlands. Monitoring is needed to test if ecological change is occurring and to develop appropriate management responses. Important attributes to monitor at Ord River Floodplain are water quality, vegetation, aquatic fauna and waterbird numbers.

Recommendation 20: The Kimberley Regional Ecologist, in consultation with the East Kimberley Office, develop a program to monitor for changes in the ecological character of Ord River Floodplain. This should be developed as part of a regional program for Ramsar sites (see Section 9.3.2).

4.6.3 Management Planning

An important issue related to management and management planning is to establish a clear understanding of the boundary of the Ramsar-listed area of Ord River Floodplain. Detailed maps showing the boundary should be available at the East Kimberley Office for staff and the public. The status of the freehold land in the Parry Lagoons area should be clarified in this process.

Recommendation 21: The Regional Manager ensure that detailed maps are available at the East Kimberley Office which show the boundary of the Ramsar-listed area of the Ord River Floodplain.

Recommendation 22: The Regional Manager take the necessary steps to ensure that the Department forward a copy of the detailed maps of Ord River Floodplain to Environment Australia.

All of the Ramsar-listed area of the Ord River Floodplain is within Nature Reserves except for the marine areas of the Ord River and the False Mouths. As such the Department of Conservation and Land Management is in a position to use the Conservation and Land Management Act to develop a statutory management plan for the area.

However, a Marine Park has been recommended by the Marine Parks and Reserves Selection Working Group (1994) for the marine and Ord River areas adjacent to the Ord River Floodplain. Before commencing a public management planning process for the Ord River Floodplain it is important that the Department clarify with the Minister for the Environment a timetable for advancing the Marine Park proposal. A clear understanding of the status of the Marine Park proposal will greatly assist community participation in the planning process.

The proposed development of a fisheries management plan for the lower Ord River by the Department of Fisheries is important in the context of the Marine Park proposals for the lower Ord River.

Recommendation 23: The Regional Manager take the appropriate action to inform the Marine Branch and the Policy Section of the Department that a fisheries management plan is to be prepared for the lower Ord River and the possible opportunity to advance the Marine Park proposal for the eastern section of Cambridge Gulf.

Recommendation 24: The Regional Manager seek for the Executive Director to obtain in-principle approval from the Minister for the Environment to advance the Marine Park proposal for the areas adjacent to the Ord River Floodplain (also see Section 9.1.3).

Recommendation 25: If in-principle approval is given to advance the Marine Park proposal, the Regional Manager seek advice from the Executive Director on the arrangements, timetable and resourcing as these may have State-wide implications (also see Section 9.1.3).

Recommendation 26: Following clarification of the details for advancing the Marine Park proposal, the Regional Manager take the appropriate steps to combine management planning under the Conservation and Land Management Act with the requirements for the establishment of a Marine Park.

If it is determined that a Marine Park will not be established at this site before the next Conference of Parties to the Ramsar Conference (1999) then alternative mechanisms should be developed to enable coordinated management. This could be achieved by developing a management plan for the Nature Reserves.

Recommendation 27: If by July 1997, it appears that Marine Parks will not be advanced by 1999, the Regional Manager should take the necessary steps to commence a management plan for the Nature Reserves of the Ord River Floodplain.

In addition to giving attention to the development of a management plan for the Ord River Flood Plain it is also important that the Department of Conservation and Land Management actively participate in planning and management process for adjacent areas. At present, relevant issues are the proposed development of intensive agriculture on the Carlton Plains and Manitea Flats, environmental flows in the Ord River, changes to the quarantine regulations and fisheries management.

Recommendation 28: The Regional Manager continue to support staff involvement in government and community planning for areas adjacent to the Ord River Floodplain.

A Native Title claim has been made over the Ord River Floodplain by the Miriuwung Gajerrong Traditional Owners. This is to go before the Federal Court in March 1997 where the Aboriginal Legal Service will represent the Native Title interests of the claimants.

Recommendation 29: The Regional Manager note the special interest that Aboriginal people have in Ord River Floodplain and seek to ensure that:

- **these interests are included in any future discussions about the management of Ord River Floodplain**
- **necessary steps are taken to advise the State Government's Native Title Unit of the Ramsar-listed status of Ord River Floodplain and the interests of the Department**
- **full recognition is given to the current legal proceedings in any decisions made relating to Ord River Floodplain.**

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Lake Gregory

5.0 Lake Gregory

Located at latitude 20° 12', longitude 127° 26' Lake Gregory lies at the northern edge of the Great Sandy and Tanami Deserts but is also situated at the southern edge of the Australian wet-dry tropics (Fig. 4). It receives a relatively low average annual, predominantly summer (December to March) rainfall of around 300 mm (for Balgo Hills).

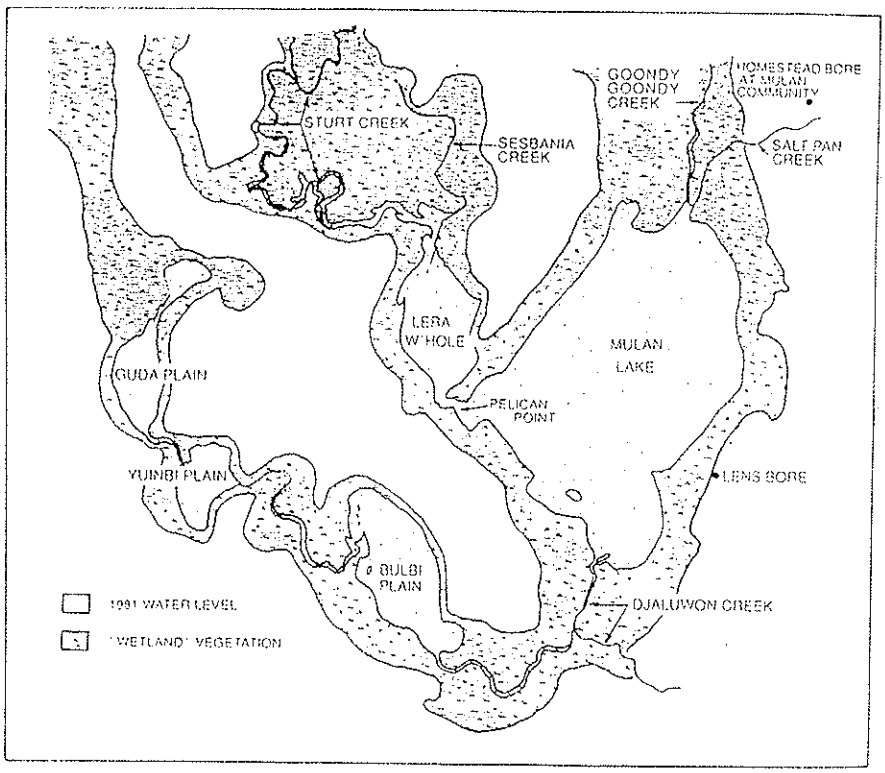
5.1 Physical Attributes

The Lake Gregory site is an inland lake complex comprising a set of shallow basins: Mulan Lake (= Lake Gregory), Lera Plain (= Lera waterhole), Bulbi Plain, Yuinby Plain, Guda Plain, Rilya Plain, Delivery Camp Plain (= Gillung Plain), interconnecting channels, and the lower reaches of the main creeks (Sturt, Sesbania and Goondy Goondy) at the end of the Sturt Creek drainage system. At the most frequent shorelines the site has an area of 38 700 ha with Lake Mulan and Lera Plain accounting for almost 70 per cent of this area The wetland system is set within a larger palaeo-lake, once part of a palaeo-river extending from Sturt Creek to the Indian Ocean (Bowler 1990).

The various lakes and channels in the system range from seasonal to semi-permanent and near permanent. The main lake, Mulan Lake, is semi-permanent having dried out completely in 1979/80 and 1990. Conversely the system has also had several major floods over the last 80 years and the largest of these, in 1982, flooded an area approaching that of the palaeo-lake. Depths in Mulan Lake can clearly be highly variable depending on the level of annual flooding and time of year. However maximum depths of 3-4 m in the centre of the lake are most common. During the time of the largest recorded flood Mulan Lake attained a depth of at least 7.8 m.

The water in Mulan Lake ranges from almost fresh to brackish with recorded salinity levels from 0.3 ppt (parts per thousand TDS) to 20 ppt though concentrations of 1-3 ppt are most common. The lake is probably a source for recharge of the regional groundwater supply (Bowler 1990).

The lands surrounding the lake have low relief and consist of a mix of flat depositional clay pans and fields of low, siliceous sand dunes. The greater catchment is dominated by Sturt Creek with a catchment area of 65 000 km^2. With the source of Sturt Creek, 170 km to the north-east, embedded in a zone of seasonally predictable, though highly variable rainfall, the creek and wetland system downstream has a much more reliable water supply than many other inland lakes in Australia.



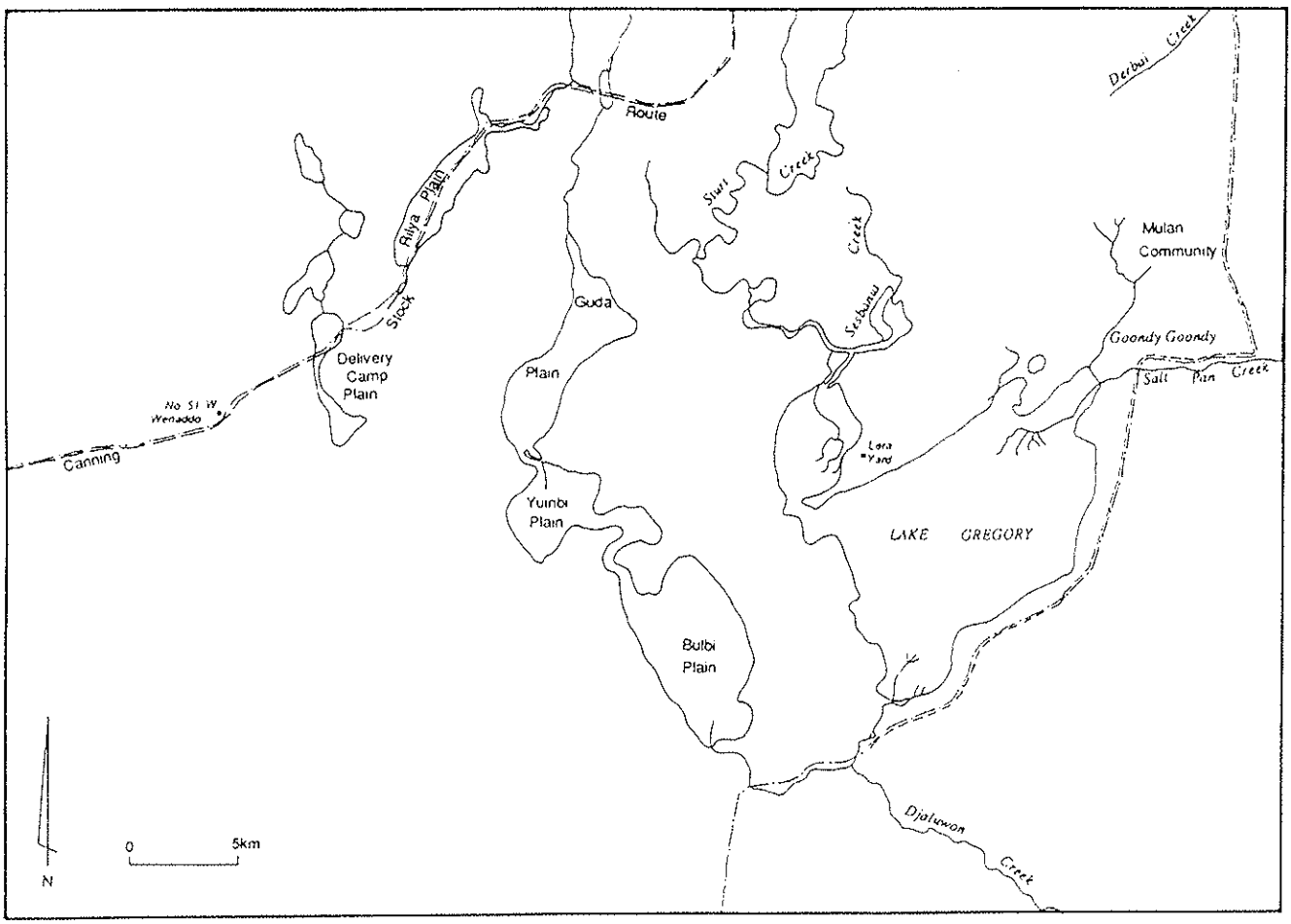
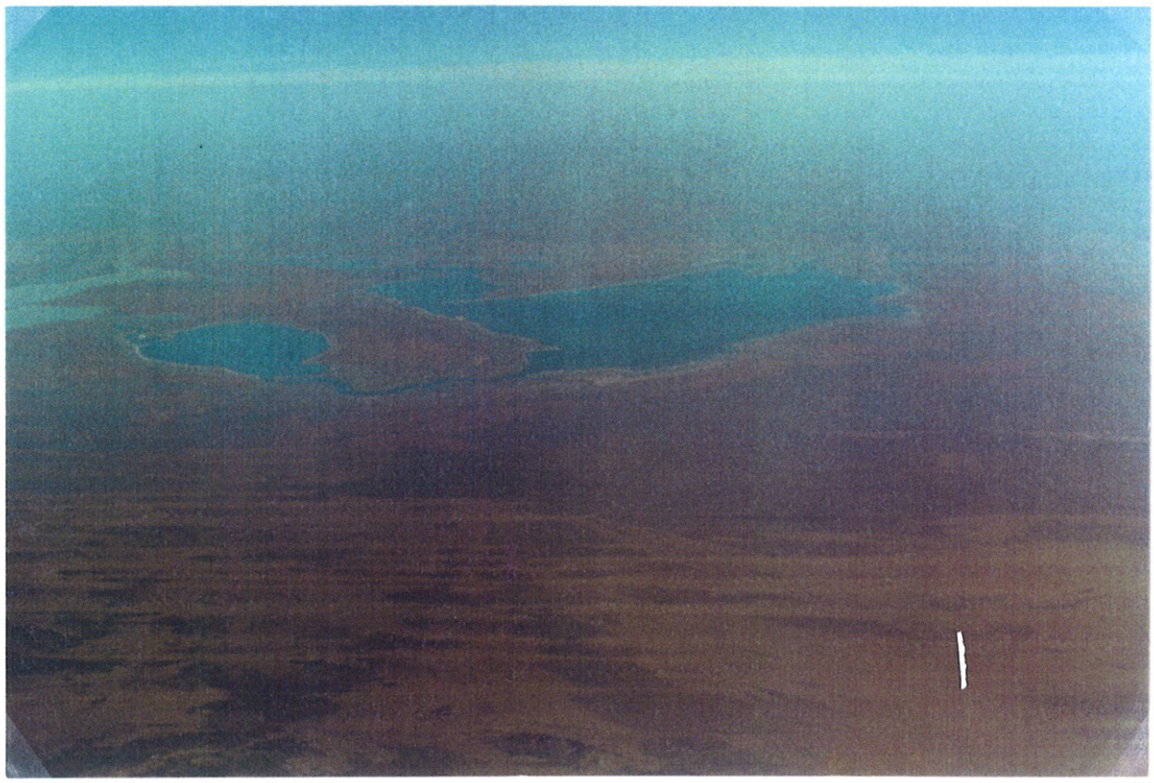


Figure 4. Lake Gregory (Halse 1990)



Photograph 27 Aerial view NW across the main basin of Lake Gregory and the flooded Bulbi Plain.
(23 November 1996, Tim Willing)

5.2 Biological Attributes

5.2.1 Flora

George and Mitchell (1983) provide some data concerning the plant life at Lake Gregory with a short review provided by Marchant and Halse (1990). However a comprehensive (published) plant checklist is not available. The aquatic flora in the lake is either poorly surveyed or has naturally low diversity. A single species of *Myriophyllum* has been collected and species of *Ruppia* are thought to occur there. Algal blooms, believed to be caused by a species of *Cladophora*, have been detected from aerial photos. The riparian vegetation includes wide bands of samphire composed of *Halosarcia halocnemoides* ssp. *tenuis*, *Halosarcia indica* ssp. *leiostachya*, *Cressa cretica*, *Eragrostis dielsii*, *Morgania floribunda*, *Sida rohlenae* and *Swainsona* sp. The upper edge of the normal shoreline includes stands of *Acacia* sp. aff. *tephrina* with an understorey of *Salsola kahli* and *Trianthema triquetra*. The banks of channelled areas support a riparian woodland composed of *Eucalyptus camaldulensis, Eucalyptus microtheca, Acacia holosericea* and *Acacia striata* with *Melaleuca glomerata* and *Melaleuca lasiandra* forming a shrub layer and the grasses *Eulalia fulva* and *Cenchrus ciliarus* dominant on the ground. Overall 130 species of plants have been recorded from the system (Stuart Halse pers. comm.). These do not include any rare or endangered species, or naturalised weeds.

From maps derived from aerial photography for 1953, 1971 and 1988 substantial changes to the riparian vegetation around the lake were detected. Belts of trees along the eastern and north-western margins of Mulan Lake and Lera Waterhole disappeared between 1971 and 1988 while those along the western edge of the lake became much reduced in extent during this same period. Losses were attributed to a large flood in 1982 with subsequent recruitment or regeneration thought to be suppressed by cattle.

5.2.2 Fauna

The Lake Gregory system includes an exceptionally rich invertebrate fauna (175 species) compared to other Australian inland lakes with species assemblages having been described in terms of salinity and ionic composition of the water (Halse in press). Fish populations in the lake can be very high, though only one species, the spangled perch *Leiopotherapon unicolor,* is known to occur. Two species of frog *Cyclorana australis* and *Notoden nichollsi* and 30 species of reptiles are known from the lake and its immediate hinterland (Burbidge 1983).

The birdlife of the Lake Gregory system was surveyed on seven occasions between 1977 and 1988 including Smith and Johnstone (1978), Start and Fuller (1983) and Jaensch and Vervest (1989) and these data were reviewed by Halse (1990). Subsequently another six aerial surveys were completed between 1991 and 1995 (Stuart Halse pers. comm.) but data from these have not been published though occasional reference to them appears in the Directory of Important Wetlands in Australia (Australian Nature Conservation Agency 1996a).

Seventy species of waterbird have been recorded from the Lake Gregory system, which is a high number for any wetland site or system in Australia. Total numbers of birds counted have approached 240 000 (August 1986) while some estimates by

extrapolation have been as high as 600 000 (March 1988). These numbers represent some of the highest waterbird counts in Western Australia and of any inland wetland in Australia. It is believed that the lake regularly holds over 100 000 birds.

Lake Gregory is internationally important for four species of shorebirds in terms of populations: Masked Lapwing *Vanellus miles*, Oriental Plover *Charadrius veredus*, Marsh Sandpiper *Tringa stagnatilis* and Sharp-tailed Sandpiper *Calidris acuminata* (Watkins 1993, Australian Nature Conservation Agency 1996a). Up to 898 Freckled Duck *Stictonetta naevosa* (a threatened species) have been recorded (Jaensch and Vervest 1990). This is the highest number recorded in Western Australia and would exceed one per cent of the world population of this species (Australian Nature Conservation Agency 1996a).

Other abundant species for which the site is highly notable in Western Australia include Eurasian Coot *Fulica atra*, Little Black Cormorant *Phalacrocorax sulcirostris*, Hardhead *Aythya australis*, Grey Teal *Anas gibberifrons*, Pink-eared Duck *Malacorhynchus membranaceus*, Pacific Black Duck *Anas superciliosa* (each with counts exceeding 20 000), Great Crested Grebe *Podiceps cristatus*, Australian Pelican *Pelecanus conspicillatus*, Darter *Anhinga melanogaster*, Great Egret *Egretta alba*, Rufous Night Heron *Nycticorax caledonicus* , Black Swan *Cygnus atratus*, Brolga *Grus rubicunda*, Whiskered Tern *Chlidonias hybrida* and Caspian Tern *Sterna caspia.*

Fifteen waterbird species have been recorded breeding on the lake. These have included the largest known Western Australian breeding colony of Little Black Cormorant as well as high numbers of Pied Cormorant *Phalacrocorax varius* and Caspian Tern.

The Lake Gregory system is used as a staging point by at least 16 species of migratory shorebirds which include high numbers of Oriental Plover and Sharp-tailed Sandpiper.

In general the system appears to support greater populations of birds during winter (the north Australian dry season, especially late in the season) than in summer though numbers may vary considerably from one year to the next depending on the level of water in the lake; greatest numbers occurring when it is from one third to two thirds full. Waterbird numbers are almost certainly also influenced by the availability and condition of wetlands both regionally and nationally. To date there has been no long-term financial commitment by the Western Australian Department of Conservation and Land Management to undertake waterbird surveys on the system with nearly all past surveys having been funded from savings on other programs. No further surveys are planned (Stuart Halse, Conservation and Land Management pers. comm.).

The contemporary native mammal fauna of the Lake Gregory system apparently includes just three species strongly associated with wetland or riparian habitat, the northern nail-tailed wallaby *Onychogalea ungifera,* larapinta *Sminthopsis macroura* and the yellow-bellied bat *Taphozous flaviventris* (McKenzie and Youngson 1983). Another three species, the sandy inland mouse *Pseudomys hermannsburgensis*, lesser hairy-footed dunnart *Sminthopsis youngsoni* and the short-tailed mouse *Leggadina forresti* are known from sand plain habitats in the hinterland. As is the case in the rest of the Australian arid zone contemporary mammal assemblages associated with Lake Gregory are probably now depleted due to losses and range contractions of species in the so-called 'critical weight range' (0.1 - 7.0 kg) throughout the last 200 years of European land management (Morton 1990). Of currently extant Australian mammals

historical records suggest that the Lake Gregory system may once have supported populations of the northern brush-tail possum *Trichosurus arnhemensis*, bilby *Macrotis lagotis*, kultarr *Antichinomys laniger*, mulgara *Dasycercus cristicauda*, golden bandicoot *Isoodon auratus* and spectacled hair-wallaby *Lagorchestes conspicillatus*.

The introduced mammal fauna of the Lake Gregory system is dominated by beef cattle *Bos taurus* with grazing pressure responsible for failure of riparian woodlands to regenerate after floods. McKenzie and Youngson (1983) found the house mouse *Mus musculus* to be strongly associated with creek and riparian habitats around the lake. Populations of wild domestic dogs are also well established (Stuart Halse, Conservation and Land Management pers. comm.). Feral cats probably occur on the site but have not been recorded (McKenzie and Youngson 1983; Stuart Halse, Conservation and Land Management pers. comm.). Neither donkeys, rabbits, camels nor foxes have been recorded on the site though it is highly possible that they could occur there in some years. Donkeys have been subjected to an eradication campaign throughout the Kimberley region of Western Australia.

5.3 Cultural Values

5.3.1 Aboriginal Cultural Values

Lake Gregory is of great cultural importance to Aboriginal people and a Native Title claim has been lodged over the area. The Tjurabalan Native Title claim was lodged by the Kimberley Land Council of behalf of the claimants in October 1995 and accepted by the National Native Title Tribunal in March 1996 (Appendix 5). It is expected that mediation will commence shortly in relation to this claim. The priority issue is mediation on a number of intra-indigenous issues. Eleven interested persons have been recognised by the Tribunal.

No consultations with the Aboriginal community of Lake Gregory were undertaken due to lack of a site visit. In the weeks prior to the planned field trip, Australian Heritage Commission staff had met with representatives from the Mulan community to discuss the listing of Lake Gregory on the Register of the National Estate. There were various reports of this meeting, some indicating that the Aboriginal representatives were unhappy about the listing and felt that they should have been consulted and their agreement sought prior to the site being listed. A further visit by one of the Heritage Commissioners was planned for the time of our field work. The timing of this visit reinforced the decision not to raise the issue of potential Ramsar nomination of Lake Gregory with the community at the time to ensure that the two issues were kept separate and to avoid any negative spin-off from the Heritage issue.

Preliminary investigation also revealed that there were a number of issues that were currently causing unrest in the community. These were related to the Aboriginal and Torres Strait Islander Commission's decision to appoint a Grant Administrator, indicating that the community was experiencing some financial difficulty, and also the ongoing meetings related to a recently lodged Native Title claim.

All these factors suggested that it was not an appropriate time to visit the community and that to do so at this time may jeopardise the success of the project.

While in Kununurra contact was made with Peter Mathie, Aboriginal and Torres Strait Islander Commission Project Officer for the desert communities and Rohan Foley, Land Tenure Officer, Kimberley Land Council to advise them of the project.

Extensive anthropological work has been undertaken recently by the Kimberley Land Council on behalf of the Aboriginal Traditional Owners in conjunction with the preparation of the Tjurabalan Native Title claim. These investigations will contain relevant information about the significance of the Lake Gregory area to people in the region and their aspirations for its future management.

The Aboriginal people who live around Lake Gregory have a strong interest in the protection and maintenance of the conservation values of the area. Since the completion of the field work Rohan Foley has followed up with the Wetlands, Waterways and Waterbirds Unit of Environment Australia (Biodiversity Group) seeking information on potential funding support for the Kimberley Land Council to coordinate the development of a management plan for Lake Gregory. He has also spoken to the East Kimberley Office of the Department of Conservation and Land Management (Gordon Graham pers. comm.).

5.3.2 Other Cultural Values

Lake Gregory and environs are listed on the Register of the National Estate for their "natural values" (wetlands and rivers).

5.4 Tenure and Management Regime

5.4.1 Tenure

Tenure under the Land Act

The site lies within the Lake Gregory Pastoral Lease which is held by the Aboriginal Lands Trust for the Mulan Aboriginal Community. The greater Sturt Creek catchment is covered by another five pastoral leases.

Native Title

The Tjurabalan Native Title claim includes the Lake Gregory wetland area. This claim was lodged by the Kimberley Land Council of behalf of the claimants in October 1995 (Appendix 5). It is expected that mediation will commence shortly in relation to this claim.

Nature Conservation Proposals

The potential importance of Lake Gregory has been recognised for over 20 years. Both the Conservation Through Reserves Committee (1977) and the Environmental Protection Authority (1980) called for additional scientific studies of the area. The Report on Nature Reserves in the Kimberley Western Australia (Burbidge *et al.* 1991) recommended that;

> *"the Department of Conservation and Land Management commence negotiations with the Aboriginal Community with a view to reserving the wetlands for conservation and developing management of Lake Gregory and associated*

wetlands, plus the lower reaches of Sturt Creek, so as to minimise cattle damage to the lake and its surrounds."

Other nature conservation proposals in the region are for a Nature Reserve at Gardner Range (125 km NE) and a National Park at Southesk Tablelands (50 km SW) (Burbidge *et al.* 1991).

There has not been any significant implementation of these three recommendations.

It has been suggested that Lake Gregory be nominated for the List of Wetlands of International Importance (Burbidge *et al.* 1991). However it is recognised that additional consultations are needed with the pastoral lease holders and other interested parties (Burbidge *et al.* 1991, Australian Nature Conservation Agency 1996b).

5.4.2 Site Management

The site is primarily managed for beef production for the local Aboriginal population rather than to supply larger commercial markets. The Lake Gregory Pastoral Lease at present carries some 4 000 head of cattle (Paul Novelly, Agriculture Western Australia pers. comm.) though numbers as high as 12 000, primarily associated with lake margins, have been recorded (Done 1990).

Rangeland monitoring occurs around the site and is conducted by Agriculture WA under the Western Australian Rangeland Monitoring System (Western Australia Department of Agriculture 1992). Representation on the Halls Creek-East Kimberley Land Conservation District is through the Kimberley Aboriginal Pastoralists Association.

There in no monitoring of water quality in the Lake Gregory system.

Access to the site is limited. All roads are unsealed and mostly not maintained. Tourist visitation is increasing from 4WD traffic on the Canning Stock route. There are no recordings of vehicle traffic.

Aboriginal residents near the site probably undertake some waterfowl hunting on wetland areas. The extent of this activity is unknown though it may well be confined to small lakes and lengths of flooded creek channel. It would be exceedingly difficult to approach waterfowl on the larger open lakes.

5.4.3 Catchment Management

The dominant land use activity in the catchment is beef cattle production and it is estimated the catchment supports around 35 000 head. The highest stocking rates occur on the most northern stations, Gordon Downs (12 000 head) and Ruby Plains (12-14 000 head) which have the greatest rainfall and best soil types and consequently the most productive rangelands. Stocking rates decrease to the south through Sturt Creek (10 000 head) and Carranya stations (1 100 head) as rainfall diminishes and the amount of unfavourable sand plain country increases. Overall the level of land degradation throughout the catchment due to cattle impact is not considered high though creek line and wetland habitats are extremely vulnerable because grazing and trampling pressure tends to be most intense along channels and lake shorelines (Paul

Novelly, Agriculture WA pers. comm.). The Water and Rivers Commission does not have gauging stations and does not undertake any water quality monitoring in the Sturt Creek catchment.

Tourism in the catchment is primarily associated with use of the Canning Stock Route by 4WD enthusiasts and wilderness /safari off-road tour operators. The Wolf Creek meteorite crater about 110 km north of the site is another popular destination. Access to it is from the north from Halls Creek on the Great Northern Highway. There are no developed tourist facilities in the catchment.

5.5 Potential Threats to the Site and its Values

The Lake Gregory system has an essentially intact, structurally unmodified catchment so one of the fundamental ingredients contributing to the ecological character of the site, the hydrological regime, continues to persist.

Apart from pastoralism, there are virtually no other activities in the catchment that could seriously affect the quality of water flowing into the site. On the site, current knowledge suggests an absence of invasive weed species which might modify the character of either the wetland areas, their riparian zones or the hinterland. This however should be qualified by noting the absence of a thorough assessment of the site for introduced plant species.

Cattle have been reported as seriously damaging the fringing vegetation around the lake (Jaensch and Vervest 1990, Burbidge *et al.* 1991). Cattle have certainly undermined the regenerative potential of riparian woodlands following extreme floods (which may kill all live trees in the basin) and this will lead to a long term decline in breeding habitat for colonial tree-nesting waterbirds such as cormorants (Jaensch and Vervest 1990). Other cattle impacts such as the long term effects of selective grazing and trampling in riparian zones and the hinterland are possibly affecting the abundances of known native mammal species and have almost certainly contributed to the demise of others.

The presence of wild domestic dogs (and possibly cats) will also be having unfavourable impacts on native mammal populations.

5.6 Conclusions

5.6.1 Urgent Management Actions

Lake Gregory is within a pastoral lease and is not listed as a Wetland of International Importance. As such it is not appropriate to be detailing recommendations about urgent site action to the Department of Conservation and Land Management.

It was not considered appropriate to visit Lake Gregory during the fieldwork and therefore we do not have experience with the current management status of the wetland.

5.6.2 Necessary Ecological Investigations

In the first instance issues concerning the impacts of cattle on the Lake Gregory site should be addressed. However it is unlikely and unrealistic to expect that total protection of wetland and riparian zones could be afforded. The Lake Gregory wetland system lies within a pastoral lease and almost certainly accounts for the most productive part of that lease. Protection will need to be achieved through negotiation with the land holders to establish cattle-free zones in particularly important areas. This could involve fencing, and funding arrangements for construction and maintenance of any fences will need to be addressed at the outset. The ongoing maintenance costs of fences could be high due to extensive periodic damage caused by floods.

While basic survey data collected over the last 20 years has probably resulted in a reasonably thorough taxonomic understanding of the site, there is little information that contributes to a functional understanding of its ecological character. This will only be achieved by establishing a coordinated, systematic monitoring regime to determine the responses of and interactions between biota as the quantity and quality of water in the system changes. In the case of waterbirds, population sizes may well be determined by wetland conditions both regionally and/or nationally and attempts to interpret census data from the site in isolation may prove futile.

In a broader context an appraisal of the site and parts of the hinterland in terms of its suitability for re-establishing a range of rare or threatened arid zone mammals should be considered. In its favour the site is already notable for its absence of foxes and rabbits and apparently very low numbers of cats. Efforts would be needed to exclude cattle from greater zones in the hinterland and probably to eradicate populations of wild dogs. However, were these actions possible the conservation value of the site could be enhanced significantly. The local land holders might benefit from financial incentives arising from the need to perform ongoing management tasks.

5.6.3 Management Planning

Lake Gregory is a clearly an internationally important wetland in ecological terms. It is also of inherent significance to the Aboriginal Traditional Owners and local Aboriginal community.

It is timely for the Department of Conservation and Land Management to reconsider how this important wetland might be maintained for its ecological and cultural values. Is seeking to have the wetland gazetted as a reserve still the most appropriate means to ensure its conservation?

Evidence suggests that the local Aboriginal communities will continue to live in the environs of Lake Gregory in the long term. The pastoral lease is held by the local Aboriginal communities and now the Aboriginal Traditional Owners are seeking to obtain legal recognition of their Native Title over the area.

In pragmatic terms, being able to successfully include nature conservation objectives in the management of a wetland like Lake Gregory, will have much more to do with generating the active support of the local community, rather then obtaining a change in land tenure. The most constructive means to achieve this would be to empower the community to develop their own management plan for the wetland, with regional staff of the Department of Conservation and Land Management offering advice on nature

conservation issues. A lead Aboriginal organisation such as the Kimberley Land Council would be in a good position to take on the coordination role for the development of such a management plan. The Kimberley Land Council is also the legal representative for the Aboriginal Traditional Owners of Lake Gregory in the Native Title claim.

The Department of Conservation and Land Management should seek to have the local community consider the nomination of the Lake Gregory for the List of Wetlands of International Importance as part of the management plan.

Recommendation 30: The Regional Manager approach the Kimberley Land Council about supporting the development of a management plan for Lake Gregory by the local community.

Recommendation 31: The Regional Manager seek information from Environment Australia on funding opportunities for the development of a management plan for a "wetland of international importance" by the local Aboriginal community.

Recommendation 32: The Regional Manager seek to have the nomination of Lake Gregory for the List of Wetlands of International Importance considered as part of the development of a management plan.

A Native Title claim has been made over the Lake Gregory by the Aboriginal Traditional Owners. It is expected that mediation by the National Native Title Tribunal will commence shortly in relation to this claim.

Recommendation 33: The Regional Manager note the special interest that Aboriginal people have in Lake Gregory and:

- **seek to ensure that necessary steps are taken to advise the State Government's Native Title Unit of the Department's interests in this wetland**
- **full recognition is given to the current legal proceedings in any decisions made relating to Lake Gregory.**

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Roebuck Bay

6.0 Roebuck Bay

Roebuck Bay is a marine embayment beside which the town of Broome has been established (17° 55'-18° 20' S, 122° 05'-122° 26' E). The Ramsar listing covers approximately 50 000 ha of the shallow water, tidal flats, mangroves and fringing vegetation (Figure 5).

Broome has a tropical monsoon climate with mean annual rainfall of 512 mm. The dry season occurs from May to October when the total rainfall is generally less than 25 mm. Most of the rain falls between November and April. Mean monthly maximum temperatures range between 20° C and 34° C, while minima range between 14° C and 29° C. The hottest months are March and April while the coolest are June and July.

Broome is subject to cyclones during the wet season. With winds over 160 km/h and intense rainfall these can cause massive erosion and damage to vegetation. In the past 70 years 11 cyclones have passed within 50 km of Broome and a further 29 have passed within 150 km (Department of Planning and Urban Development 1990).

6.1 Physical Attributes

In geological terms, Roebuck Bay is situated within the northern part of the Canning Basin. Seven geological structures can be observed around Roebuck Bay. Five of these are superficial deposits of sand, silt, clay and gravel formed during the Quaternary period (Gibson 1983).

The most dominant structure of the land component of the site is the fine to medium red sand, called pindan, which is characteristic of the town, Broome Road and much of the Great Northern Highway. This sand is wind-borne (aeolian) from the dunes in the Great Sandy Desert. The pindan sand is between two to six metres in depth.

The second most extensive feature is the grey clay, silt and sand of the supratidal mud flats. This can be seen on the grass plains behind Dampier Creek and on Roebuck Plains. A similar structure, but with a higher clay and organic content, occurs under the mangrove stands of Dampier Creek and from Crab Creek south around the Bay to Sandy Point.

Near the Port an area of white calcareous sand occurs that has been blown up into high dunes (Roebuck Dunes). There are also some small areas of water-borne (alluvial) and estuarine (lacustrine) sand, silt and clay near Thangoo Station homestead.

These superficial deposits overlay a thin lateritic layer called the Bossut Formation which is on top of the Broome Sandstone. The Bossut Formation and the top of the Broome Sandstone can be seen along the shoreline from Gantheaume Point to the Port and around Fall Point. The Broome Sandstone is of considerable interest because it contains plant fossils, micro-fossils and dinosaur footprints.

The Broome Sandstone is estimated to be 240 m thick (Gibson 1983). Beneath this there are several other layers before meeting the Precambrian igneous, metamorphic and sedimentary rocks that form the basement of the Canning Basin.

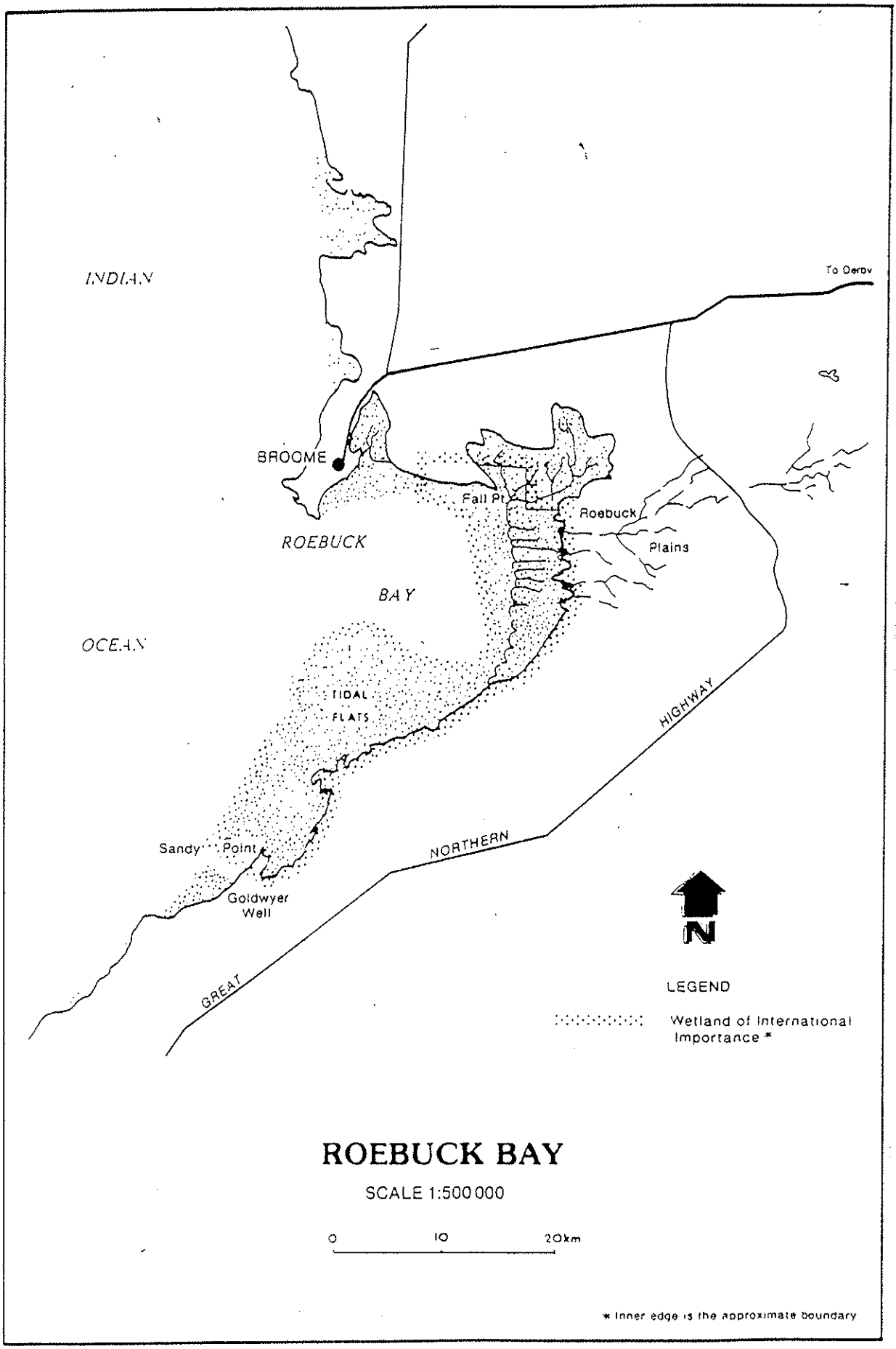

Figure 5. Roebuck Bay
(Department of Conservation and Land Management 1990)

Landform

Sea level changes have been a major factor in the development of the soils and the formation of the modern day landforms in the Roebuck Bay area. The Broome Sandstone that underlies most of the area is considered to have formed from the deposition of sand and mud in a shallow sea about 130 million years ago (Gibson 1983).

Since that time there have been many oscillations in sea level. During the drier and lower sea level period of the late Tertiary (~ 5 million years BP) the pindan sands were blown into the area. About one million years ago the low areas around the bay were flooded and the sediments of the tidal flats were deposited as the pindan sands were reworked. The substrate of the mud flats near Crab Creek is described as very soft and muddy with silt content ranging from 40 per cent to 73 per cent (mean = 52.2%, SD=12.5%, n=7) (Tulp and de Goeij 1994).

A sea level drop to minus 100 m occurred about 30 000 years ago during the last ice age. During this period the deep gorge of the Roebuck Deep and the Inner Anchorage were formed by water running off Roebuck Plains (Chalmers and Woods 1987).

The sea level rose again to its present level about 6 000 years ago. In areas where the sea has come against the pindan dunes these have been eroded to form cliffs. This is characteristic of the coast between Dampier Creek and Crab Creek. The shoreline in these areas continues to erode at a rate of 300 mm/year, although during a cyclone in February 1985 the rate was measured at 600 - 1 500 mm/day (Chalmers and Woods 1987).

Tides

A massive tidal range is the dominant hydrological feature of Roebuck Bay. Spring tides may exceed 9 m while neaps fall to 0.5 m. The area of mudflat exposed during neap tides is 10 per cent of that exposed during spring tides. The tide moves at 0.2 m/s during spring tides, measured at 20 m from the tide line (Tulp and de Goeij 1994).

The rough seas and heavy swells associated with cyclones have been suggested as the dominant process in shaping the coastline around Broome (Chalmers and Wood 1987) despite the brevity of these events.

6.2 Biological Attributes

The draft Interim Marine and Coastal Regionalisation for Australia describes Roebuck Bay as part of the Canning bioregion (Thackway and Cresswell 1996). The coastal regionalisation is being developed by the Australian and New Zealand Environment and Conservation Council to provide a framework for a National Representative System for Marine Protected Areas.

The onshore areas are part of the Dampierland Bioregion (Thackway and Cresswell 1995). This corresponds to the Dampier district within the Northern Botanical Province (Beard 1975).

6.2.1 Flora

Seagrass Beds

Extensive seagrass beds occur in Roebuck Bay and are dominated by *Halophila ovalis* and *Halodule uninervis* (Prince 1986). The most vigorous stands grow in areas that are exposed for less than two hours at low tide.

No information is available on the vegetation of the deeper water areas in Roebuck Bay or on the rocky substrate.

Mangroves

Broome is situated in the south-west Kimberley mangrove region (Johnstone 1990). This region runs from Cape Leveque, near the northern tip of the Dampier Peninsula, south to Whistle Creek, at the northern end of Eighty Mile Beach.

Within Roebuck Bay, Johnstone (1990) divides the mangroves into a northern and southern section. The northern section is estimated to cover 640 ha and consists of a low open to closed forest of *Avicennia marina*, *Aegiceras corniculatum*, *Camptostemon schultzii* and *Rhizophora stylosa* with some *Aegialitis annulata* understorey. The common species on the landward and seaward edge of the mangroves is *Avicennia marina*. Scattered shrubs and trees of *Excoecaria agallocha* occur on the outer fringe.

The 200 ha Thangoo section is described as a mixed woodland (to 5 m) of *Avicennia marina, Bruguiera exaristata, Osbornia octodonta and Camptostemon schultzii. Ceriops tagal* occurs as closed thickets on the landward zone with some *Excoecaria agallocha* (Johnstone 1990).

The mangroves have highest species diversity and tallest trees in Dampier and Crab Creeks and in the inlet between Bush and Sandy Point. In these areas there is distinct zonation of the mangroves. Factors that determine this are: frequency of flooding by tidal waters, soil type, soil salinity, drainage, plant interactions and animal interactions (Semeniuk *et al.* 1978). The typical sequence of species in landward direction is *Avicennia*, *Rhizophora*, *Ceriops* and samphire or salt flats (Chalmers and Woods 1987).

Landward of the mangroves are areas of bare flats that are inundated on high spring tides. The hypersalinity of the soil in these areas inhibits the establishment of vegetation.

Samphire Flats

Samphire also occurs landward from the edge of the mangroves. The dominant species in this community are: *Halosarcia halocnemoides, Neobassia astrocarpa, Sueda arduscuioides, Sesuvium portulacastrum, Hemichroa diandra* and *Limonium salicorniaceum* (Chalmers and Woods 1987). These flats may be inundated by some high tides.

Saline Grasslands

The saline grassplains are slightly higher in elevation than the samphire flats and the soil has a lower salinity. The dominant species is *Sporobolus virginicus* (salt water couch) which forms a dense grassland 15-20 cm tall. Other species are *Dicanthium fecundum*, *Eragrostis falcata* and *Salsola kali*. Towards the edge of the grassplains, at the interface with pindan soils, occur thickets of *Melaleuca acacioides* which grow to 10 m in height.

Pindan

The dominant vegetation type on inland areas around Broome is called pindan. The term pindan is common to all the Aboriginal groups around Broome and means "waterless open bush" (Fallaw and Hayward 1995). Pindan is very common in the south-western Kimberley covering 55 000 km^2 or 65 per cent of the Dampierland district (Beard and Sprenger 1984).

Pindan occurs inland from the low cliffs between Fisherman's Bend and Crab Creek. The main tree species are: *Eucalyptus* aff *papuana*, *Eucalyptus* aff *terminalis*, *Gyrocarpus americanus*, *Terminalia petiolaris*, *Lysiphyllum cunninghamii*, *Ventilago viminalis*, *Canthium attenuatum*, *Premna acuminata*, *Hakea macrocarpa*, *Persoonia falcata*, *Atalaya hemiglauca* and *Gardenia pyriformis*. The main shrub species are: *Acacia eriopoda*, *Acacia colei*, *Acacia adoxa*, *Pavetta brownii*, *Carissa lanceolata*, *Distichostemon hispidulus*, *Ehretia saligna* and *Santalum lanceolatum*.

6.2.2 Fauna

Birds

Birds are the most studied faunal group in Roebuck Bay. Studies were commenced by members of the Royal Australasian Ornithologists Union (RAOU) in September 1981 (Lane 1987). This led to the establishment of the Broome Bird Observatory which has an ongoing biological research program. By 1995, 285 bird species had been recorded in the Broome area (Collins 1995).

Roebuck Bay is now known to support up to 850 000 shorebirds of 44 species. Most of these species breed in northern China, Mongolia, Siberia and Alaska during the May to July period (Lane 1987). Each year, birds complete two trans-equatorial flights between their breeding and non-breeding areas. This migration route is called the East Asian-Australasian Flyway (Parish 1987).

Roebuck Bay is considered to be of international importance for 19 species of shorebirds (Watkins 1993a). It has the highest numbers recorded in Australia for the Bar-tailed Godwit *Limosa lapponica*, Ruddy Turnstone *Arenaria interpres* and Sanderling *Calidris alba*. It has the second highest counts of Large Sand Plover *Charadrius leschenaultii* and the third highest for Red Knot *Calidris canutus*, Oriental Plover *Charadrius veredus*, Black-tailed Godwit *L. limosa*, Eastern Curlew *Numenius madagascariensis*, Grey Plover *Pluvialis squatarola* and Whimbrel *N. phaeopus* (Table 6). On this basis Roebuck Bay is one of the three most important areas for shorebirds in the entire East Asian-Australasian Flyway (Lane 1987, Watkins 1993a). The Bay also supports around 20 000 Great Knot *Calidris tenuirostris* and Red-necked Stint *C. ruficollis* (Table 6).

Shorebird numbers in Roebuck Bay start to increase in September of each year with the arrival of adult birds after breeding. Numbers continue to rise until November as the juvenile birds arrive. In March numbers decline as adults return to breed in the northern hemisphere. Birds in their first year of life and some adults remain in Australia during the breeding season. In Roebuck Bay shorebird numbers in May to July are approximately 10 per cent of the non-breeding season population.

Banding, colour marking and radar studies have shown Roebuck Bay to be of particular importance as a migration staging area for birds spending the non-breeding season in southern Australia. Twelve Red-necked Stints colour marked in the north-west of Western Australia in spring have been resighted within weeks in Victoria

(Minton 1983). Similar movements have been recorded for Curlew Sandpipers *C. ferruginea* (Lane *et al.* 1983, Minton 1983).

Recoveries of banded shorebirds link Roebuck Bay with Hong Kong, China, Taiwan, Japan and Russia (Pook 1992).

Studies conducted on the feeding ecology of shorebirds in Roebuck Bay show that most shorebirds follow the tide edge (Tulp and de Geoij 1994). Visual observations and scat analysis indicate that Great Knot and Red Knot feed mainly on bivalves. Visual observations of Whimbrels and Eastern Curlew show that they feed mostly on crabs. Other feeding observations are: Bar-tailed Godwits on worms, crabs and bivalves; Pied Oystercatcher *Haematopus longirostris* on dog cockles *Anadara granosa*; and Terek Sandpipers *Tringa terek* on crabs.

Table 6 International Importance of Roebuck Bay for Shorebirds (from Watkins 1993a)

Species	Max Count	Rank in Australia
Bar-tailed Godwit	65 000	1
Ruddy Turnstone	2 060	1
Sanderling	1 510	1
Large Sand Plover	26 900	2
Red Knot	11 200	3
Oriental Plover	8 700	3
Black-tailed Godwit	7 374	3
Eastern Curlew	2 160	3
Grey Plover	1 300	3
Whimbrel	1 020	3
Great Knot	22 600	4
Grey-tailed Tattler	3 180	4
Terek Sandpiper	1 000	4
Red-capped Plover	3 300	6
Red-necked Stint	19 800	7
Mongolian Plover	1 057	7
Common Greenshank	560	7
Curlew Sandpiper	6 000	10
Pied Oystercatcher	190	18

On high neap tides birds are able to remain on the mudflats and in the northern area of the Bay shorebirds concentrate around Crab Creek. On most high tides, shorebirds are pushed up onto the sandy beaches to roost. The largest roost site is at the southern part of the bay at Bush Point - Sandy Point. The major roosts at the north end of the Bay are at Crab Creek - Fall Point and at Quarry Beach. Between these two roosts there are a number of smaller roosts. The species composition of the roosts varies with roost site. The highest concentration of large shorebirds is found on the Crab Creek beaches, while Ruddy Turnstone, Terek Sandpiper and Grey-tailed Tattler *Heteroscelus brevipes* prefer to roost on small beaches along the cliffs between Fall Point and Quarry Beach.

Some shorebirds roost on the beach between the Port and Mangrove Point and near Riddell Point. On some high spring tides shorebirds leave the Crab Creek and Quarry Beaches and fly to the bare mudflats on the landward side of the mangroves.

While most of the shorebird activity is centred on the mudflats of Roebuck Bay, the small tidal creeks behind the mangroves are important to some species such as Whimbrel.

Further inland, adjacent to the Roebuck Bay Ramsar-listed area, the grassplains provide important feeding areas for Little Curlew *N. minutus* and Oriental Pratincole *Glareola maldivarum*. Up to 50 000 Little Curlew (Minton 1987) and 50 000 Oriental Pratincole (Hooper and Wells 1989) have been recorded. This is the highest count of Oriental Pratincole and the second highest count of Little Curlew in Australia and qualifies Roebuck Plains as an area of international importance for shorebird conservation under the Ramsar Convention (Watkins 1993a).

The mangroves are also important habitat for birds. They provide the primary habitat for 16 bird species in the South-west Kimberley and are regularly used by an additional 22 species (Johnstone 1990).

Other Vertebrate Fauna

The insectivorous bats of the mangroves at Crab Creek have been studied as part of a larger study of the bat guilds in the Kimberley mangroves (McKenzie and Rolfe 1986). The species recorded were: *Taphozous flaviventris, Chaerephon jobensis, Mormopterus loriae, Chalinolobus gouldii, Nycticeius greyi, Pipistrellus tenuis* and *Nyctophilus arnhemenis*. Two species of flying fox (*Pteropus alecto* and *Pteropus scapulatus*) and one blossom bat (*Macroglossus lagochilus*) also occur at Broome. Flying foxes are known to form large camps in the mangroves at Dampier Creek and can be observed dispersing from this area at dusk.

A survey of dugongs *Dugong dugon* in the Kimberley, conducted by the Department of Conservation and Land Management in 1984 (Prince 1986), estimated the population in Roebuck Bay at 50 - 100 individuals. The species is listed as vulnerable to extinction in the IUCN Red Data Book (Thornback and Jenkins 1982). In Western Australia it is gazetted as a species in need of special protection.

Dugong occur in highest densities in sheltered waters less than 5 m in depth. The distribution has been correlated with the extent of seagrass beds on which dugong feed (Bayliss and Freeland 1989). In tropical waters dugong are thought to be sedentary, with local movements in the order of 10 km (Marsh 1988). The minimum reproductive age is 10 years with individuals having been estimated to be up to 73 years in age (Marsh 1988). Dugong have a low rate of natural increase and natural mortality levels must be low for populations to be sustainable (Marsh 1986).

Dolphins are known to occur in the Bay and include the Irrawaddy Dolphin *Orcaella brevirostris*. Prince (1986) counted 37 during an aerial survey of the dugong population.

Loggerhead turtle *Caretta caretta* and green turtle *Chelonia depressa* have been recorded in Roebuck Bay. Loggerhead Turtles use the Bay as a seasonal feeding area and as a transit area on migration. The recovery of banded loggerhead turtles indicated that some of the individuals nest on the sandy beaches near Exmouth. No turtle nesting is known from the beaches inside Roebuck Bay.

Estuarine crocodiles *Crocodylus porosus* are recorded on an infrequent basis near Broome (<1/year).

The inshore seas of north-western Australia are considered to have approximately 1 400 species of fishes (Allen and Swainston 1988). In general these species tend to be widely distributed over the Indo-Pacific Region. Limited surveys have been

conducted by the Western Australian Museum. The mangroves around the Bay can be assumed to be important nursery areas for larval and juvenile fishes.

Invertebrate Fauna

The Western Australian Museum has collected information on fiddler crabs (George and Jones 1982). Nine of the 17 species of fiddler crabs that occur in Australia have been recorded at Broome (Chalmers and Woods 1987). The scientific importance of the mangrove habitats and flats for the study of crabs has been noted in previous studies of the area (Chalmers and Woods 1987).

Broome is recognised world-wide for the variety of shellfish that can be found on the rocky shores around Gantheaume Point and out from Fall Point. The most notable species is ruby murex *Chicoreus rubiginosus* which is endemic to the Broome area.

Studies have also commenced on the benthic fauna of the mudflats by researchers associated with the Broome Bird Observatory and the Department of Conservation and Land Management. The zoobenthic biomass near Crab Creek has been estimated to average 13.9 g ash free dry mass/m^2 (Tulp and de Goeij 1994). This is an index of the food availability in the top 30 cm of the mudflat. The most abundant invertebrate species and groups on the tidal flats are; sunset shells *Macoma* sp. and *Siliqua* cf. *winteriana*, angel wings *Anodontia omissa*, mussels *Modiolus micropterus*, brittle star, sea-cucumber and tubeworms (Tulp and de Goeij 1994).

6.3 Cultural Values

6.3.1 Aboriginal Cultural Values

Roebuck Bay is within the Yawuru Native Title Claim. This claim was lodged by the Yawuru in February 1994 and accepted by the National Native Title Tribunal in May 1994. The Kimberley Land Council is the Native Title Representative Body acting on behalf of the claimants.

The application covers 1 300 square kilometres and includes land and waters in and around Roebuck Bay. The application includes portions of vacant crown land, reserves, special leases near Broome townsite, plus a large portion of Roebuck Bay, including pearl farms and water extending beyond the three mile territorial limit. Appendix 6 contains details of the claimants and the area under claim. The Tribunal has accepted the applications of twelve interested parties to be involved in the mediation process including the Commonwealth and State Governments.

After the application was lodged, Djugun and Goolarabooloo people asserted that they also had Native Title rights in relation to the claim area. This conflict was resolved through the formation of the Rubibi Working Group. The Working Group now facilitates the lodging of Native Title Claims in the region and ensures appropriate representation during mediations set up by the Native Title Tribunal. It also oversees Aboriginal interests in the management and strategic development of land in claim areas. The Working Group has lodged a further twelve Native Title Claims relating to the Broome townsite and surrounding areas.

Mediation by the Native Title Tribunal is ongoing. Resolution of issues relating to marine waters are unclear.

Over the past two years the Rubibi Working Group has been successful in negotiating a number of agreements outside of the Native Title Tribunal. These include:

- an agreement with the Shire of Broome in relation to Aboriginal involvement in planning, development and heritage issues
- the establishment of the Local Government Development Project
- an agreement with the State of Western Australia on the development of an aquaculture park
- involvement by Aboriginal people in the planning process for the future land use of Waterbank Station, and,
- an agreement in relation to the development of the Paspaley Shopping Centre (National Native Title Tribunal 1996).

It was not possible to meet with the Working Group in person because of the previous commitments of the Working Group. However the work of the consultants on management planning for Roebuck Bay was discussed at a meeting of the Working Group on 2 July 1996. The Working Group indicated interest in participating in the development of the management plan and asked to be kept informed.

The aspiration of the Rubibi Working Group is to hold Native Title over Roebuck Bay and to lease it to the State Government at which time a management plan would be developed. The Aboriginal people want ownership of the management plan to ensure that their rights are protected.

Meetings were held with the Yawuru Aboriginal Corporation and the Kimberley Land Council solicitor (George Irving) working on the Yawuru Native Title claim. The meeting with the Yawuru Aboriginal Corporation was held at the Mamabulangin Resource Centre in Broome on Thursday, 4 July 1996. It was attended by ten representatives from the Yawuru community and representatives from the Kimberley Land Council.

Yawuru people are widely recognised in the Broome area as the Traditional Owners of the sea and inter-tidal areas of Roebuck Bay. Yawuru use the sea constantly with frequent fishing and hunting and important ceremonies are conducted along the coast. The Yawuru language describes features of the environment and marine processes. The marine and coastal environments are a constant reference point for the Yawuru (Jackson 1995).

Consultation found that Aboriginal people considered the Ramsar listing and the proposal for the Marine Park to be closely related. However, this presented some problems as there was a belief that they had only been informed about the Marine Park proposal after it had been on the agenda for a number of years. Yawuru people expressed concern that their traditional food gathering activities would be affected. This particularly relates to the coastal section of the proposed marine park where Yawuru people fish, gather crabs and shellfish and hunt turtles.

This lingering concern about the late inclusion in the consultation process highlights how important it is to ensure that consultations with Aboriginal stakeholders are undertaken at the earliest possible time, especially at the strategic planning point where protected areas are identified, and that an environment of open communication is maintained throughout the process.

The Aboriginal people at the meeting also advised that they wish to negotiate for areas of land on the coastal region to be designated as living areas.

The site register compiled by the Heritage and Culture Division of the Aboriginal Affairs Department lists a number of ethnographic and archaeological sites adjacent to Roebuck Bay.

Anthropological work would need to be undertaken to fully document the cultural and historical significance of the wetland area to Aboriginal people. The Rubibi Working Group would be the key organisation to be involved in the management of anthropological work on Roebuck Bay.

6.3.2 Other Cultural Values

Roebuck Bay is listed on the Register of the National Estate.

There are a number of sites of historical importance in and around the Bay however further research is needed to collate information on these sites.

6.4 Tenure and Management Regime

6.4.1 Tenure

Pastoral Leases

The two major leases adjacent to Roebuck Bay are Roebuck Plains Station and Thangoo Station. There are also a few small leases between Fall Point and the Broome Road (e.g. Wattle Downs).

An area of 5 334 ha was excised from Roebuck Plains Station when a change of lessees occurred in the late 1980s. It was intended that this land would become part of a conservation area to protect the mangroves from Crab Creek south to Thangoo Station. This land is at present Vacant Crown Land. The Thangoo Station lease extends to 40 m above the high water mark.

Freehold

Freehold land adjacent to the Bay is limited to the Broome townsite. Most of this land is separated from the high water mark of the Bay by a foreshore reserve. Details of the various allotments are shown on the 1:2 000 cadastral maps (Department of Land Administration) of Broome.

Crown Reserves

There are a number of Crown Reserves along the edge of the Bay between Fall Point and Gantheaume Point. These are shown in Table 7.

Vacant Crown Land

There are five areas of Vacant Crown Land on the coast around Roebuck Bay. The largest of these is the area around Crab Creek that was excised from the Roebuck Plains Station. A small area exists between Crab Creek Road and the Bay between Fisherman's Bend and Fall Point. The third area is on the western side of Dampier Creek, extending out to the Broome Road. The remaining two areas are between the townsite and the Port, and between Riddell Point and Gantheaume Point.

Native Title

Roebuck Bay is within the Yawuru Native Title Claim. This claim was lodged by the Yawuru in February 1994 and accepted by the National Native Title Tribunal in May 1994. The Kimberley Land Council is the Native Title Representative Body acting on behalf of the claimants. Mediation by the Native Title Tribunal is ongoing. Resolution of issues relating to marine waters are unclear.

Table 7 Crown reserves around Roebuck Bay (excluding those between the Broome townsite and the Bay)

Reserve No.	Gazetted Purpose	Area(ha)	Vested Body
41066	Bird Observatory	3	CALM
631	Common	844	(not vested)
35493	Gravel	38	Shire of Broome
30906	Use and benefit of Aborigines	212	Aboriginal Lands Trust
35827	Recreation	4	Shire of Broome
28650	Harbour Purposes	108	Minister for Transport
35828	Recreation	24	Shire of Broome
22648	Recreation	66	Shire of Broome
19289	Recreation	6	Shire of Broome

Note: CALM - Department of Conservation and Land Management

Petroleum and Mineral Tenements

Most of the study area is at present covered by one petroleum exploration tenement (EP 114 R2 Part 1).

There are six current mineral tenements in the Roebuck Bay area (Department of Minerals and Energy TENGRAPH Report, 24 June 1996). The two tenements near Fisherman's Bend and Crab Creek are gravel quarries. In the past, shell grit has been extracted from the Crab Creek area near important Aboriginal sites. The four tenements over Bush Point are considered to be for mineral sands. Some land based exploration holes have been drilled on Thangoo Station.

The State Government has indicated that a "petroleum and mineral resource assessment" must be conducted before Marine Park proposals are submitted to Cabinet (Department of Mines 1992).

Broome Port Limits

Port limits have been defined by the Department of Marine and Harbours to administer the movement of ships. The Broome Port limits cover the marine area from Fall Point, south for 8 km, then west for 19 km, then north for 15 km through Escape Rocks, then east to the Cable Beach shoreline in front of Station Hill (Approaches to Broome 1:50 000, Aus 50).

The Department of Marine and Harbours has prepared an Oilspill Contingency Plan for the Port.

Pearl Oyster Farms

Leases currently exist for pearl farms in the middle of Roebuck Bay. These 21-year leases have been issued under the Pearling Act, administered by the Fisheries Department. Applications may be made for additional leases at some time in the future.

Conservation Proposals

The Roebuck Bay Ramsar listing primarily covers 50 000 ha of tidal mudflats of the Bay. It extends from Fall Point (8 km east of Broome) to Goldwyer Well (40 km south of Broome) (Figure 5). Other areas included are the beaches and pindan cliff along the northern edge of the site and the mangroves along the eastern shore of the Bay. In nominating Roebuck Bay as a Ramsar site the Department of Conservation and Land Management proposed that the area become a Nature Reserve (Department of Conservation and Land Management 1990).

In the review of Nature Conservation Reserves of the Kimberley the Department of Conservation and Land Management reaffirmed its desire for the area to become a Marine Park vested in the National Parks and Nature Conservation Authority (Burbidge *et al.* 1991). In this review the area covered in the recommendation extended to include parts of the supra-tidal flats and grasslands on Roebuck Plains Station.

Two more recent studies have recommended that a Marine Park for the Bay should be extended to include the waters of the Bay. The area recommend by Watkins (1993b) was the whole of the Bay enclosed by a line from Gantheaume Point to Goldwyer Well but excluding a 4 km radius around the Port. The proposed eastern and northern boundaries extended inland to station tracks or existing fence lines. The Marine Parks and Reserves Selection Working Group (1994) recommended that in general terms the Marine Park should extend from the "*north side of Gantheaume Point to Cape Villaret and from the High Water Mark to the limit of the Territorial Sea*". On the northern and eastern edges the Working Group recommended that the Marine Park extend inland to include areas of pastoral leases which are "*an integral part of the drainage and geomorphological systems of the coast*".

The Australian and New Zealand Environment and Conservation Council is currently developing a framework for a National Representative System for Marine Protected Areas (Thackway and Cresswell 1996). Roebuck Bay is within the Canning Coastal Region. This process is intended to lead to the development of a national marine protected area system.

East Asian - Australasian Shorebird Reserve Network

At the Ramsar Conference of Parties in Brisbane in March 1996 the Western Australia Government announced its involvement in a shorebird conservation project called the East Asian-Australasian Shorebird Reserve Network. This project seeks to address the conservation needs of migratory shorebirds on a flyway basis through the development of an international network of sites managed for shorebird conservation. The Western Australian Government nominated two wetlands and also foreshadowed the nomination of Roebuck Bay and Eighty Mile Beach. Being part of the Shorebird

Reserve Network does not have legal implications. Responsibility for the management of Network sites remains with the nominating agency (Watkins 1995).

6.4.2 Site and Catchment Management

Tourism

Broome has a large and growing tourism industry. During the 1980s a large amount of infrastructure was developed (e.g. Club Cable Beach, Roebuck Bay Resort, redevelopment of Chinatown) to cater for the increasing demand. A number of the tourist ventures have programs based on the biological features of the area. Examples of these are Broome Bird Observatory, Hovercraft Tours, the Mangrove Walk, the Lurujarrie Trail, fishing, and safari operations.

Commercial hovercraft operations have regularly operated in Roebuck Bay since 1990. This has involved landings at Quarry Beach. These operations are licensed by the Department of Transport.

Considerable disturbance of roosting shorebirds is caused by recreation along the Fisherman's Bend to Crab Creek coast. Crab Creek is a popular fishing and crabbing area and people often drive their four wheel drive vehicles on the beach. Roosting shorebird are disturbed when approached in vehicles or on foot. In April/May 1991 up to seven vehicles and 25 people were counted on the 3 km beach at one time (Tulp and de Goeij pers. comm.).

In mid-1996 a new tourism development opened on the coast near Cape Villaret (Eco-Beach). The development was approved by the Environmental Protection Agency following an informal assessment. This area is approximately 6 km south of the Ramsar-listed site but immediately adjacent to the proposed Roebuck Bay Marine Park (Marine Parks and Reserves Selection Working Group 1994). There is no formal road access to the site and it is proposed to use a charter boat to transport people between the development and Broome. The development aims to:

> *"set a new standard for environmental responsibility amongst tourism accommodation venues in Australia. Environmental considerations have been given top priority in decision-making from the inception of the project with the overriding objective being to create a truly ecologically sustainable resort which will provide comfortable accommodation while preserving its natural surroundings".*

Pearling, Fishing and Shipping

The pearling industry has a 130 year history at Broome. It is now focused on cultured pearls rather than pearl shells. The value of annual production is estimated to be over $60 million (Department of Planning and Urban Development 1990). Most of the pearling areas are outside Roebuck Bay, however a pearl culture area has been established in the middle of the Bay.

Fishing is a much smaller industry at Broome. In 1989-90, 209 tonnes of fish were caught around the Broome region. Of this total, 53 tonnes came from within or adjacent to Roebuck Bay (Fishing Block 1822) (Australian Bureau of Statistics 1991). No commercial catches of crabs, prawns or molluscs were recorded for Broome during the two year period to July 1990 (Australian Bureau of Statistics 1991). It is not possible to obtain updated information because the Fisheries Department no longer releases information on the basis of fishing blocks (Fisheries Department pers. comm.).

Roebuck Bay is part of the Northern Gill Net and barramundi Fisheries. Up to three commercial fishermen have operated concurrently in the Bay. Crab Creek, Dampier Creek and the shallow waters adjacent to the townsite are closed to commercial fishing.

Recreational fishing is managed by the Fisheries Department of Western Australia. It has regulations to cover issues such as methods of capture, seasons, bag limits. In recent years recreational "set net" fishing has been banned in the north of the State. Use of a haul net requires a Recreational Fishing Licence and this has limits on the number, length and mesh size in addition to bag limits and minimum legal sizes for netted fish. Roebuck Bay is closed to net fishing between 1 December and 31 January (Department of Fisheries pers. comm.).

Shell collecting is also managed by the Fisheries Department. The Fisheries Act has been used to close the area around Gantheaume Point to the collection of gastropods.

Aboriginal people in Broome have recently formed a cooperative to collate information on dugong hunting in the Bay. The Department of Conservation and Land Management is providing technical advice. This initiative is in response to concern about falling dugong numbers and a sense of responsibility to manage dugong harvesting.

Broome and Wyndham are the only two operating ports in the Kimberley. In 1994-95, 71 784 tonnes of produce, materials and equipment were imported through Broome port and 24 825 tonnes were exported. The major imports were: bulk fuel (55 542 tonnes), explosives and ammonium nitrate (4 037 tonnes), building materials (4 827 tonnes), bitumen (3 117 tonnes) and general (1 640 tonnes). Also included were fertiliser (363 tonnes), copper sulphate/zinc sulphate (223 tonnes), and sodium cyanide (92 tonnes). The major exports were: bulk oil (Blina) (14 122 tonnes), livestock (7 074 tonnes) explosives and ammonium nitrate (1 350 tonnes) and fertiliser (1 032 tonnes) (Department of Transport 1995).

Port visits for 1994-95 totalled 915 ships: 66 trading, 405 fishing, 55 charter, 341 pearling, 41 naval, 1 passenger liner and 7 miscellaneous (Department of Transport 1995). Broome was listed as the survey location (in most cases the "home port") for 60 commercial vessels (Department of Marine and Harbours 1991).

Agriculture

Roebuck Plains Station and Thangoo Station graze cattle on the grassplains and pindan vegetation around Roebuck Bay. Roebuck Plains Station lease covers 283 459 ha of Roebuck Plains and the adjacent pindan. Roebuck Plains Station has undertaken an extensive refencing program in which environmentally sensitive areas such as mangroves and Lake Eda have been fenced to prevent grazing by cattle. The Kimberley Regional Plan Study expressed concern that large areas of the grassplains on Roebuck Plains were unsuitable for grazing Report (Department of Regional Development and the Northwest and the Department of Planning and Urban Development 1990).

Thangoo Station is to the south of Roebuck Plains Station. The lease covers 172 834 ha and extends to 40 m above the high tide mark. This seaward boundary is not fenced.

Agriculture WA has identified the inland pindan and grass plain as suitable areas for irrigated agriculture.

Mining, Mineral and Oil Exploration

Roebuck Bay is at present zoned as a Special Protection Locality under the "Procedures for the Protection of the Western Australian Marine Environment from Oil Spills" (Jones *et al.* 1984). With this zoning an Environmental Review and Management Program would need to be prepared for any drilling proposals.

6.5 Potential Threats to the Site and its Values

The major threats to site relate to the development of the townsite of Broome on the north-western shores of the Bay and the associated commercial and tourism activities. Broome has become the regional service centre and major tourist destination for the West Kimberley. Its population of approximately 10 000 people is augmented by seasonal visitors: 117 000 people visited Broome in 1994-5 (Broome Tourist Bureau pers. comm.).

Northern shores of the Bay

Accidental spills from shipping traffic and associated activities are a significant potential threat to the biota of the Bay. It is important that the Oil Spill Contingency Plan developed by the Broome Port Authority contains adequate recognition of the ecological importance of the Bay. The Department's West Kimberley Office should be fully familiar with this plan and its role in the event of an emergency.

Protection of mangroves along the town foreshore is an issue due to clearing and poisoning of trees. Rehabilitation of damaged areas may help change community attitudes.

Waste water discharge and storm water discharge have potential impacts on the Bay. Emergency plans for chemical spills from road transport should be developed. A number of old illegal rubbish dumps still remain along the Crab Creek Road coastline, as well as several squatters' shacks. Annual community cleanups (e.g. Ocean Care Day) have removed substantial quantities of rubbish from the Crab Creek coastline since 1993.

A new airport facility is planned for Broome. The planning should consider the flight routes of shorebird flocks migrating out of the Bay (to the north-west) in March-April.

Wetland Fauna

People and vehicles on Crab Creek beach are causing disturbance to shorebirds, particularly at high tide when the birds are roosting on the beach. Crab Creek beach is the major shorebird roost area for the north end of the Bay. Further studies are needed to quantify the significance of this disturbance.

Non-sustainable hunting of dugong appears to be occurring. However the local Aboriginal community, with technical advice from the Department of Conservation and Land Management, is seeking to address management of dugong hunting.

Careful management of shell collection is needed. Efforts should also be made to increase public awareness of the impacts on marine fauna from people walking on reefs.

Erosion

Major erosion damage is caused by vehicle tracks down to beaches between Fisherman's Bend and Crab Creek. A small number of managed access points is needed. Additional erosion problems to cliffs along this coast result from the proximity of Crab Creek Road to the cliffs. Crab Creek Road is not a gazetted road. A review should be undertaken of the road alignment and the possible advantage of sealing the road surface.

Most of the above threats could be addressed with appropriate zoning of the Bay to cater for commercial, recreational and Aboriginal cultural activities while minimising impact on nature conservation values.

6.6 Conclusions

6.6.1 Urgent Management Actions

No urgent site management actions were identified.

6.6.2 Necessary Ecological Investigations

Implementation of a monitoring program is one of the core obligations of management of Ramsar-listed wetlands. Monitoring is needed to test if ecological change is occurring and to develop appropriate management responses. Important attributes to monitor at Roebuck Bay are seagrass beds, benthos, dugongs and waterbird numbers. Roebuck Bay possibly has the highest potential to get community groups involved in monitoring.

Recommendation 34: The Kimberley Regional Ecologist, in consultation with the West Kimberley Office, develop a program to monitor for changes in the ecological character of Roebuck Bay. This should be developed as part of a regional program for Ramsar sites (see Section 9.3.2).

6.6.3 Management Planning

An important issue related to management and management planning is to establish a clear understanding of the boundary of the Ramsar-listed area of Roebuck Bay. Detailed maps showing the boundary should be available at the West Kimberley Office for staff and the public.

Recommendation 35: The Kimberley Regional Ecologist, in consultation with the West Kimberley Office, work with the Department's wetland research officers to define in detail the boundaries of the Ramsar-listed area of Roebuck Bay.

Recommendation 36: The Regional Manager ensure that detailed maps are available at the West Kimberley Office that show the boundary of the Ramsar-listed area of Roebuck Bay.

Recommendation 37: The Regional Manager take the necessary steps to ensure that the Department forward a copy of the detailed maps of Roebuck Bay to Environment Australia.

The Marine Parks and Reserves Selection Working Group (1994) has recommended that a Marine Park be established at Roebuck Bay. Before commencing a public management planning process for Roebuck Bay it is important that the Department clarify with the Minister for the Environment a timetable for advancing the Marine Park proposal. A clear understanding of the status of the Marine Park proposal will greatly assist community participation in the management planning process.

Consideration should be given to combining the process for the establishment of Marine Parks at Eighty Mile Beach and Roebuck Bay because of similar issues and stakeholders.

Recommendation 38: The Regional Manager seek for the Executive Director to obtain "in-principle" approval from the Minister for the Environment to advance the Marine Park proposal for Roebuck Bay (also see Section 9.1.3).

Recommendation 39: If "in-principle" approval is given to advance the Marine Park proposal, the Regional Manager seek advice from the Executive Director on the arrangements, timetable and resourcing as these may involve State wide considerations (also see Section 9.1.3).

Recommendation 40: Following clarification of the details for advancing the Marine Park proposals, the Regional Manager take the appropriate steps to combine management planning under the Conservation and Land Management Act with the requirements for the establishment of a Marine Park.

If it is determined that a Marine Park will not be established at this site before the next Conference of Parties to the Ramsar Conference (1999) then alternative mechanisms should be developed to enable coordinated management.

A mechanism for this would be to establish a consultative management committee chaired by the Department of Conservation and Land Management in its capacity as the State implementation agency for the Ramsar Convention. Key stakeholders to consider as part of the committee are: the Department of Fisheries, Shire of Broome, Broome Port Authority, Pearling Association, Rubibi Working Group, Roebuck Bay Game and Sport Fishing Club and Kimberley Tourism Association.

Recommendation 41: If by July 1997, it is concluded that Marine Parks will not be advanced by 1999, the Regional Manager should take the necessary steps to establish a consultative management committee for Roebuck Bay.

In addition to giving attention to the development of a management plan for Roebuck Bay it is also important that the Department of Conservation and Land Management actively participate in other planning and management process for Roebuck Bay and adjacent areas.

Recommendation 42: The Regional and District Manager continue to support staff involvement in government and community planning for Roebuck Bay and adjacent areas.

A Native Title claim has been made over Roebuck Bay by the Yawuru people. The Kimberley Land Council is the Native Title Representative Body acting on behalf of the claimants. The Tribunal has accepted the applications of twelve interested parties to be involved in the mediation process including the Commonwealth and State Governments.

Recommendation 43: The Regional Manager note the special interest that Aboriginal people have in Roebuck Bay and seek to ensure that:

- **these interests are included in any future discussions about the management of Roebuck Bay**
- **necessary steps are taken to advise the State Government's Native Title Unit of the Ramsar-listed status of Roebuck Bay and the interests of the Department**
- **full recognition is given to the current legal proceedings in any decisions made relating to Roebuck Bay.**

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Eighty Mile Beach

7.0 Eighty Mile Beach

The Eighty Mile Beach is located between latitudes 19° 03'-19° 58' S and longitudes 119° 46'-121° 31' E. It extends from 140 km south south-west of Broome to 130 km east north-east of Port Hedland. Anna Plains, Mandora and Wallal Downs Station homesteads are at or near the inland edge of the site (Fig.6).

The beach part of the Ramsar site comprises a narrow coastal strip of 220 km of Eighty Mile Beach between Cape Missiessy and Cape Keraudren. The 25 000 ha site includes the base of the primary dunes, the white sandy beach and adjoining tidal mudflats. This delineation of the "Eighty Mile Beach site" is smaller then the total Ramsar listing which includes the Mandora Marshes (Department of Conservation and Land Management 1990). The Marshes have been addressed separately (see Section 8). It also differs from the "Eighty Mile Beach System" (Australian Nature Conservation Agency 1996a) which included the wetlands on the plains adjacent to the beach.

The climate is semi-arid monsoonal with a hot summer and a warm dry winter. Median and mean annual rainfall at Mandora Station are 327 mm and 341 mm respectively, mostly falling in January-March. Annual evaporation is 3 400-3 600 mm. The main cyclone period is January to March. In a 40 year period 21 cyclones crossed the coast between Broome (17° S) and the mouth of the De Grey River (20° S) (Beard 1975). In the Pilbara, 35 per cent-45 per cent of the annual rainfall is cyclonic (Beard 1975). Cyclones are a major factor in the land formation process because of their high winds and heavy rainfall.

7.1 Physical Attributes

In geological terms, Eighty Mile Beach is situated in the southern part of the Canning Basin. The Basin consists of Cretaceous sedimentary rocks that formed during a time when a large area of north-west Australia was under the sea. About 80 million years ago, during the Cretaceous, the basin was up-lifted. Since this time there have been fluctuations in mean sea level, the most recent significant changes being around 10 000 years ago when the coastal plain existed as a shallow sea (Beard 1967). The retreat of the sea level and its recent relative stability has enabled sand dunes to build up along the shoreline.

Eighty Mile Beach is interrupted at two places by mangrove lined creeks near Wallal and small rocky headlands south of Wallal. There is no significant discharge of surface water from these creeks into the site. Two palaeo-rivers (Wallal and Sturt Creek) that were active 10 - 45 million years BP occur at the northern end of the site. These would have been important in transporting silt to the coast.

Tidal flats extend up to 3 km seaward from the beach. They are at their greatest extent in the section of the beach between Wallal and Anna Plains Station. The mudflats consist of a soft silty clay. A sample from the northern area of the beach near Anna Plains Station had a 38 per cent silt and 4.1 per cent organic content (Tulp and de Goeij 1994). This is a similar composition to Roebuck Bay. The nature of the substrate is important in contributing to the biological productivity of the tidal zone.

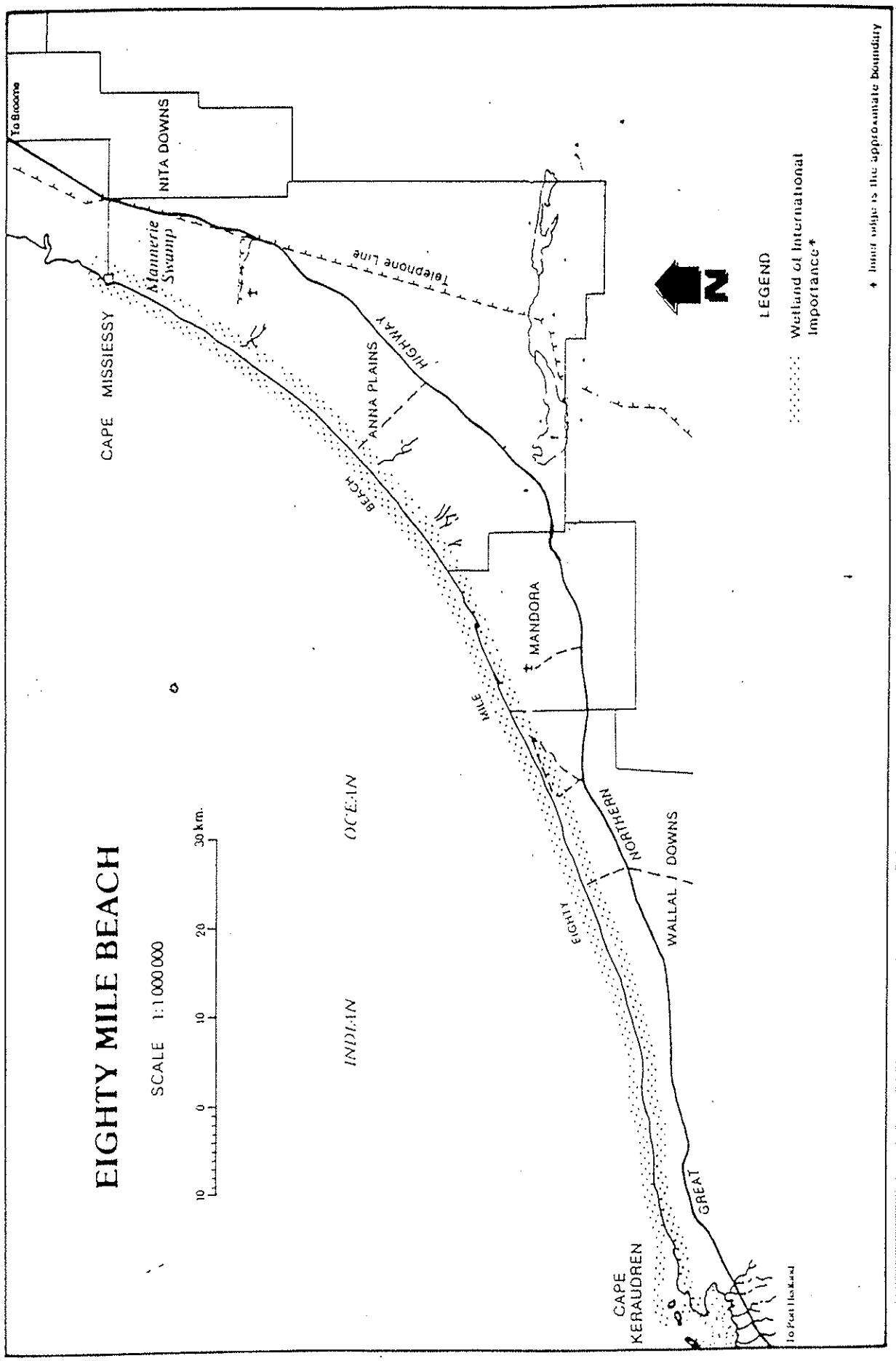

Figure 6. Eighty Mile Beach
(Department of Conservation and Land Management 1990)

The inshore areas have a gentle slope out to sea and at approximately 25 km from shore have a depth of 20 m. Irregular shoals exist in the area 10 -15 km from shore.

Eighty Mile Beach has very large twice-daily tides that reach 8 m (spring tides). Neap spring tides are approximately 1 m. This large tidal variation exposes very large areas of mudflats. On high spring tides the water washes within a few metres of the primary dune.

7.2 Biological Attributes

Eighty Mile Beach is recognised as a distinct bioregion in the Interim Coastal Regionalisation of Australia (Thackway and Cresswell 1996). The coastal regionalisation is being developed by the Australian and New Zealand Environment and Conservation Council to provide a framework for a National Representative System for Marine Protected Areas.

The onshore areas are part of the Dampierland Bioregion (Thackway and Cresswell 1995). This corresponds to the Dampier district within the Northern Botanical Province (Beard 1975).

7.2.1 Flora

The primary dunes along the beach are stabilised by *Crotalaria cunninghamii* and *Spinifex longifolius* (Marine Parks and Reserves Selection Working Group 1994). Other species occurring on the dune include *Ipomoea pes-caprae, Euphorbia myrtoides* and *Ptilotus villosiflorus* (Burbidge 1944).

There are two stands of mangroves along Eighty Mile Beach in small tidal creeks near Mandora. These are the only areas of coastal mangroves between the south-west Kimberley and the Pilbara (Johnstone 1990). Each stand is approximately 50 ha and is dominated by *Avicennia marina* with a few *Ceriops tagal* plants. The *Avicennia* form a woodland of 4-6 m height on the southern creek. It has been noted that the landward zone of the northern creek is being covered by dunes (Johnstone 1990). Both stands are backed by samphire.

There has not been any documentation of the marine flora of the tidal flats.

7.2.2 Fauna

Eighty Mile Beach is one of the most important areas for shorebirds in the East Asian-Australasian Flyway. Up to 337 500 shorebird have been counted on the Beach (Lane 1987). This is the highest count of shorebirds at any site in the East Asian - Australasian Flyway (Watkins *in prep.*). This information has been collected by the Royal Australasian Ornithologists Union which has been conducting field work in the area since 1982.

Forty shorebird species have been recorded on the beach (Australian Nature Conservation Agency 1996). Thirty-three of these species are included in migratory bird agreements between Japan, China and Australia. These species breed in the northern latitudes of the Russian Far East, China and Alaska and each year migrate south to avoid the northern winter.

The most abundant species on Eighty Mile Beach are Great Knot *Calidris tenuirostris*, Red Knot *C. cantus*, Curlew Sandpiper *C. ferruginea*, Red-necked Stint *C. ruficollis*, Bar-tailed Godwit *Limosa lapponica*, Large Sand Plover *Charadrius leschenaultii*, and Oriental Plover *C. veredus*. These counts are the largest or second largest recorded for each of these species in Australia (Table 8).

Eighty Mile Beach has been found to support at least one per cent of the population of 15 species of shorebirds (Table 8). On this basis it is the third most important site for migratory shorebirds in Australia (Watkins 1993).

Table 8 International Importance of Eighty Mile Beach for Shorebirds (from Watkins 1993)

Species	Max. Count	Rank in Australia
Red-capped Plover	9 600	1
Red Knot	80 700	1
Grey-tailed Tattler	8 580	1
Curlew Sandpiper	60 000	1
Large Sand Plover	30 400	1
Terek Sandpiper	6 100	1
Great Knot	160 000	1
Greenshank	2 440	1
Grey Plover	1 650	1
Oriental Plover	18 400	2
Sharp-tailed Sandpiper	25 000	2
Red-necked Stint	60 000	2
Bar-tailed Godwit	34 300	2
Ruddy Turnstone	740	4
Eastern Curlew	480	11

Sharp-tailed Sandpiper *Calidris acuminata* is included in this list but its occurrence on the beach is linked to flooding of the claypans and plains behind the dunes (Lane 1987).

High tide roosts of in the order of 10 000 shorebirds occur along the Beach. Analysis of five aerial surveys has shown that approximately 90 per cent of the shorebirds are concentrated in the Cape Missiessy to Wallal section of Eighty Mile Beach (Watkins 1991). The mangrove creeks delineate the southern boundary of the high densities of shorebirds.

The area of highest concentration appears to be the 15 km section of beach south of the access track from Anna Plains Station. This area regularly supports more than 40 000 shorebirds during March and April. However, at this time numbers can build up to 140 000 shorebirds (Minton 1987). During June, when most adult shorebirds are on the breeding grounds, between 8 000 and 18 000 shorebirds remain on this section of the Beach (Pattinson 1993, Fallaw and Hayward 1994).

Shorebird banding studies have formed a major part of the research work conducted by the Royal Australasian Ornithologists Union. Approximately 20 000 shorebirds have been banded in the Anna Plains area of Eighty Mile Beach. This effort, along with that at Roebuck Bay, makes these two sites the most intensive banding sites in the East

Asian-Australasian Flyway. Banding studies have used metal bands, colour dye and in recent years colour leg flags.

Movements of banded and marked shorebirds from south-western and south-eastern Australia have confirmed the importance of Eighty Mile Beach as a migration staging area on both northward and southward migration (Lane 1987). Band recoveries suggest that many of the medium sized shorebirds such as Great Knot and Bar-tailed Godwit migrate non-stop from north-west Australia to the Shanghai area in China (Barter and Wang 1990).

The enormous shorebird populations feed on the mudflats during the falling and rising tides. Only preliminary samples have been taken of the mudflat biomass and these are inadequate to characterise productivity (Tulp and De Goeij 1994).

7.3 Cultural Values

7.3.1 Aboriginal Cultural Values

Advice from the Kimberley Land Council is that the Karajarri people residing at Bidyadanga community, consider the Eighty Mile Beach area part of their traditional lands. At the time of this report no Native Title claim had been lodged over Eighty Mile Beach though claims had been registered over adjacent areas (Appendix 7).

At a meeting with the Land Council's lawyer the possibility of a future land claim over the Eighty Mile Beach area was raised. The anthropologist working directly with the Traditional Owners was unable to attend this meeting as she was involved in field work.

A meeting was also held with the Project Officer from Mamabulanjin Aboriginal Corporation with responsibility for the Bidyadanga area to discuss the Ramsar status of Eighty Mile Beach and the proposed management planning process. He was not aware of the Ramsar Convention and asked to be kept informed of any future progress towards the development of a management plan. He makes regular field trips to Bidyadanga and advised that he would convey this information to the people at the community.

The site register held by the Heritage and Culture Division of the Aboriginal Affairs Department lists a number of ethnographic and archaeological sites within and adjacent to the Eighty Mile Beach wetland area.

The presence of a number of significant sites in and around the wetland area indicates the importance of the area for Aboriginal people. As with other sites in the Kimberley, Aboriginal people have an expectation that their agreement and involvement would be integral to develop a management plan for the area.

7.3.2 Other Cultural Values

Eighty Mile Beach is listed on the Register of the National Estate.

7.4 Tenure and Management Regime

7.4.1 Tenure

Tidal flats of the Eighty Mile Beach sites are not covered by the Lands Act. Land behind the beach is pastoral lease, special lease or Crown Reserve (Table 9).

There are five large pastoral stations adjacent to Eighty Mile Beach. These are Frazier Downs, Anna Plains, Mandora, Wallal Downs and Pardoo. These leases extend to 40 m above high water mark. Each pastoral lease extends more than 10 km inland from the coast.

The Kimberley-De Grey Stock Route runs parallel to the coast a few kilometres inland. Reserves for water are located approximately every 25 km along the stock route.

There are public roads to Eighty Mile Beach from the Great Northern Highway at Wallal and Cape Keraudren. A Road Reserve to the beach also exists at Anna Plains Station. This station road is not sign marked and at times the gates are locked (Gordon Graham pers. comm.).

Table 9 Land Tenure in areas adjacent to Eighty Mile Beach

Name	Type of Reserve	Area (ha)
Frazier Downs Station	Pastoral Lease (3114/483)	76 756
Anna Plains Station	Pastoral Lease (3114/1154)	381 426
Kimberley-De Grey	Stock Route (9697)	82 401
Anna Plains Road	Road No. 12638	
Cape Missiessy	Water Reserve (1526)	259
McPhee Well	Water (16723)	2
Noreen Well	Watering Place (1528)	259
Moojan Well	Water (16734)	259
Nambeet Well	Watering Place (1529)	259
Mandora Station	Pastoral Lease (3114/485)	92 296
Marlambool Well	Watering Place (1530)	259
Worroo Well	Watering Place (1531)	259
Wallal Downs Station	Pastoral Lease (3114/1079)	
Wallal Well	Watering Place (1532)	250
Eighty Mile Beach Caravan Park	Special Lease (3116/11429/57)	11
"Wallal"	Travellers (11784)	2064
"Wallal"	Use and Benefit of Aborigines (21750/54)	8
Curgen Curgen Well	Watering Place (1533)	259
Charleymia Well	Water and Stopping Place (541)	809
"Pardoo"	Microwave Translator (38769/12)	7
Forty Two Mile Well	Watering Place (1542)	259
Cape Keraudren	Recreation (39135)	4800

There is a cluster of small reserves at Wallal and the most significant of these is a Special Lease for the Eighty Mile Beach Caravan Park. The southern end of Eighty Mile Beach, at Cape Keraudren, is part of a Recreation Reserve vested in the Shire of East Pilbara.

Native Title

Although no Native Tittle claim has been lodged over Eighty Mile Beach there is a strong possibility that this will occur.

Marine Park Proposal

The Marine Parks and Reserves Selection Working Group (1994) has recommended that *"a section of Eighty Mile Beach be reserved for the protection of marine flora and fauna and the habitat of migratory shorebirds"*. The Working Group recommended that the primary area to be included in a reserve was from 40 m above high the high tide mark to the low tide mark. It also recommended that the marine waters between the low water mark and the limit of State waters be included as a buffer to the tidal flats. The boundaries of the area were to be determined following the completion of shorebird studies by the Royal Australasian Ornithologists Union.

The Australian and New Zealand Environment and Conservation Council is currently developing a framework for a National Representative System for Marine Protected Areas (Thackway and Cresswell 1996). Eighty Mile Beach is recognised as a distinct bioregion in the framework. The implication of this work is that a national representative system should include a protected area along Eighty Mile Beach.

East Asian-Australasian Shorebird Reserve Network

At the Ramsar Conference of Parties in Brisbane in March 1996 the Western Australia Government announced its involvement in a shorebird conservation project called the East Asian-Australasian Shorebird Reserve Network. This project seeks to address the conservation needs of migratory shorebirds on a flyway basis through the development of an international network of sites managed for shorebird conservation. The Western Australian Government nominated two wetlands and also foreshadowed the nomination of Eighty Mile Beach and Roebuck Bay. Being part of the Shorebird Reserve Network does not have legal implications. Responsibility for the management of Network sites remains with the nominating agency (Watkins 1995).

7.4.2 Site and Catchment Management

The two major land uses on and adjacent to Eight Mile Beach are tourism and pastoralism.

The operation of the pastoral leases has little direct impact on the conservation values of Eighty Mile Beach. The Ramsar listing of Eighty Mile Beach runs up to the seaward boundary of the pastoral leases. As such only the beach and the primary dune are in the site. This boundary is not fenced but cattle rarely move onto the beach because of the lack of feed and the distance from watering points. However, large numbers of cattle have drowned in the sea during cyclones.

Agriculture WA has identified the coastal plains around Wallal as being suitable for irrigated agriculture using ground water.

Access and facilities for tourism have been developed at Cape Keraudren and Wallal. During the cooler months, at any one time well over one hundred people may be holidaying at these sites. The visitors are a mixture of people from the Pilbara, regular "winter" visitors from the south-west of Western Australia and tourists travelling around Australia. Almost all of the activities of visitors are beach based and include fishing, four-wheel driving, swimming and beach-combing.

The Cape Keraudren Reserve was created in the mid 1980s in response to a request from the East Pilbara Shire. At that time there was a high demand for coastal recreation from people in Goldsworthy and Shay Gap. A management plan was developed for the site as a condition of approval for the reserve (Chalmers 1986). A caretaker is present at the reserve to look after the site. Camping is informal, without electricity and is scattered over the reserve.

Eighty Mile Beach Caravan Park is a commercial caravan park that operates on an 11 ha special lease at Wallal. The site is fenced and has a formal arrangement of camp sites with power and water.

These is no existing commercial use of the tidal mudflats. Pearl shell is understood to be collected from the shallow banks off Eighty Mile Beach for use in cultured pearl industry. No commercial inshore fishing is known to occur.

7.5 Potential Threats to the Site and its Values

The major obligation associated with the Ramsar listing of a wetland is that the government will ensure that the ecological character of the site is not adversely affected by human activities. Eighty Mile Beach can be considered to be comparatively resilient to ecological change because its character is dominated by coastal processes.

The major threats to the site and its values relate to disturbance from people and adverse impacts on migratory shorebirds when they are away from Eighty Mile Beach. Many of the "off-site" impacts on migratory shorebirds are occurring in other countries of the Flyway. These issues can only be addressed through international agreements (Ramsar Convention) and other initiatives (e.g. East Asian-Australasian Shorebird Reserve Network).

Tourism is considered to be having a significant local effect around Cape Keraudren and Wallal because of the number of people and vehicles on the beach. Access along the beach from both of the sites is limited at high tide by creeks and rocky headlands. The managers of the Eighty Mile Beach Caravan Park have called for motor bikes to be banned from the Beach between 1 November and 30 April to minimise impact on turtle nesting and shorebirds (Watson 1996).

The development of additional access points for tourism needs to be carefully planned and managed. Eighty Mile Beach is famous for its abundance of large baler and other shells and because of this it has become a popular shell-collecting area.

Increased public access to the Anna Plains section of Eighty Mile Beach would be a major threat to shorebirds. At high tide concentrations of tens of thousands of

shorebirds are pushed up into tight flocks on the narrow beach. At this time any movement of people or vehicles along the beach would disturb the roosting flocks. Over use of 4WD's on the beach is also likely to have a detrimental effect on beach crab populations, especially ghost crabs (*Ocypode* spp.).

In the 1940s a military base called Talgarno was established inland from the Anna Plains Station homestead. In the post-war period, its function was the monitoring of British Blue Streak rockets test-fired from Woomera in South Australia. The base included a large gravel airstrip. Today the only remains are the airstrip, building foundations and two artesian bores. If facilities were redeveloped at this site it may have the potential to cause adverse effects on Eighty Mile Beach due to increased human and aircraft activity.

Shipping and off-shore petroleum extraction are a potential threat in the event of a major spillage. This could be expected to have a catastrophic impact on the biota using Eighty Mile Beach. A major spill in the September to April period would significantly impact on international migratory species such as shorebirds and marine turtles.

The Bureau of Transport and Communications Economics (1991) estimated that the probability of a major spill (greater then 1 000 tonnes) from offshore petroleum rigs and pipelines in Australian waters was 39 per cent in any 5 year period, 61 per cent in any 10 year period and 83 per cent in any 20 year period. The risk of platform spills for these periods was estimated to be 26 per cent, 44 per cent and 67 per cent respectively. These estimates have been criticised for being overly pessimistic given Australia's good safety record (Swan *et al.* 1993).

To the south of Eighty Mile Beach are the ports of Dampier and Port Hedland. These are the two largest ports in Australia in terms of cargo loaded (Zann 1996). This shipping traffic is a potential threat because it passes offshore from Eighty Mile Beach. The shallow waters off Eighty Mile Beach constitute the most important live shell resource for the Broome-based pearling industry.

7.6 Conclusions

7.6.1 Urgent Management Actions

During the fieldwork for this project Eighty Mile Beach was visited at Anna Plains Station, Eighty Mile Beach Caravan Park and Cape Keraudren. No urgent site management actions were identified.

7.6.2 Necessary Ecological Investigations

The Ramsar listing of the Eighty Mile Beach obliges the State Government to monitor the ecological character of the site. Monitoring is needed to test if ecological change is occurring and to develop appropriate management responses. In the present case, important aspects to monitor are shorebird populations and public use of the beach. The program developed should build on the research and monitoring that has been conducted by the Royal Australasian Ornithologists Union (specifically Broome Bird Observatory and the Australasian Wader Studies Group).

This program should also seek to draw on information collected by the Eighty Mile Beach Caravan Park and the ranger of the Cape Keraudren Reserve.

Recommendation 44: The Kimberley Regional Ecologist, in consultation with the West Kimberley Office, develop a program to monitor for changes in the ecological character of Eighty Mile Beach. This should be developed as part of a regional program for Ramsar sites (see Section 9.3.2).

7.6.3 Management Planning

An important issue related to management and management planning is to establish a clear understanding of the boundary of the Ramsar-listed area of Eighty Mile Beach. Detailed maps showing the boundary should be available at the West Kimberley Office for staff and the public.

Recommendation 45: The Kimberley Regional Ecologist, in consultation with the West Kimberley Office, work with the Department's wetland research officers to define in detail the boundaries of the Ramsar-listed area of Eighty Mile Beach.

Recommendation 46: The Regional Manager ensure that detailed maps are available at the West Kimberley Office that show the boundary of the Ramsar-listed area of Eighty Mile Beach.

Recommendation 47: The Regional Manager take the necessary steps to ensure that the Department forward a copy of the detailed maps of Eighty Mile Beach to Environment Australia.

At present Eighty Mile Beach and the Mandora Marshes are combined on the List of Wetlands of International Importance as "Eighty Mile Beach". The two wetlands are geographically separated, ecologically distinct and independent and each qualifies on several criteria as a Wetland of International Importance. If the two sites are to be managed as independent wetlands then the Department of Conservation and Land Management should give consideration to having the sites individually listed under the Ramsar Convention.

Recommendation 48: The Regional Manager give consideration to taking the appropriate action to have the present Ramsar listing of Eighty Mile Beach revised and that Eighty Mile Beach and Mandora Marshes be designated individually on the List of Wetlands of International Importance.

Currently no government agency is recognised as having responsibility for the management of Eighty Mile Beach. The Marine Parks and Reserves Selection Working Group (1994) has recommended that a Marine Park be established at Eighty Mile Beach. Implementation of the marine park proposal for the area would provide a constructive mechanism to clarify the future tenure and management responsibility for the area. Before commencing a public management planning process for Eighty Mile Beach it is important that the Department clarify with the Minister for the Environment a timetable for advancing the Marine Park proposal. A clear understanding of the status of the Marine Park proposal will greatly assist community participation in the management planning process.

The Marine Parks and Reserves Selection Working Group (1994) also recommended that the details on boundaries of a conservation area await the results of shorebird research being conducted Royal Australasian Ornithologists Union. This is a key issue requiring follow-up by the Department of Conservation and Land Management.

Recommendation 49: The Regional Manager take the appropriate action to seek advice from the Royal Australasian Ornithologists Union on the results of their studies on shorebirds and on the implications for setting of boundaries for the proposed Eighty Mile Beach Marine Park.

Consideration should be given to combining the process for establishment of Marine Parks at Eighty Mile Beach and Roebuck Bay because of similar issues and stakeholders.

Recommendation 50: The Regional Manager seek for the Executive Director to obtain "in-principle" approval from the Minister for the Environment to advance the Marine Park proposal for Eighty Mile Beach (also see Section 9.1.3).

Recommendation 51: If "in-principle" approval is given to advance the Marine Park proposal, the Regional Manager seek advice from the Executive Director on the arrangements, timetable and resourcing as these may involve State wide considerations (also see Section 9.1.3).

Recommendation 52: Following clarification of the details for advancing the Marine Park proposals, the Regional Manager take the appropriate steps to combine management planning under the Conservation and Land Management Act with the requirements for the establishment of a Marine Park.

If it is determined that a Marine Park will not be established at this site before the next Conference of Parties to the Ramsar Conference (1999) then alternative mechanisms should be developed to enable coordinated management. A mechanism for this would be to establish a consultative management committee chaired by the Department of Conservation and Land Management in its capacity as the State implementation agency for the Ramsar Convention. Key stakeholders to consider as part of the committee are: the Department of Fisheries, Shire of Broome, Shire of East Pilbara, Broome Port Authority, Port Hedland Port Authority, Pearl Producers Association, owners and managers of pastoral stations, Aboriginal Traditional Owners, and the Kimberley Tourism Association.

Recommendation 53: If by July 1997, it is concluded that Marine Parks will not be advanced by 1999, the Regional Manager should take the necessary steps to establish a consultative management committee for Eighty Mile Beach.

In addition to giving attention to the development of a management plan for Eighty Mile Beach it is also important that the Department of Conservation and Land Management actively participate in other planning and management process for Eighty Mile Beach and adjacent areas.

Eighty Mile Beach is a major natural tourism asset. Increased numbers of tourists and the development of tourism facilities are the major management issues for Eighty Mile Beach. It is important that the Department of Conservation and Land Management take an active interest in planning studies for tourism.

Recommendation 54: The Regional and District Manager continue to support staff involvement in government and community planning for Eighty Mile Beach and adjacent areas.

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Mandora Marshes

8.0 Mandora Marshes

The Mandora Marshes are immediately north-east of Sandfire Roadhouse on the Great Northern Highway between Broome and Port Hedland (19° 45' S and 121° 30' E) (Figs.7 and 8). Most of the 80 000 ha site is part of the Anna Plains Station pastoral lease.

Mandora Marshes is included in the List of Wetlands of International Importance as a component of the "Eighty Mile Beach site". It is individually listed in the Directory of Important Wetlands in Australia (Australian Nature Conservation Agency 1996a).

The climate is semi-arid monsoonal with a hot wet summer and a warm dry winter. Median and mean annual rainfall at Mandora Station are 327 mm and 341 mm respectively, mostly falling in January-March; annual evaporation is c. 3 400-3 600 mm. The main cyclone period is January to March. In a 40 year period 21 cyclones crossed the coast between Broome (17° S) and the mouth of the De Grey River (20° S) (Beard 1975). In the Pilbara, 35 per cent-45 per cent of the annual rainfall is cyclonic (Beard 1975). Cyclones are a major factor in the land formation process because of the high winds and heavy rainfall.

8.1 Physical Attributes

The Mandora Marshes consist of two claypans with fringing fresh and saline springs to the east and south. Whereas the springs have a permanent flow of water the claypans only flood following substantial rain associated with tropical lows or cyclones. The Marshes are embraced on three sides by the red sand dunes (up to 15m high) of the Great Sandy Desert which are oriented east/west on the north side but north-east/south-west on the south side. They are situated at the interface of the grassy coastal plain and the tree and shrub steppe of the desert.

Around 15 million years BP the climate of north-west Australia was very different with high humidity and rainfall. At this time the Mandora Marshes were part of a large drainage system called the Wallal Paleoriver [sic] (Van De Graaff *et al.* 1977). This river is considered to have run inland for over 300 km. As the climate became more arid the drainage valley filled with alluvial and aeolian material.

Changes in sea level have also had a major impact on the local landscape. About 10 000 years ago the Mandora Marshes and the coastal flats that back Eighty Mile Beach were a shallow marine system. At this time the Mandora Marshes were probably part of an estuary at the mouth of the Wallal Paleoriver [sic] (Beard 1967). The fall in sea level and the formation of sand dunes along Eighty Mile Beach have left behind a broad flat plain that extends inland to include the lower areas of the Mandora Marshes. Most of the plain is between 6 m and 9 m above the present mean sea level.

The core landscape feature within the Mandora Marshes is two saline claypans. The western claypan is approximately 25 km long and up to 4 km wide and has a elevation of 5 m. The eastern claypan is approximately 30 km long and rises from approximately 15 m to over 20 m. The two claypans are linked by a 10 km creek (Salt Creek, Photograph 28, 29). This creek is approximately 2m deep and permanently contains saline water supplied from saline seeps around the eastern claypan.

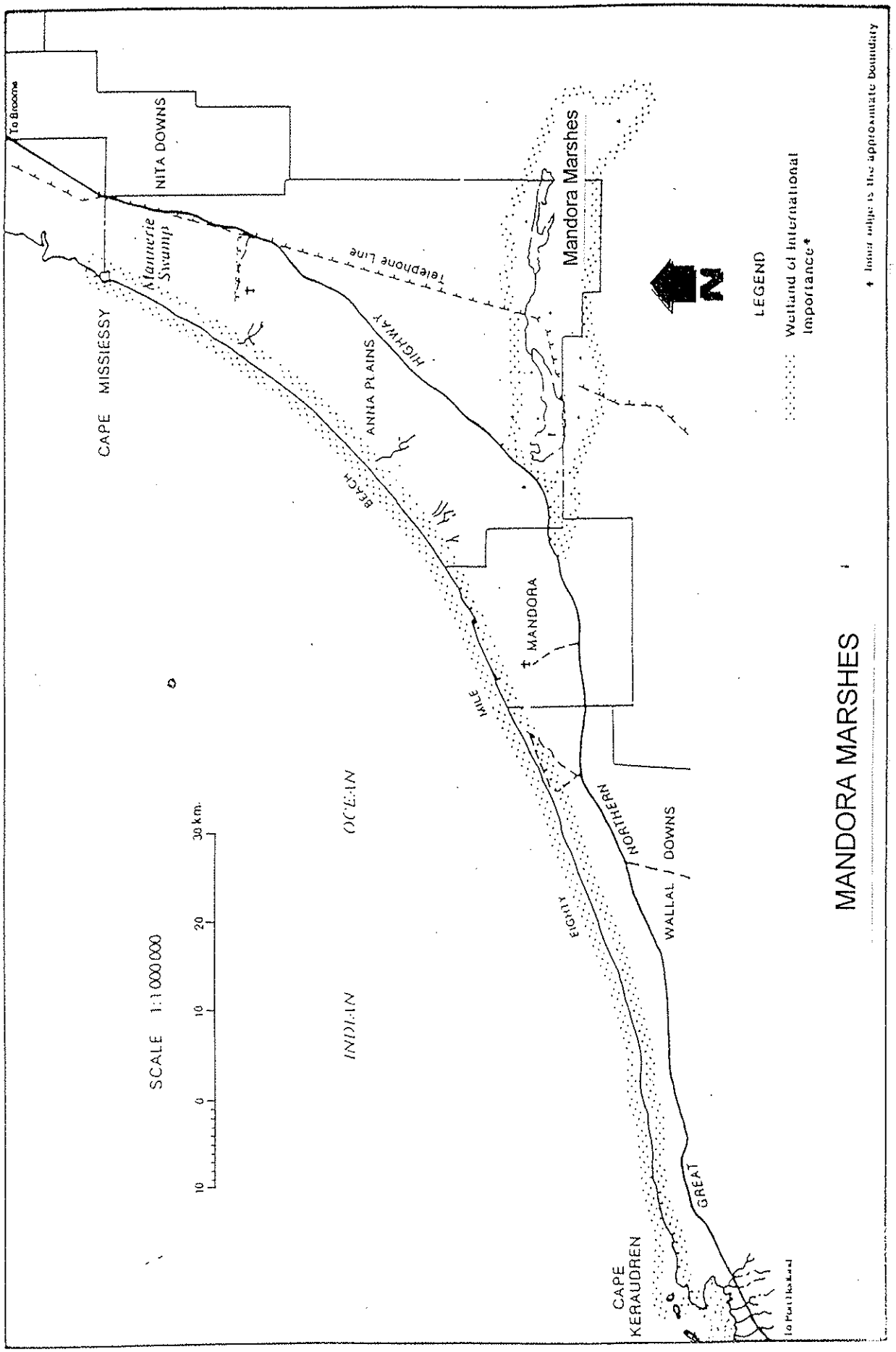

Figure 7. Mandora Marshes
(Dept. Conserv. & Land Managemt. 1990)

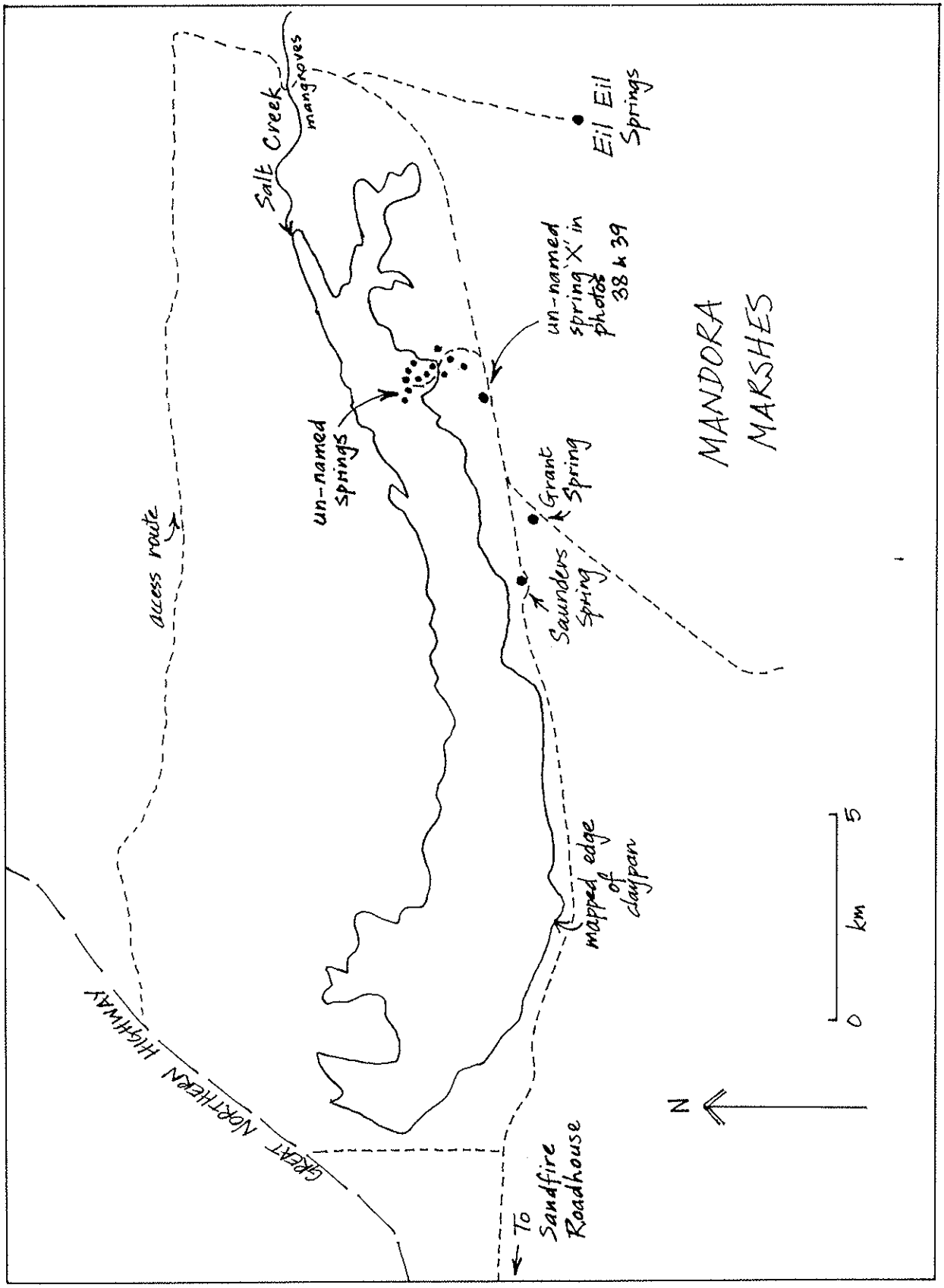

Figure 8. Detail of western part of Mandora Marshes

The hydrology of the Mandora Marshes is dominated by the Wallal Paleoriver [sic] which supplies a continuous flow of ground water (Wyrwoll *et al.* 1986) . During the field work a minimum of 16 freshwater soaks were counted along the southern margin of the claypans. Formally named springs are: Eil Eil (19° 47'48"S 121° 26'36"E) (also called Mandora Swamp in Wyrwoll *et al.* 1986), Saunders (19 46'59"S 121 20'10"E), Grant (19° 47'06"S 121° 21'20"E), Cardong Biddy (19° 47'01"S 121° 33'20"E), Baramith (19° 47'00"S 121° 38'36"E), and Top (19° 48'53"S 121° 36'42"E).

Eil Eil Springs consists of two areas of water and is the largest documented permanent freshwater wetland in the area (Photographs 31 - 35). The southern part has a crescent shaped stand of paperbarks. Around the inner edge of the paperbark stand is open water with flooded sedges. On the inner edge of the water is a slightly raised area of compacted peat. The north-western part exists as a "raised bog" under an open paperbark forest.

The bare area of compacted peat and clay between the two springs acts as a high run-off catchment during high intensity rainfall (Photograph 31). This water would shed to the north-west and wash around the "raised bog" of north-west Eil Eil Spring.

The peat at Eil Eil Springs is of considerable scientific interest (Burbidge *et al.* 1991). Cores of up to 3.3 m have been obtained. Analysis indicates that organic sedimentation has been occurring for at least 6 000 years (Wyrwoll *et al.* 1986). The data have contributed to climate change studies.

The second significant source of water for the Marshes is rainfall during cyclones. These events occur approximately once in each decade and result in the total flooding of the western claypan and the coastal plain. The bed of the western claypan is lower than much of the coastal plain. However once the water reaches approximately 1m in depth in the western claypan it floods westward across the Great Northern Highway. There has not been any systematic documentation of flood levels. These rare flood events are very significant in providing habitat for aquatic organisms.

8.2 Biological Attributes

In the 1970s and early 1980s a comprehensive survey of the vegetation of Western Australia was published at a 1:100 000 scale. From this work three botanical provinces and 21 botanical districts have been described. The Marshes are at the interface of the Northern Botanical Province and the Eremaean Botanical Province (Beard 1975). The lower areas of the Marshes are part of the Dampier Botanical District while the surrounding areas to the north, east and south are part of the Canning Botanical District (Beard 1975).

More recently an interim bio-regionalisation has been developed for Australia (Thackway and Cresswell 1995). The core area of the Mandora Marshes is in the Dampierland Bioregion and the surrounding areas to the north, east and south are in the Great Sandy Desert Bioregion.

Photograph 28 Salt Creek at crossing looking upstream to the E
(8 July 1996, Doug Watkins)

Photograph 29 Salt Creek at crossing looking downstream to W
Avicennia marina seedlings in the creek and along the banks.
(8 July 1996, Doug Watkins)

Photograph 30 1 km north of Eil Eil Springs on access track.
View across the site to NW, high sand dune along the N of the site visible in the background. (9 July 1996, Doug Watkins)

Photograph 31 Eil Eil Springs - south-western portion looking SE.
Large *Melaleuca argentea* on a raised peat bed in the background. Compacted peat and clay in the foreground. Stand of cumbungi *Typha domingensis* on right of photo. Note cattle pad across left side of the photo. (9 July 1996, Doug Watkins)

Photograph 32 Eil Eil Springs - south-western portion.
Melaleuca argentea on the raised peat bed. Understorey of *Schoenoplectus litoralis.*
(9 July 1996, Doug Watkins)

Photograph 33 Eil Eil Springs - south-western portion.
Melaleuca argentea on the edge of the raised peat bed.
(9 July 1996, Doug Watkins)

Photograph 34 Eil Eil Springs - south-western portion.
Melaleuca argentea on the raised peat bed. A young white dragon tree *Sesbania formosa* is visible in the right mid-ground. Understorey of *Schoenoplectus litoralis.* (9 July 1996, Doug Watkins)

Photograph 35 Eil Eil Springs - south-western portion.
Melaleuca argentea on the raised peat bed. Mangrove ferns *Acrostichum speciosum* in the centre of the photo. (9 July 1996, Doug Watkins)

Photograph 36 3 km ENE of unnamed Spring 'X'
Jim Lane in a raised bog with mangrove ferns *Acrostichum speciosum*, young white dragon tree *Sesbania formosa and Acacia spp.*
(9 July 1996, Doug Watkins).

Photograph 37 Saunders Spring
Jim Lane in a stand of cumbungi *Typha domingensis* with white dragon tree *Sesbania formosa* growing on a raised peat bed. Tops of the white dragon trees were probably broken off in the March 1996 cyclone. (9 July 1996, Doug Watkins).

8.2.1 Flora

The two most striking botanical features of the Marshes are the presence of white mangroves *Avicennia marina* along Salt Creek (Photographs 28, 29), and the paperbark *Melaleuca argentea* and white dragon tree *Sesbania formosa* groves of the freshwater soaks (Photographs 31 - 35, 37, 41). Isolated stands of Avicennia marina also occur west of Salt Creek on the western claypan and in several remarkable spring communities at 19° 46'S 121° 23'E (Tim Willing pers. comm.).

The mangrove stand is unusual because it is over 40 km from the sea. The trees grow to 4 m high along the steep banks of the creek (which is not connected to the sea). It has been suggested that this is a relict stand from a time when sea levels were higher and the Marshes were a mangrove lined estuary (Beard 1967). There is only one other occurrence of mangroves separated (inland) from the Western Australian coast (Lake MacLeod).

The freshwater springs provide a sharp contrast to the surrounding shrub steppe. The 20 m paperbark trees make the freshwater springs stand out on the landscape. From the top of the dune to the north of Salt Creek it is possible to identify a minimum of 16 groves of paperbarks around the east and south margins of the Marshes.

The north-western wetland in Eil Eil Springs has an understorey of mangrove ferns *Acrostichum speciosum* (Photograph 33) The sedges on the south-eastern wetland are *Schoenoplectus litoralis* and *Fimbristylis ferruginea.*

The vegetation of the freshwater springs inside the fenced area of Anna Plains Station (including Saunders and Spring 'X') is being disturbed by cattle. This is particularly evident at Spring 'X' which has become a camping area for cattle and is now totally devoid of understorey.

At Saunders Spring a small soak has been excavated and this has relieved grazing pressure on the main spring. The understorey is dominated by a thick stand of cumbungi *Typha domingensis.*

The vegetation along the southern edge of the claypans is a Melaleuca scrub of *Melaleuca acacioides, M. lasiandra and M. glomerata* (Beard 1967, 1975).

The western edge of the Marshes meets with the grass plains that occur across Anna Plains, Mandora and Wallal Stations. Species found in this area are *Eragrostis dielsii, E. lacunaria, Xerochloa barbata, Enneapogon planifolius, Sporobolus actinocladus, Triraphis mollis, Dichanthium affine, Chloris ruderalis, Panicum decompositum* var. *scaberrimum* and *Sporobolus virginicus* (Burbidge 1944, Beard 1975, Burbidge *et al.* 1991). Burbidge (1944) noted that on the plains "a good deal of the native grasses have been replaced by the introduced Buffel Grass *Cenchris ciliaris*".

Samphire occurs in the high salinity soils between the bare claypan and the grass plains. Burbidge (1944) has described this as having three zones (from the grass plain to the claypan):

- *Sporobolus virginicus* with *Trianthema turgidifolia*, *Ptilotus exaltatus* and *Scaevola spinescens*
- *Trianthema turgidifolia* with *Neobassia astrocarpa* and *Atriplex elachophylla*, occasional thickets of *Acacia bivenosa* or *Acacia ampliceps*
- *Halosarcia* sp. (red or black samphire).

8.2.2 Fauna

The has been very little study of the fauna of the Marshes. A short visit of several days was made by the Department of Conservation and Land Management in August 1983. The survey recorded: red kangaroo, larapinta *Sminthopsis macroura*, lesser hairy-footed dunnart *S. youngsonii*, delicate mouse *Pseudomys delicatulus*, yellow-bellied sheath-tailed bat *Taphozous flaviventris* and northern mastiff bat *Chaerephon jobensis* (Burbidge *et al.* 1991). The survey also recorded a number of species of birds, reptiles and amphibians.

During flood events large numbers of waterbirds congregate on the claypans and the adjacent flooded samphire (Jaensch 1982, Storr 1984 and 1991, Kolichis 1992). Twenty-four species of waterbirds have been recorded, including seven herons and allies, four waterfowl, five shorebirds, and other species that favour open habitats, e.g. Brolga *Grus rubicunda* (Australian Nature Conservation Agency 1996a). Six species have been recorded breeding including: more than 15 pairs of Red-kneed Dotterel *Erythrogonys cinctus*, several pairs of Red-necked Avocets *Recurvirostra novaehollandiae,* many pairs of Black-winged Stilt *Himantopus himantopus* and Whiskered Tern *Chlidonias hybridus* and a Plumed Whistling-Duck *Dendrocygna eytoni.* The following species were each present in hundreds in inundated samphire, 7-8 km east of the highway in March 1980 or near the highway in March-April 1982: Australian Pelican *Pelecanus conspicillatus*, Pacific Heron *Ardea pacifica*, Rufous Night Heron *Nycticorax caledonicus*, Straw-necked Ibis *Threskiornis spinicollis*, Grey Teal *Anas gibberifrons*, Black-winged Stilt, Silver Gull *Larus novaehollandiae*, Whiskered Tern and Gull-billed Tern *Sterna nilotica* (Australian Nature Conservation Agency 1996a).

When inundated extensively, the site is suitable for migratory shorebirds preparing to depart Australia on northward migration in March and April.

At least one species of fish occurs: Whiskered Terns apparently were feeding on fish that had congregated at spill-over points when water was running over the Great Northern Highway in March-April 1982.

Camels tracks were observed around and in Eil Eil Springs. Damage had been caused by trampling of vegetation and grazing on the white dragon trees. The Station manager said that the camels regularly knocked down the boundary fence in this part of the Station. This also enables cattle to move out to the unfenced half of the Marshes where they use the springs as water points.

The springs may be an important drought refuge area for fauna of the Great Sandy Desert. The may also provide temporary habitat for waterbirds moving within Australia (e.g. crakes, Clamorous Reed-Warbler *Acrocephalus stentoreus*).

8.3 Cultural Values

8.3.1 Aboriginal Cultural Values

At the time of this report no Native Title claim had been lodged over Mandora Marshes. The Traditional Owners of the area (Karajarri people) have lodged a Native Title Claim to the north of the Marshes. This claim covers parts of Shamrock and Nita Downs Stations and Vacant Crown Land adjoining the northern parts of Anna Plains Station (Appendix 7). The Kimberley Land Council is representing the Karajarri people in their Native Title claims.

There is the probability that a Native Title Claim will be lodged covering the Mandora Marshes in the future.

As with other sites in the Kimberley, Aboriginal people have an expectation that their agreement and involvement would be integral to develop a management plan for the area.

The site register held by the Heritage and Culture Division of the Aboriginal Affairs Department lists a number of ethnographic and archaeological sites near the Marshes.

8.3.2 Other Cultural Values

The Mandora Marshes are under assessment for listing on the Register of the National Estate. The principal group it is being assessed for is "Natural Environment" (Register of the National Estate Place Database, Report 13 June 1996).

8.4 Tenure and Management Regime

8.4.1 Tenure

Approximately 85 per cent of the Marshes is within the south-east corner of the Anna Plains pastoral lease. The additional 15 per cent to the east of the pastoral lease is Vacant Crown Land. The western boundary of the site is formed by the Great Northern Highway.

At the time of this report no Native Title claim had been lodged over Mandora Marshes. A claim has been lodged to the north of the area and there is a possibility that a future land claim will incorporate the Mandora Marshes.

There are no current mineral or petroleum exploration leases over the area.

It has been proposed that the Marshes be included in the proposed Mandora Nature Reserve to be vested in the National Parks and Nature Conservation Authority (Burbidge *et al.* 1991). Consultation between the Department of Conservation and Land Management and the Anna Plains Station owners (eg. June 1993) have not yet led to agreement on land acquisition or on formal management arrangements for the Ramsar-listed area of the Mandora Marshes (Dave Hampton pers. comm.).

8.4.2 Site and Catchment Management

The major land use in the Marshes is cattle production. While the Anna Plains pastoral lease covers approximately 85 per cent of the area only 40 per cent is fenced and managed for cattle production. The Marshes are contained within one large paddock. The eastern boundary fence of the Station is approximately 25 km inland from the Great Northern Highway. There are six bores from which water is pumped for cattle around the margins of the western claypan. Most of these are along the northern edge of the site adjacent to the Joanna Springs track. Cattle also water at the freshwater springs on the southern side of the western clay pan.

Water points are of key importance to the management of cattle. They become the epicentre of grazing pressure and Station management. Water points need to be

checked every few days to ensure they are functioning correctly and because of their remoteness from the homestead maintenance costs are very high. These costs have limited the expansion of the Station into the eastern portions of the lease. The freshwater springs are a considerable asset for the Station because they provide water points with no capital or maintenance costs involved.

Cyclonic rains are important for the regeneration of the vegetation on which cattle graze. Flooding can cause problems for fence maintenance and mustering of cattle around the Marshes. Nobody had driven around the south-east fence line in the three months before the project site visit because the area had not dried out sufficiently (Station Manager pers. comm.).

The low quality of feed in the eastern parts of the Marshes, combined with the capital and maintenance costs for fencing and water points, and the difficulty of mustering means that this area of the lease has a very low economic viability.

The two other land uses of the Marshes are low level eco-tourism (one operator with occasional visits) and probable cultural activities of Aboriginal people.

Cleared seismic lines of petroleum exploration from the late 1960s are visible in the area.

Along the northern edge of the site is a track that continues on to Joanna Springs in the Great Sandy Desert. A small, but increasing, number of 4WD enthusiasts use this access track (Station Manager pers. comm.).

The western boundary of the site is the Great Northern Highway. During flood events the road has a temporary damming effect and water floods across the road. The ecological consequences (if any) of this damming are not known.

Sandfire Roadhouse is situated five kilometres to the south of where the road crosses the Marshes. This is one of only three roadhouses on the 620 km stretch of Great Northern Highway between Port Hedland and Broome. Associated with the operation of the roadhouse are environmental issues of rubbish disposal, waste water and fuel storage. These are not considered to be impacting on Marshes because the roadhouse is not in the catchment.

In summary the primary stakeholders are considered to be Anna Plains Station, the Department of Conservation and Land Management and the Aboriginal Traditional Owners. The secondary stakeholders are Sandfire Roadhouse, tourist operators, the mining industry and the Department of Main Roads.

8.5 Potential Threats to the Site and its Values

The obligation associated with Ramsar listing is that the government will ensure that the ecological character of the site is maintained.

The ecological character of the freshwater springs in the fenced area of Anna Plains Station is at present being adversely changed by cattle. The impact is acute at Spring 'X' and Saunders Springs where cattle congregate in large numbers to drink and rest. Around these springs there are changes to the landform (soil compaction, structure of the spring), surface hydrology (sheet and gully erosion, low infiltration rates) and vegetation (denudation of native vegetation, introduction of exotic species). This is shown in Photographs 38 - 41.

The Department of Conservation and Land Management has recognised that these areas are in "imminent danger of major structural and floristic change in the short to medium term" (Conservation and Land Management 1992). This threat is also recognised in the 1992 State of the Environment Report for Western Australia (Government of Western Australia 1992). However, the National Report for Australia to the Sixth Meeting of the Conference of Contracting Parties to the Ramsar Convention did not mention these adverse changes occurring to the ecological character of the site (Australian Nature Conservation Agency 1996b).

Camels are also impacting in a similar way, but to a much lesser extent, on Eil Eil Spring. The level of damage may be greater in the eastern part of the Mandora Marshes where presumably exposure to influence of camels is greater. Further into the Great Sandy Desert, camels are known to pose a major threat to Dragon Tree Soak (Bamford 1995).

Camels are causing an additional problem at the Mandora Marshes by knocking down the south-eastern boundary fence. This enables cattle to move out to the unfenced soaks.

No current threats could be identified for the salt seeps, Salt Creek or the claypans. However grazing is denuding native vegetation in the western half of the Marshes and is providing favourable conditions for the invasion of exotic plant species.

Water extraction in the area has the potential to adversely impact the local hydrology. There does not appear to be any monitoring of ground water levels.

Photograph 38 Changes in ecological character at Spring 'X'
Destruction of vegetation and soil compaction around Spring 'X' caused by cattle.
(9 July 1996, Doug Watkins)

Photograph 39 Changes in ecological character at Spring 'X'
Destruction of understorey and soil disturbance caused by cattle at Spring 'X'
(9 July 1996, Doug Watkins)

Photograph 40 Changes in ecological character at Saunders Spring
Excavated soak adjacent to Saunders Spring.
(9 July 1996, Doug Watkins).

Photograph 41 Changes in ecological character at Saunders Spring
Destruction of vegetation and soil compaction caused by cattle. Stand of white dragon tree *Sesbania formosa* on Saunders Spring in the background. Excavated soak in the centre mid-ground behind the cattle. (9 July 1996, Doug Watkins).

8.6 Conclusions

8.6.1 Urgent Management Action

Urgent management action is needed to minimise further ecological change to the freshwater soaks inside the fenced portion of the Mandora Marshes. Discussions need to be continued with the Station Manager to establish a suitable agreement for the protection of these springs. The issue of water points along the southern edge of the Marsh needs to be addressed in these discussions.

Additional fieldwork and aerial photo interpretation is needed to identify all of the freshwater soaks. This will provide the basis for fencing plans and costings. Options for Commonwealth Government funding should be explored, notably the Save the Bush Program.

Recommendation 55: The West Kimberley District Manager follow up preliminary discussions with the Manager of Anna Plains Station with the aim of fencing off Saunders, Spring 'X' and other freshwater springs along the south side of the western claypan by the end of 1997.

Recommendation 56: The West Kimberley District Manager seek assistance from within the Department to map the freshwater springs outside the fenced area of Anna Plains Station and implement measures to minimise impacts from camels and cattle by the end of 1998.

Australia has a obligation under Article 3 of the Ramsar Convention to inform the Ramsar Bureau "*at the earliest possible time*" of adverse changes to the ecological character of listed wetlands caused by human activities. The Montreux Record has been developed under the Ramsar Convention to highlight sites where "adverse change in ecological character has occurred, is occurring, or is likely to occur, and therefore in need of priority conservation attention" (Ramsar Resolution VI.1). The Department of Conservation and Land Management needs to consider if it will seek to have the site listed on the Montreux Record.

Recommendation 57: The Kimberley Regional Manager advise the Executive Director of the Department of Conservation and Land Management of the adverse changes that are occurring to the ecological character of the Mandora Marshes. This advice should outline the action that is being taken and give details on proposed resourcing and timetable.

Recommendation 58: The Department of Conservation and Land Management inform Environment Australia of the status of the ecological character of the Mandora Marshes and of the actions that are being taken.

8.6.2 Further Ecological Investigations

No further ecological investigations have been identified that will be required prior to the preparation of a management plan. However, scientific information on the area is very limited and additional studies would greatly assist in developing a greater understanding of the ecology of the wetlands.

The peat deposits associated with the freshwater springs are of considerable scientific interest for climatic studies. This research should be encouraged.

The Ramsar listing of the Mandora Marshes obliges the State Government to monitor the ecological character of the site. Important aspects to monitor are: impacts on the native vegetation of grazing by cattle, establishment of introduced plants and groundwater hydrology.

Recommendation 59: The Kimberley Regional Ecologist, in consultation with the West Kimberley Office, develop a program to monitor for changes in the ecological character of the Mandora Marshes. This should be a component of a Kimberley regional program of monitoring at Ramsar sites (see Section 9.3.2).

8.6.3 Management Planning

An important issue related to management and management planning is to establish a clear understanding of the boundary of the Ramsar-listed area of Mandora Marshes.

The existing boundary of the Ramsar-listed is poorly defined and this needs to be addressed. Consideration should be given to using fence lines and tracks where possible to guide the definition of the site boundary. There is a need to clarify that Sandfire Roadhouse is outside the Ramsar-listed area. Detailed maps showing the boundary should be available at the West Kimberley Office for staff and the public.

Recommendation 60: The Kimberley Regional Ecologist, in consultation with the West Kimberley Office, work with the Department's wetland research officers to define in detail the boundaries of the Ramsar listing.

Recommendation 61: The Regional Manager ensure that detailed maps are available at the West Kimberley Office which show the boundary of the Ramsar-listed area of the Mandora Marshes.

Recommendation 62: The Regional Manager take the necessary steps to ensure that the Department forward a copy of the detailed maps of Mandora Marshes to Environment Australia.

At present Mandora Marshes and Eighty Mile Beach are combined on the List of Wetlands of International Importance as "Eighty Mile Beach". The two wetlands are geographically separated, ecologically distinct and independent and each qualifies on several criteria as a Wetland of International Importance. If the two sites are to be managed as independent wetlands then the Department of Conservation and Land Management should give consideration to having the sites individually listed under the Ramsar Convention.

Recommendation 63: The Regional Manager give consideration to taking the appropriate action to have the present Ramsar listing of Eighty Mile Beach revised and that Mandora Marshes and Eighty Mile Beach be designated individually on the List of Wetlands of International Importance.

Over three quarters of the area of Mandora Marshes is currently part of Anna Plains Station. It is understood that the Department of Conservation and Land Management has tried over several years to acquire the Mandora Marshes section of the Anna Plains Pastoral Lease. It has also discussed the development of a management agreement for the area under Section 16 of the Conservation and Land Management Act. These negotiations have not been successful (Dave Hampton, Conservation and Land Management, pers. comm.).

It appears that a good relationship exists between staff of the Department of Conservation and Land Management and the present Manager of Anna Plains Station. He appeared supportive of suggestions to fence the freshwater soaks. Implementation of fencing would significantly address the identified threats to the Marshes.

The Department should continue to seek agreement with Anna Plains Station on management arrangements for the Mandora Marshes. These discussions should focus on agreement to fence the freshwater springs inside the fenced area of the lease.

The priority for the development of a management plan is low as long as a constructive relationship can be maintained with the lessee of Anna Plains Station. Attention also needs to be given to building relations with the Aboriginal Traditional Owners. This will take on legal importance if a Native Title Claim is made over the Marshes.

Consideration needs to be given to the timetable for implementation of the existing Mandora Nature Reserve proposal. It can be expected that Anna Plains Station, the Aboriginal Traditional Owners, and mining industry would take an active interest in this issue. Issues associated with Native Title would need to be resolved before any changes in tenure can be anticipated. The tourism industry could be expected to support the establishment of a conservation area.

Recommendation 64: The Regional Manager ensure that the focus of the Departments efforts are to have implemented an appropriate management regime for the Mandora Marshes and to take a long term approach to the implementation of the Nature Reserve proposals.

8.7 References

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9.0 Conclusions

Managers of wetlands listed under the Ramsar Convention are obliged to:

- ensure there is an appropriate description of the ecological character of each site
- monitor for changes in ecological character
- manage to minimise adverse impacts on listed wetlands caused by human activities.

Management plans produce a mechanism to address these issues and to obtain organisational and community support for wetlands management. The Ramsar Convention has developed guidelines for the development of management plans (Table 2; Davis 1994). The components of the recommended model are similar to those required in management plans produced by the Department of Conservation and Land Management. In the Ramsar Convention Strategic Plan 1997-2002 (Ramsar Convention Bureau 1996) an Action Statement calls for Contracting Parties to *"..have management plans or other mechanisms in preparation, or in place, for at least half of the Ramsar sites.."* This report forms the first stage in the development of management plans for the Ramsar sites in the Kimberley.

This section presents an overview of the management actions needed at the Ramsar sites, including the development of management plans. The conclusions are presented as action statements that draw from and are cross-referenced to the recommendations in the site accounts.

For purposes of this report the "Lake Argyle and Kununurra" site has been considered as two sites. This is also the case for the "Eighty Mile Beach" site which is considered to consist of Eighty Mile Beach and the geographically separated Mandora Marshes.

As yet, Lake Gregory has not been nominated for listing under the Ramsar Convention. Conclusions relating to Lake Gregory are given in the site account for this wetland (Section 5.0).

9.1 Clarification of Planning and Management Responsibility

9.1.1 Overview

An overview of the tenure and land use of the Ramsar-listed sites shows:

- Only one (Ord River Floodplain) of the six areas is vested in the Department of Conservation and Land Management (Table 10)
- Biodiversity conservation is the primary management objective at only one site (Table 11)
- Commercial exploitation of wetland products occurs at five of the sites (Table 11)
- No coordinating management agency has been identified for the two marine sites
- Proposals exist for four of the six areas to be vested in the Department of Conservation and Land Management; two as Marine Parks, one as Marine Park and Nature Reserve and, one as Nature Reserve
- Native Title claims exist over four of the sites and may also be lodged over the remaining two.

Table 10 Tenure and primary management agency for Ramsar sites in the Kimberley

Site	Current Tenure	Management Agency	Proposed Tenure*
Lake Argyle	Water Reserve	WRC	Water Reserve
Lake Kununurra	Water Reserve	WRC	Water Reserve
Ord River Floodplain	Nature Reserve	CALM	Nature Reserve
Roebuck Bay	State Waters, +	none	Marine Park
Eighty Mile Beach	State Waters, VCL	none	Marine Park
Mandora Marshes	Pastoral Lease	Anna Plains Station	Nature Reserve

Note: WRC - Water and Rivers Commission
CALM - Department of Conservation and Land Management
** - Proposed tenure based on Marine Parks and Reserves Selection Working Group (1994) and Burbidge et al. (1991)*

Table 11 Multiple land use of Ramsar-listed wetlands in the Kimberley

Lake Argyle: irrigation water storage, power generation, mine site water supply, Aboriginal cultural activities, biodiversity conservation, recreation, tourism, aquiculture, fishing, cattle production.

Lake Kununurra: irrigation water supply, environmental flow for the lower Ord River, Aboriginal cultural activities, biodiversity conservation, tourism, storm water discharge.

Ord River Floodplain: biodiversity conservation, tourism, recreation, road and power access way between Kununurra and Wyndham, Aboriginal cultural activities.

Roebuck Bay: pearl cultivation, tourism, biodiversity conservation, recreation, Aboriginal cultural activities, shipping, fishing, storm water and waste water, cattle production.

Eighty Mile Beach: biodiversity conservation, tourism, Aboriginal cultural activities.

Mandora Marshes: cattle production, biodiversity conservation, Aboriginal cultural activities (?), tourism.

Note: Underlined use is the current primary management purpose.

In calling for management plans for Ramsar-listed wetlands the Contracting Parties recognised the need for plans to have an appropriate legal and administrative basis (Resolution C.5.7, Davis 1994). In Western Australia the legal and administrative basis for management are generally directly related to the tenure of the site.

The primary statutory basis for management planning and implementation for nature conservation is the Conservation and Land Management Act. In addition to land and waters administered by the Department, agreements can also be enter into for the management of freehold and pastoral leases under Section 16 of the Act.

Additions to the protected area system have only occurred at one site (Ord River Floodplain) in the six years since the sites were entered on the List of Wetlands of International Importance. In some cases it has been 20 years since proposals were made by State Government committees for the establishment of conservation areas. In promoting the concept of "wise use" of wetlands (Section 1.0) the Ramsar Convention does not require that wetlands designated on the List of Wetlands of International Importance become part of a protected area system. Opportunities to incorporate nature conservation as part of the multiple use of important wetlands, that are outside the protected are system, need to be explored.

If the changes in land tenure were to occur as recommended by the Marine Parks and Reserves Selection Working Group (1994) and the Department of Conservation and Land Management (Burbidge *et al.* 1991) then management plans could be implemented for four of the six sites under the Conservation and Land Management Act (Table 10).

While changes in tenure would be the optimum outcome for the Department of Conservation and Land Management, the lack of vesting should not continue to be a justification for a lack of coordinated management at Ramsar sites.

Native Title Legislation places additional complexity on potential changes in tenure because of the legal rights it gives to Native Title claimants.

Proposals for the clarification of planning and management responsibilities are presented below.

9.1.2 Cooperative Arrangements with the Water and Rivers Commission (Lake Argyle and Lake Kununurra)

At Lake Argyle and Lake Kununurra no changes in tenure have been proposed. These areas are vested with the Water and Rivers Commission and as such the management plans developed should have, as a minimum, a statutory basis under legislation administered by the Commission. It is understood that the Water Conservation Act is at present being revised to enable it to be applied on a State wide basis (Luke Penn, Water and Rivers Commission pers. comm.) and that in this form it would provide a suitable statutory basis for management planning and implementation.

The Department of Conservation and Land Management should have a formal role in the development of management plans for these two Ramsar-listed wetlands because of its responsibility for implementation of the Ramsar Convention in Western Australia. The mechanism for this could be a consultative committee established with the

Kununurra Office of the Water and Rivers Commission to provide advice on Ramsar related issues. These consultative arrangements could also pick up issues associated with the proposed Packsaddle Swamp Nature Reserve and the proposed Carr Boyd Range and Lake Argyle National Park. The consultative committee could be used to discuss the development of a management plan for Lake Argyle and Lake Kununurra. It could also consider including other agencies and stakeholders in the consultations (especially Aboriginal Traditional Owners).

Action 1a: The Regional Manager establishes a mechanism (committee) for consultation with the Kununurra Office of the Water and Rivers Commission on Ramsar issues related to management of Lakes Argyle and Kununurra.

Action 1b: The Regional Manager uses the committee to discuss development of linked management plans for the two wetlands, which would be implemented under an amended Water Conservation Act.

9.1.3 Advancing Marine Park Proposals (Ord River Floodplain, Roebuck Bay, Eighty Mile Beach)

Marine Park proposals have been recommended by the Marine Parks and Reserves Selection Working Group for Roebuck Bay, Eighty Mile Beach and the marine and Ord River area adjacent to the Ord River Floodplain. There is currently no cross-sectorial management agency for these areas. The process involved in implementing the Marine Park recommendations is to obtain the approval of the Ministers for the Environment, Fisheries and Mines to establish an advisory committee to consider the proposals and, if considered appropriate, develop a Notice of Intent for each site.

Before commencing a public management planning process for these three Ramsar sites it is important that the Department clarify with the Minister for the Environment a timetable for advancing the Marine Park proposals. A clear understanding of the status of the Marine Park proposals will greatly assist community participation in any planning process.

Consideration should be given to combining the process for the establishment of Marine Parks at Eighty Mile Beach and Roebuck Bay because of similar issues and stakeholders.

The proposed development of a fisheries management plan for the lower Ord River by the Department of Fisheries is important in the context of the Marine Park proposals for the lower Ord River.

Management planning for Roebuck Bay, Eighty Mile Beach, and the Ord River Floodplain should be incorporated into the process for the establishment of Marine Parks at these sites.

Action 2a: The Regional Manager informs the Marine Branch and the Policy Section of the Department that a fisheries management plan is to be prepared for the lower Ord River and liaises with the Fisheries Department on development of the Marine Park proposal for the eastern section of Cambridge Gulf. (Rec. 23).

Action 2b: The Regional Manager requests the Executive Director to obtain in-principle approval from the Minister for the Environment to advance the Marine Park proposals for Roebuck Bay, Eighty Mile Beach and areas adjacent to the Ord River Floodplain. (Rec. 24, 38, 50).

Action 2c: If in-principle approval is given to advance the Marine Park proposals, the Regional Manager seeks advice from the Executive Director on the arrangements, order, timetable and resourcing as these may have State-wide implications. (Rec. 25, 39, 51).

Action 2d: Following clarification of details for advancing the Marine Park proposals, the Regional Manager acts to ensure that management planning under the Conservation and Land Management Act is combined with the requirements for establishment of a Marine Park. (Rec. 26, 40, 52).

At Eighty Mile Beach additional information is required to assist in determining potential boundaries for a Marine Park. The Marine Parks and Reserves Selection Working Group (1994) recommended that Royal Australasian Ornithologists Union be requested to provided advice based on results of shorebird research conducted at the site.

Action 2e: The Regional Manager seeks advice from the Royal Australasian Ornithologists Union on the results of their studies on shorebirds especially the implications for defining boundaries for the proposed Eighty Mile Beach Marine Park. (Rec. 49).

If it is determined that Marine Parks will not be established at these three sites before the next Conference of Parties to the Ramsar Convention (1999) then alternative mechanisms should be developed to enable coordinated management. In the case of the Ord River Floodplain this does not present any problems because the area is a Nature Reserve and the statutory planning process can be applied to the Ramsar-listed area.

For Roebuck Bay and Eighty Mile Beach it would be important to establish a consultative management committee chaired by the Department of Conservation and Land Management in its capacity as the State implementation agency for the Ramsar Convention. Key stakeholders to consider as part of the committee are: the Department of Fisheries, Shire of Broome, Broome Port Authority, Pearling Association, Aboriginal Traditional Owners, Kimberley Tourism Association.

Action 2f: If by July 1997 it is clear that establishment of the Marine Parks will not be substantially advanced by 1999, the Regional Manager establishes a consultative management committee for Roebuck Bay and Eighty Mile Beach and starts a management plan for the Ord River Floodplain (Rec. 27, 41, 53).

9.1.4 Mandora Marshes

Mandora Marshes is currently managed by Anna Plains Station for cattle production. It is understood that the Department of Conservation and Land Management has tried over several years to acquire the Mandora Marshes section of the Anna Plains Pastoral Lease. It has also discussed the development of a management agreement for the area under Section 16 of the Conservation and Land Management Act. These negotiations have not been successful (Dave Hampton, Conservation and Land Management, pers. comm.).

The Department should continue to seek agreement with Anna Plains Station on management arrangements for the Mandora Marshes. These discussions should focus on agreement to fence the freshwater springs inside the fenced area of the lease.

Action 3: The Regional Manager ensures that the focus of the Department's effort on the Mandora Marshes is to establish and implement an appropriate management regime and that the Department has a long-term goal to implement the Nature Reserve proposals. (Rec. 64).

9.2 Urgent Site Management Action

Mandora Marshes

There is a need for urgent action at Mandora Marshes because of the ecological change that is occurring to the freshwater soaks inside the fenced portion of the site. Discussions need to be continued with the Station Manager to establish a suitable agreement for the protection of these springs. The issue of water points along the southern edge of the marsh needs to be addressed in these discussions.

Additional fieldwork and aerial photo interpretation is needed to identify all of the freshwater soaks. This will provide the basis for fencing plans and costings. Options for Commonwealth Government funding should be explored, notably the Save the Bush Program.

Action 4a: The West Kimberley District Manager follows up preliminary discussions with the Manager of Anna Plains Station with the aim of fencing off Saunders and other freshwater springs along the south side of the western claypan by the end of 1997. (Rec. 55).

Action 4b: The West Kimberley District Manager seeks assistance from within the Department to map the freshwater springs outside the fenced area of Anna Plains Station and implement measures to minimise impacts from camels and cattle by the end of 1998. (Rec. 56).

Australia has an obligation under Article 3 of the Ramsar Convention to inform the Ramsar Bureau "*at the earliest possible time*" of adverse changes to the ecological character of listed wetlands caused by human activities. The Montreux Record has been developed under the Ramsar Convention to highlight sites where "adverse change in ecological character has occurred, is occurring, or is likely to occur, and

therefore in need of priority conservation attention" (Ramsar Resolution VI.1). The Department of Conservation and Land Management needs to consider if it will seek to have the site listed on the Montreux Record.

Action 4c: The Regional Manager advises the Executive Director of the adverse changes occurring in the ecological character of the Mandora Marshes. This advice should outline the action that is being taken and give details on proposed resourcing and timetable. (Rec. 57).

Action 4d: The Department of Conservation and Land Management informs Environment Australia of the status of the ecological character of Mandora Marshes and the actions that are being taken. (Rec. 58).

9.3 Monitoring and Research Needed for Management

Several issues should be addressed in regard to developing the ecological information base needed for management of the sites.

9.3.1 Lakes Argyle and Kununurra

Lake Argyle

A greater understanding of the ecology of the lake is needed, especially how management of water levels and grazing of the margins could be optimised for ecological goals. A detailed scientific case will need to be presented if trade-offs are to be obtained with water supply and cattle production. An understanding of the response of introduced plant species to changes in water supply and cattle production would be an important component of this research.

Action 5: The Regional Ecologist encourages researchers within the Department and the Water and Rivers Commission to help develop long-term research programs on the relationship between water levels and the biota of Lake Argyle. A pilot study of the impact of cattle grazing on fringing vegetation should be a component of this work. (Rec. 1).

Lake Kununurra

It was clear from the brief fieldwork that the ecological attributes of the lake have changed considerably since the nomination information was prepared in 1989. These changes have been underpinned by the massive proliferation of cumbungi which has caused structural habitat modification characterised by infestation of margins and shallow water by tall, dense aquatic vegetation. Some of the fauna values for which the lake was originally noted (e.g. concentrations of waterfowl) have probably been much reduced. There is a need to update the Information Sheet for Lake Kununurra and in this recognise that there will continue to be significant changes in the ecological attributes until the lake reaches a dynamic equilibrium.

Action 6a: The Regional Ecologist updates the Ramsar Information Sheet for Lake Kununurra, including revised information on the site's ecological character and recognition of the dynamic changes that will continue to occur at the lake. (Rec. 12).

It is important to ensure that commercial fishing occurring in the lake is being conducted at a sustainable level and that all measures are being taken to minimise the catch of non-target species. Additional studies or data collection may be needed.

Action 6b: The Regional Manager consults with the regional office of the Department of Fisheries providing details on the Ramsar Convention and seeking information on management of the fishery at Lake Kununurra. (Rec. 11).

9.3.2 A Regional Wetland Monitoring Program

A program needs to be implemented to monitor the ecological character of all the Ramsar-listed wetlands in the Kimberley. This should be addressed on a regional (and perhaps State wide) basis to assist in developing a sound systematic methodology.

A framework for designing a wetland monitoring program, based on that of Finlayson (1996b), has been developed and is shown in Figure 9. The framework is not a prescriptive recipe for any particular monitoring program. It simply provides a series of steps, in a logical sequence, that can be used by wetland managers and planners, working in partnership with local users and managers, to design a monitoring program based on their particular circumstances and needs. Arrows are used in Figure 8 to illustrate the feedback which enables assessment of the effectiveness of the monitoring program in achieving its objectives.

Andrew Storey (Consultant to the Department) and Jim Lane (Principal Research Scientist) are currently developing a methodology for monitoring Ramsar sites, with funding from Environment Australia. Ord River Floodplain and Eighty Mile Beach have been included in the study (Jim Lane pers. comm.). This study should form an important base for the development of an appropriate monitoring program for the Kimberley sites.

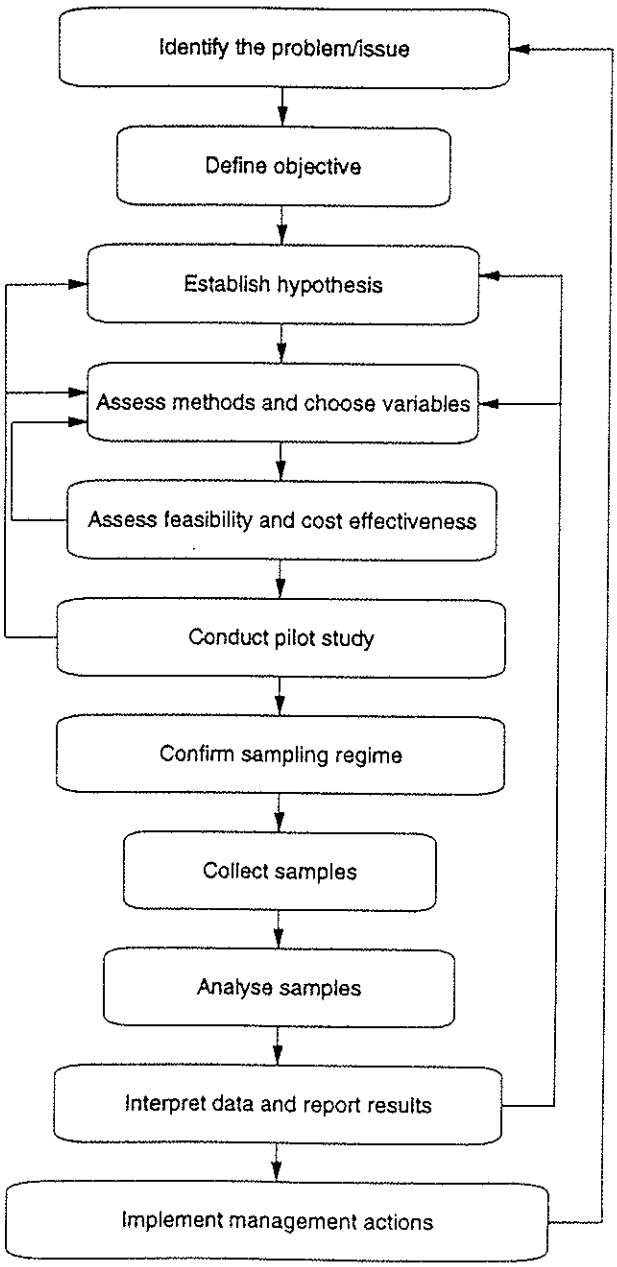
Community groups and other government agencies can play an important role in the implementation of a monitoring program. Representatives of groups and agencies active at the sites should be involved in the development of the monitoring program.

Action 7: The Kimberley Regional Ecologist, in consultation with the West and East Kimberley Offices, seeks specialist advice on development of a regional program to monitor changes in the ecological character of Ramsar sites in the Kimberley (Rec. 2, 10, 20, 34, 44, 59).

9.4 Special Interests of Aboriginal Communities (Native Title)

All the wetland sites, with the exception of Eighty Mile Beach and Mandora Marshes, are part of Native Title claims which have been lodged with and accepted by the National Native Title Tribunal. Once the mediation phase has commenced this places a heavy burden on the claimants in terms of the time and resources required to prepare for mediation and to undertake the mediation itself. In the Broome area, where a number of Native Title claims have been lodged, claimants are involved in meetings on a daily basis. In addition, separate but related negotiations are being conducted between the claimants, the State Government and the Broome Shire relating to proposed developments in Broome.

Figure 9. A framework for designing a monitoring program (based on that prepared for assessing water quality using bio-indicators as presented by Maher & Norris 1990 and adapted by Finlayson 1994)



In the Kununurra/Wyndham area the wetland sites form part of the Miriuwung Gajerrong No. 1 Native Title claim. Tribunal mediations are currently being undertaken with the interested parties. There are also negotiations between the claimants, the Shire and the State Government relating to Stage 2 of the Ord River Irrigation Project.

As a consequence of these other activities and the day to day management of local issues, the Aboriginal stakeholders have little time available to spend on discussing proposals which will not have an immediate impact. This should not be misinterpreted as a lack of interest in the future management of wetland areas. On the contrary, all expressed a keen desire to be involved in each stage of the process and to be kept informed. However, it will be important in developing management plans for the wetlands to give due recognition to these other projects, particularly when estimating the time allocated for consultations with Aboriginal communities.

The consultations relating to Lake Gregory and Roebuck Bay in particular highlight how important it is to ensure that consultations with Aboriginal stakeholders are undertaken at the earliest possible time, preferably when potential protected areas are identified. The lack of early consultation can resulted in the creation of a barrier which has to be overcome before further negotiations can be successfully undertaken.

As with all the negotiations relating to Aboriginal attachment to land it is important to ensure that the people who are consulted are those who are able to speak for that country. The most important aspect of the work undertaken prior to the lodgment of a Native Title claim is the identification of the Traditional Owners for the country under claim. In addition, this process also brings to the fore the most appropriate channel through which to undertake negotiations relating to Native Title claims. In most cases one organisation is appointed to represent people's interests. However, in some cases the claims are complex and there are intra-Aboriginal tensions that are best accommodated by the use of more than one representative organisation.

It is important that the decisions Aboriginal people have made about who should represent their interests is respected and utilised when deciding how to initiate negotiations relating to the future management of lands with Native Title claims. The organisation(s) nominated by Aboriginal people to represent their Native Title interests is identified for each site.

Action 8a: The Regional Manager notes the special interests that Aboriginal people have in the Ramsar sites and ensures that these interests are included in future discussions on management of these sites, that the State Government's Native Title Unit is aware of the Ramsar-listed status of the sites and of the interests of the Department, and that full recognition is given to any legal proceedings when making decisions related to the Ramsar sites. (Rec. 9, 18, 29, 43).

Action 8b: The Regional Manager requests the Kimberley Officer for the National Native Title Tribunal to brief the East and West Kimberley District Offices on the Native Title Act and the operations of the Tribunal.

9.5 Development and Implementation of Management Plans

9.5.1 Boundaries of Ramsar-listed Wetlands

There is a poor understanding and awareness of the boundaries of each Ramsar-listed wetland. Much of this exists because the nomination documentation available to the public and at the District Officers consists of maps of a scale of 1:400 000 to 1:1 000 000. This means that the boundary lines on some of these maps are about 2 km wide.

It is essential that the Districts have a clear understanding and detailed maps of the Ramsar boundaries.

Action 9a: The Kimberley Regional Ecologist, in consultation with the West and East Kimberley Offices, works with the Department's wetland research officers to define in detail the boundaries of each Ramsar site. (Rec. 3, 13, 35, 45, 49, 60).

Action 9b: The Regional Manager ensures that detailed maps showing the boundaries of the Ramsar-listed areas are available at the West and East Kimberley Offices. The maps should also be provided to other managers of the sites. (Rec. 4, 14, 21, 36, 46, 61).

Action 9c: The Regional Manager ensures that the Department forwards a copy of the detailed site maps to Environment Australia. (Rec. 5, 15, 22, 37, 47, 62).

At present Eighty Mile Beach and the Mandora Marshes are combined on the List of Wetlands of International Importance as "Eighty Mile Beach". The two wetlands are geographically separate and ecologically distinct and each qualifies as a Wetland of International Importance on several criteria. If the two sites are to be managed as independent wetlands then the Department of Conservation and Land Management should give consideration to having the sites individually listed under the Ramsar Convention.

Action 9d: The Regional Manager considers taking action to have the present Ramsar listing of Eighty Mile Beach revised so that Eighty Mile Beach and Mandora Marshes become individually designated on the List of Wetlands of International Importance. (Rec. 47, 63)

9.5.2 Management Plans

A major limitation for the development of management plans is a lack of staffing and resources. The Kimberley Region does not have any Planning Officers. It does however have a Regional Ecologist based at the East Kimberley Office and a Conservation Officer in West Kimberley Office who would be able to provide expert advice in the development of management plans.

The second important limitation is the ability of the community and local government agencies to provide input into a planning process. The stakeholder groups divide into an East Kimberley cluster around Kununurra and Wyndham and a second cluster

mainly associated with Broome. The communities at Kununurra and Wyndham are currently being asked to participate in several planning studies associated with the development of irrigation areas and Native Title claims.

The Department of Conservation and Land Management is at present preparing a Regional Management Plan for the Kimberley. While it is not proposed that this address the details of site action it may be possible for it to address some of the action statements in this report.

> **Action 10:** The Regional Manager ensures that, where possible, the information and conclusions of this report are incorporated in the Regional Management Plan for the Kimberley.

It is difficult to provide detailed recommendations on the order in which detailed management plans should be developed for the Ramsar sites. The processes by which planning and management responsibilities are clarified will have a considerable bearing.

Progress at Lake Argyle and Lake Kununurra is dependent on consultation with the Water and Rivers Commission. It would be possible to proceed with Ord River Floodplain, but the issue of Marine Parks needs to be addressed. Marine Parks are the crucial issue at Roebuck Bay and Eighty Mile Beach and Marine Parks appear to be the only means of providing a framework for a statutory management plan for these areas. At Mandora Marshes the development of a management plan will remain unrealistic until agreement is reached with the lessee of Anna Plains Station.

The crucial issue to be addressed is advancing the Marine Parks in the Kimberley.

Funding for Management Planning

The Australian National Report to the 1996 Conference of Parties to the Ramsar Convention stated that consideration was being given to the development of MoUs between the Commonwealth and State/Territory Government's that would "*clearly set out roles and responsibilities, and would prompt the development of appropriate site management plans*" (Australian Nature Conservation Agency 1996). At the time that the MoUs were proposed they would have been between the Commonwealth and State/Territory implementation agencies for the Ramsar Convention. That is, in Western Australia, an agreement between the (then) Australian Nature Conservation Agency and the Department of Conservation and Land Management.

The passing of Commonwealth legislation for the establishment of the Natural Heritage Trust in December 1997 is likely to impact on the proposed MoUs for implementation of the Ramsar Convention. The Commonwealth and State/Territory cooperative agreements for the implementation of Trust programs may now pick-up on implementation of the Ramsar Convention.

Under the Rivers Package of the Natural Heritage Trust, the National Wetlands Program is to receive $ 8 million over 5 years. One of the emphases of this Program is proposed to be management planning for Ramsar-listed wetlands (Natural Heritage Trust 1996). The National Wetlands Program is administered by the Wetlands, Waterways and Waterbirds Unit of Environment Australia (Biodiversity Group).

Action 11a: The Regional Manager ensures that issues related to implementation of the Ramsar Convention are addressed in the Commonwealth/State discussions on implementation of the Natural Heritage Trust.

Action 11b: The Regional Manager obtains funding from the Wetlands, Waterways and Waterbirds Unit of Environment Australia (Biodiversity Group) to support management planning at Ramsar-listed sites in the Kimberley.

In addition to giving attention to the development of a management plan for the Ramsar-listed sites it is important that the Department of Conservation and Land Management actively participate in other planning and management process for these and adjacent areas.

Action 12: The Regional and District Managers continue to support staff involvement in government and community planning for Ramsar-listed wetlands and adjacent areas. (Rec. 8, 18, 28, 42, 54).

9.6 Summary of Recommendations and Actions

An overview of the Actions derived from the Recommendations is given in Table 12.

Table 12 Overview of Actions arising from Conclusions.

Theme	Action No.	description / keywords	Relevant Recommendations
Cooperative Arrangements	1a, 1b	consult with Water and Rivers Commission and develop management plans (Arg, Kun)	6, 7, 16, 17
Advance the Marine Park Proposals	2a-2g	link marine park and management planning processes; specific actions re Ord and 80M (Ord, Roe, 80M)	23, 24, 25, 26, 27, 38, 39, 40, 41, 49, 50, 51, 52, 53
Mandora Marshes	3, 4a-4d	implement management regime, especially fencing of springs against cattle damage and mapping of the springs; advise on changes in ecological character (MM)	55, 56, 57, 58, 64
Monitoring and Research	5, 6a, 6b, 7	develop long-term research on water-levels, biota and grazing impact (Arg); update Ramsar Information Sheet (Kun) ; develop regional program for monitoring change in ecological character of Ramsar sites	1, 2, 10, 11, 12, 20, 34, 44, 59
Aboriginal Interests	8a, 8b	ensure that Aboriginal interests, including Native Title, are included in discussions on site management planning (all sites)	9, 19, 29, 43
Ramsar Site Boundaries	9a - 9d	define in detail the Ramsar site boundaries and make maps available (all sites); consider splitting 80M Ramsar site	3, 4, 5, 13, 14, 15, 21, 22, 35, 36, 37, 45, 46, 47, 48, 49, 60, 61, 62, 63
Development of Management Plans	10, 11a, 11b, 12	incorporate these actions into Regional Management Plan; seek support for implementation via Natural Heritage Trust and National Wetlands Program; maintain involvement in other relevant planning processes.	8, 18, 28, 42, 54

Notes:

Arg	=	Lake Argyle	Recommendations 1-9
Kun	=	Lake Kununurra	Recommendations 10-19
Ord	=	Lower Ord Floodplain	Recommendations 20-29
Roe	=	Roebuck Bay	Recommendations 34-43
80M	=	Eighty Mile Beach	Recommendations 44-54
MM	=	Mandora Marshes	Recommendations 55-64

Lake Gregory (Recommendations 30-33) is not included in Table 12 because the Actions derived in Section 9.0 relate only to Ramsar sites.

9.7 References

Australian Nature Conservation Agency. 1996. National Report for Australia. Prepared for the Sixth Meeting of the Conference of Contracting Parties to the Convention on Wetlands (Ramsar Convention), Brisbane, Australia, 19-27 March 1996. Canberra, Australia.

Burbidge, A.A., McKenzie, N.L., and Kenneally, K. 1991. *Nature Conservation Reserves in the Kimberley, Western Australia*. West Aust. Department of Conservation and Land Management.

Davis, T.J. (ed.), 1994. *The Ramsar Convention Manual: A Guide to the Convention on Wetlands of International Importance especially as Waterfowl Habitat.* Ramsar Convention Bureau, Gland, Switzerland.

Marine Parks and Reserves Selection Working Group. 1994. *A Representative Marine Reserve System for Western Australia*. Department of Conservation and Land Management, Western Australia.

Natural Heritage Trust. 1996. Fact Sheet, 2: The Rivers Package. http://www.erin.gov.au/portfolio/library/minister_env/nhtrp.html. 12/12/96.

Ramsar Convention Bureau. 1996. Convention on Wetlands Strategic Plan: Objectives and Actions 1997-2002. 6 th Meeting of the Conference of Contracting Parties, Brisbane, Australia 19-27 March 1996. Conference Proceedings Vol. 5/12.

Appendix 1 Work Specifications set by the Department of Conservation and Land Management

1. The Department of Conservation and Land Management has been awarded a consultancy under the auspices of the National Wetlands Program (ANCA) to undertake work entitled "Management planning for Ramsar Sites in the Kimberley region of Western Australia: Phase 1." This Contract is a sub-contract within the context of CALM' s obligations under the above consultancy.

2. In the first instance it is intended that the period under which the work should take place is for a period of six months from the date of signing of the contract. Any changes to this schedule envisaged by either party must be advised in writing to the other at the earliest possibility and acceptance of any change must be agreeable to both parties.

3. The Consultant shall undertake a thorough assessment of the management status of the four existing Ramsar sites in the Kimberley region of Western Australia and the proposed Lake Gregory Ramsar site. In doing so the Consultant shall ensure that the review takes into account the Ramsar guidelines on management planning for Ramsar sites and the recommendations regarding the essential character of wetlands and the need for zonation within wetland reserves. Both concepts were adopted by the the Fifth meeting of Contracting Parties to the Ramsar Convention and described in the Annex to Resolution C.5.7. and Recommendation C.5.3.

4. As soon as practical and in close consultation with the Project Supervisor advise and consult with relevant landowners and Aboriginal groups regarding the management planing study and the implications under the Ramsar Convention for these areas.

5. Undertake a thorough analysis of existing and potential threats to the ecological character of these sites from activities occurring, or proposed, at or near the site and within the surrounding catchment.

6. Assess the cultural heritage significance of each of the wetlands.

7. Assemble information needed as background for the preparation of management plans for these sites.

8. Identify critically important investigations or other actions required prior to preparation of plans for these sites.

9. Apart from literature reviews the Consultant is required to undertake field work of a substantive nature to inspect the sites, gather information and consult with relevant parties.

10. The Consultant will be required to submit a progress report approximately three months after the project start.

11. The Consultant is required to submit four typed copies of the final report.

12. A copy is also required on a 3.5 inch diskette formatted to IBM XT/AT compatible specifications, preferably in Word 6 format.

13. All reports produced under this contract will remain the property of the Executive Director Department of Conservation and Land Management. Material may be used otherwise only with the written permission of the Executive Director Department of Conservation and Land Management.

14. All reports and other publications resulting from the work provided under this contract shall acknowledge that financial assistance was provided by the Australian Nature Conservation Agency through the National Wetlands Program.

15. All reports shall note that copyright in the document vests in the Executive Director Department of Conservation and Land Management and shall carry an agreed disclaimer of responsibility for the views expressed.

Appendix 2 Voluntary questionnaire for assessing whether or not a site should be placed on the Montreux Record of Ramsar sites where adverse change in ecological character has occurred, is occurring, or is likely to occur (Finlayson 1997).

Section One: Information for assessing possible inclusion of a listed site in the Montreux Record

Essential items

- Name of site
- Ramsar criteria for listing the site as internationally important
- Nature of the change in ecological character/potential for adverse change
- Reason(s) for adverse change, or potential adverse change, in ecological character

Additional items which may be included

- Date Information Sheet on Ramsar Wetlands submitted
- Date and source of Information Sheet updates (e.g. National Reports, specific survey)
- Benefits and values derived from the site
- Extent to which values and benefits derived from the site have decreased or changed
- Monitoring program in place at the site, if any (technique(s), objectives, and nature of data and information gathered)
- Assessment procedures in place, if any (how is the information obtained from the monitoring program used)
- Ameliorative and restoration measures in place or planned (if any) so far
- List of attachments provided by the Contracting Party (if applicable)
- List of attachments provided by the Ramsar Bureau (if applicable)

Section Two: Information for assessing possible removal of a listed site from the Montreux Record

- Success of ameliorative, restoration or maintenance measures (describe if different from those covered in Section One of this questionnaire)
- Proposed monitoring and assessment procedures (describe if different from those in Section One of this questionnaire)
- Extent to which the ecological character, benefits and values of the site have been restored or maintained (provide details)
- Rationale for removing the site from the Montreux Record (refer to guidelines for operation of the Montreux Record, together with Section One of this questionnaire)
- List of further attachments (if applicable)

Appendix 3 Miriuwung Gajerrong No.1 Native Title Claimants and Claim Area

Lake Argyle, Lake Kununurra and Ord River Floodplain

Register of Native Title Claims

Registration Number: C00008

Body Application Lodged With: National Native Title Tribunal **Ref.No.:** WC94/2

Date Lodged: 6 April 1994 **Date Accepted:** 26 May 1994

Date Registered: 6 April 1994

Status: Referred to Federal Court **Date:** 7 February 1995

Registered Native Title Claimant: Ben Ward, John Toby and others (See attachment D).

Address for Service: C/- Greg Benn
Aboriginal Legal Service of Western Australia
Land & Heritage Unit
PO Box 8194
Stirling Street
PERTH WA 6849
Tel.No.: (09) 265 6666 Fax.No.: (09) 221 1767

Description of Persons Claimed to Hold Native Title:
The Miriuwung people, The Gagerrong people

Area Covered

State/s: Northern Territory, Western Australia

ATSIC Region/s or TSRA: Wunan Regional Council

Local Government Area/s: Wyndham-East Kimberley Shire

Location: Land & water in & around Kununurra, Wyndham, Cambridge Gulf, Turkey Creek in WA & the Keep River NP in the NNTT region; W Northern Territory. The area incs Lacrosse, Kanggurrya, Pelican, Monsmont

Description: Land and water in and around Kununnurra, Wyndham, Cambridge Gulf, Turkey Creek in Western Australia and the Keep River National Park in the NNTT region; West Northern Territory. The area includes Lacrosse, Kanggurrya, Pelican, Monsmont and Guy Reid Islands and Lake Kununurra and Lake Argyle.
The area covered by the Application is clearly indicated in the attached series of 18 cadastral maps described below.
The boundary of the area covered by the Application is marked with a red line and includes all the coloured land within the red boundaries.
The Application includes land, inland waters, and coast as marked on the attached maps.
The different land status of each of the areas covered by the Application is represented in colour in each of the attached maps as follows:-
1. The areas shaded GREEN - represent various types of Reserve Land as identified below;
2. The areas shaded ORANGE - represent vacant crown land;
3. The areas shaded BLUE - represent inland waters;
4. The areas shaded RED - represent leasehold/freehold land as identified below;
5. The area shaded YELLOW - represents coastal tidal plains;
Following is a specific identification of the areas covered by the Application in relation to each cadastral map:-
(I) Western Australia
1. Medusa Banks SD 52-10, 1:250,000
a) Vacant Crown Land

(i) Vacant Crown Land - as indicated by the ORANGE shaded areas
(ii) Lacrosse Island
(iii) Kanggurryu Island
b) Reserves - as indicated by the GREEN shaded area
i) Pelican Island
ii) Conservation of Flora and Fauna 31967/671
c) Tidal grass plains dotted with natural springs as indicated by the YELLOW shaded area
2. Cambridge Gulf SD 52-14, 1:250,000
a) Crown Land - all land indicated by ORANGE shaded area
b) Reserves
i) For the Use and Benefit of Aboriginal Inhabitants 40536/690
ii) Natural Regeneration 35289/512
iii) Conservation of Flora and Fauna 42155
iv) Tropical Agriculture 18810/736
v) Public Utility 1061
vi) Public Utility 1166
vii) Public Utility 1060
viii) Point Spring Nature Reserve 2904/68
ix) Government requirements 31165/373
x) Public Utility 1064
xi) Resting Place for Travellers and Stock 8663
xii) Palm Springs Nature Reserve 42155
xiii) All other places indicated by the GREEN shaded area
c) Tidal Grass Plains dotted with natural springs - as indicated by the YELLOW shaded area
3. Lissadell SE 52-2, 1:250,000
a) Crown Land
i) Monsmont Island
ii) Guy Reid Island
iii) All other Vacant Crown Land indicated by the ORANGE shaded areas
b) Reserves
i) For Government Requirements 31165/373
ii) For Government Requirements 31165/374
iii) For Government Requirements 31165/380
iv) For Government Requirements 31165/12
c) Lease (King Location 701) - Land indicated by the RED shaded area is leased to the traditional owners
4. Burt Range NW 466-11NW, 1:25,000
a) Crown Land - all land indicated by the ORANGE shaded areas
b) Reserves
i) Recreation 41617/664
ii) Use and Benefit of Aboriginal Inhabitants 40260/2238
iii) Use and Benefit of Aboriginal Inhabitants 40536/690
iv) Agricultural Research Station 1063/321
v) Conservation and Recreation 31780
vi) National Park 37883/1636
vii) Natural Regeneration 35289/512
viii) Government Requirements 31165/373
5. Pincombe Range SW 4666-1 SW, 1:25,000
a) Crown Land
i) King Location 332
ii) King Location 328
iii) All other land as indicated by the ORANGE shaded area
b) Reserves
i) Native Paintings 32446/334
c) Lease (King Location 333 and 330) - land leased by traditional owners as indicated in the RED shaded area
6. Pincombe Range NW 4666-1 NW, 1:25,000
a) Crown Land
i) King Location 335
ii) King Location 339
iii) King Location 282
iv) King Location 323
v) All other land indicated by the ORANGE shaded area
7. Ivanhoe NE 4666-IV-NE, 1:25,000
a) Crown Land - as indicated by ORANGE shaded area
b) Reserves
i) Public Utility 1062
ii) Dumas Lookout 505
8. Ivanhoe SE 4666-IV-SE, 1:25,000
a) Crown Land - as indicated by the ORANGE shaded area
b) Reserves

i) Quarry 36951/514
ii) Park Land 38358/277
iii) Public Utility 1062
iv) Native Paintings 32446/234
v) All other land indicated by the GREEN shaded area
9. Deception Range NE 4666-III-NE, 1:25,000
a) Vacant Crown Land
i) Vacant Crown Land 715
ii) Vacant Crown Land 716
iii) All other land indicated by the ORANGE shaded area
b) Reserves
i) Natural Regeneration 35289/512 (including Lots 1,2,3 and 4 of Plan 18474 and Lots 2,3 and 4 of Plan 17045 which were part of a subdivision which did not proceed
ii) Conservation and Recreation 31780
iii) Cattle Experiments 30356/976
iv) Irrigation Works 29277/313
v) Protection of Diversion dam 37380/515
vi) Quarry 36951/514
vii) Gravel 30804/352
viii) Tropical Gardens 38368/768
ix) Recreation 29297/714
x) Foreshore and Recreation 41812/667
xi) National Park 37883/1636
xii) Use and Benefit of Aboriginal Inhabitants 31504/1180
xiii) All other land indicated by the GREEN shaded area
10. Kununurra Townsite ORD DH79 22.17 1:2,000
a) Reserves
i) Drainage 39000/2228
ii) Use and Benefit of Aboriginal Inhabitants 41401
iii) Use and Benefit of Aboriginal Inhabitants 31221/2229 -
iv) Recreation and Community Facilities 29799/77
11. Kununurra Townsite ORD DH79 23.16, 1:2,000
a) Vacant Crown Land - as indicated by the ORANGE shaded area
b) Reserves
i) National Park 37883/1636
ii) Recreation and Community Facilities 29799/77
12. Kununurra Townsite ORD DH79 23.15 1:2,000
a) Vacant Crown Land
i) King Location 715
ii) All other land indicated by the ORANGE shaded area
b) Reserves
i) Foreshore and Recreation 41812
13. Kununurra Townsite QRD DH79 23.17 1:2000
a) Reserves
i) Use and Benefit of Aboriginal Inhabitants 31221/2229
ii) Use and Benefit of Aboriginal Inhabitants 41401
iii) National Park 37883/1636
iv) Landscape Protection and Recreation 42441/2422
v) Drainage 39000/2228
vi) Park 39128/2230
vii) Recreation and Community Facilities 29799/77
14. Kununurra Townsite ORD DH79 23.18 1:2000
a) Vacant Crown Land - as indicated by the ORANGE shaded area
b) Reserves
i) Landscape Protection and Recreation 42441/2422
ii) Use and Benefit of Aboriginal Inhabitants 31504/1180
iii) Use and Benefit of Aboriginal Inhabitants 26600/233
iv) Use and Benefit of Aboriginal Inhabitants 31221/2229
v) Park 39128/2230
vi) Drainage 39000/2228
vii) All other land indicated by the GREEN shaded area
15. Kununurra Townsite ORD DH79 24.15 1:2000
a) Vacant Crown Land - as indicated by the ORANGE shaded area
b) Reserves
i) National Park 37883/1636
ii) Cattle Experiments, Department of Agriculture 30356/976
16. Kununurra Townsite ORD DH79 24.16 1:2000
a) Vacant Crown Land - as indicated by the ORANGE shaded area
b) Reserves
i) National Park 37883/1636
17. Kununurra Towsite ORD DH79 24.18 1:2000
a) Reserves
i) National Park 37883/1636

(II) Northern Territory
Location Fitzmaurice Sheet 7 1:500,000 (A4 extract only)
Keep River National Park (as indicated by the GREEN shaded area)
Aborignal Freehold (as indicated by the red shaded area) 3541, 3542 and 3863

Size: 6,350 sq km

Land and/or Waters: Land and Waters

Native Title Rights and Interest Claimed:
Possession, occupation, use and enjoyment of the area. Special and exclusive relationship with and connection to the area in accordance with traditional customs, laws, practices and usages such that the area comprised Miriuwung and Gajerrongs' traditional homeland.
(A) The Aboriginal people known as Miriuwung/Gajerrong ("Miriuwung/Gajerrong") are, and were, at and for some time before the acquisition of sovereignty over Western Australia by the British Crown ("the acquisition of sovereignty"), and have been since the acquisition of sovereignty, a community or society linked by a commonality and complex of social, economic and cultural practices, customs, usages and beliefs.
Particulars of common practices, customs, usages and beliefs among Miriuwung/Gajerrong and which determine membership of Miriuwung/Gajerrong:-
1. Possession, occupation, use and enjoyment of the land covered by this Application and identified in the attached maps ("the Land")
2. Residence on the Land
3. Geographical, topographical, ecological, environmental and climatic knowlege of the Land
4. Spiritual knowledge of the Land.
5. Belief in the special and exclusive relationship of Miriuwung/Gajerrong to the Land
6. Belief that the Land is the traditional homeland of Miriuwung/Gajerrong
7. Belief that the Land is Miriuwung/Gajerrong's land
8. Hunting and gathering food on the Land
9. Bearing, rearing and teaching children on the Land
10. Building and using shelter on the Land
11. Holding ceremonies on the Land
12. Conducting ceremonies concerning the Land
13. Conducting Law Business on the Land
14. Conducting Law Business concerning the Land
15. Conducting Men's Law Business on and concerning the Land
16. Conducting Women's Law Business on and concerning the Land
17. Holding meetings for secular purposes on the Land
18. Holding meetings for spiritual purposes on the Land
19. Using water from the Land
20. Digging for and using stones, ochres and minerals on and from the Land
21. Assumption of responsibility and acknowledgment of a spiritual obligation to care for the Land and particular places on the Land
22. Caring for the Land pursuant to spiritual obligations
23. Caring for the Land according to environmental requirements
24. Caring for the Land by burning the Land, harvesting produce and conducting Law Business
25. Maintaining and passing on to younger generations knowledge of the Land
26. Sharing and exchanging resources derived on and from the Land
27. Travelling on the Land
28. Visiting and/or camping at particular places on the Land
29. Recognition of particular connections of an individual to particular parts of the Land
30. Recognition of particular connections of an individual to particular parts of the Land by reference to multiple criteria, such criteria being one or a number of the following:
a) Place of birth
b) Place of mother's birth
c) Place of father's birth
d) Descent
e) Marriage
f) Kinship ties
g) Residence
h) Initiation and ritual entitlement
i) Spiritual affiliation
j) Caretakership of country and objects
31. Knowledge and use of language
32. Descent, including by adoption
33. Biological and marital family ties

34. Kinship ties
35. Use and application of a kinship system
36. Recognition of other persons who are Miriuwung/Gajerrong
37. Cultural beliefs and practices concerning death of a member of Miriuwung/Gajerrong
38. Attendance at funerals of deceased members of Miriuwung/Gajerrong and kinship obligations to attend funerals

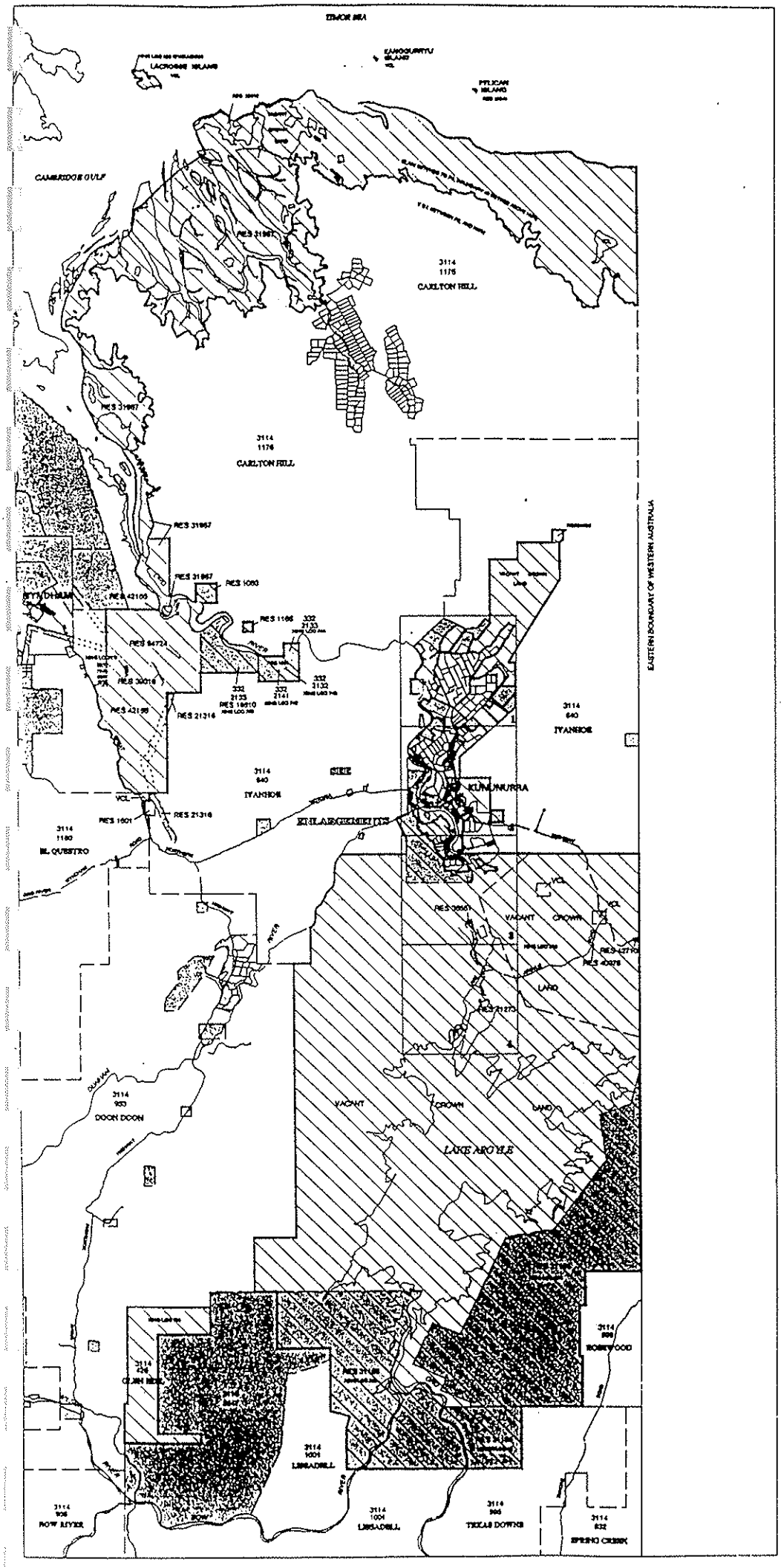
(B) At and for some time before the acquisition of sovereignty Miriuwung/Gajerrong had a special and exclusive relationship with and connection to the Land in accordance with traditional customs, laws, practices and usages such that the Land comprised Miriuwung/Gajerrong's traditional homeland.

Particulars of customs, laws, practices and usages giving rise to Miriuwung/Gajerrong's relationship with and connection to the land:-

Miriuwung/Gajerrong:

1. possessed, occupied, used and enjoyed the Land
2. resided on the Land
3. maintained a nomadic way of life on the Land
4. derived sustenance from the Land
5. hunted and gathered food on the Land
6. hunted and gathered food differently according to gender
7. women generally searched for food in groups and often took children with them
8. men hunted and searched for food alone or in pairs as well as in groups
9. bore, reared and taught their children on the Land
10. built and used shelter on the Land
11. held ceremonies on the Land
12. held ceremonies concerning the Land
13. men conducted Men's Law Business on the Land
14. women conducted Women's Law Business on the Land
15. held meetings on the Land for secular purposes
16. held meetings on the Land for spiritual purposes
17. dug for and used stones, ochres and minerals on and from the Land
18. cared for the Land according to environmental requirements
19. assumed responsibility and acknowledged a spiritual obligation to care for the Land and particular places on the Land
20. cared for the Land pursuant to spiritual obligations
21. cared for the Land by burning the Land, harvesting produce and conducting Law Business
22. men and women maintained and passed on to younger generations spiritual knowledge of the Land
23. men and women maintained and passed on to younger generations geographical, topographical, environmental and climatic knowledge of the Land
24. shared, exchanged and/or traded resources derived on and from the Land.
25. visited and/or camped at special or particular places on the Land
26. knew and avoided spiritually dangerous places on the Land
27. recognised particular connections of an individual to particular parts of the Land
28. recognised particular connections of an individual to particular parts of the Land by reference to multiple criteria. Such connections were recognised by reference to one or a number of the following:
    a) Place of birth
    b) Place of mother's birth
    c) Place of father's birth
    d) Descent
    e) Marriage
    f) Kinship ties
    g) Residence
    h) Initiation and ritual entitlement
    i) Spiritual affiliation
    j) Caretakership of country and objects
29. regulated access to parts of the Land according to initiation status, status of spiritual knowledge and gender
30. regulated access to the Land by persons who were not members of Miriuwung/Gajerrong
31. prevented the Land being harmed physically and spiritually by observing or engaging in the customs, laws, practices and usages referred to in subparagraphs B (1) to B (30) herein.

(C) Miriuwung/Gajerrong have substantially maintained the special and exclusive relationship and connection described in paragraph B herein to the Land.



MIRIUWUNG GAJERRONG

NATIVE TITLE CLAIM

WC94/2

ACCEPTED (26/05/94)

CURRENT LAND TENURE

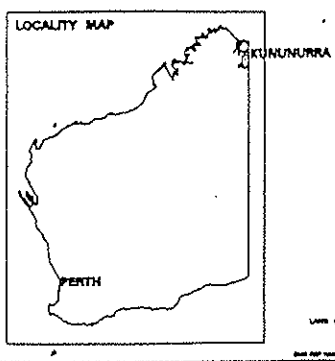
(AS AT 01/06/96)

Attachment 1
Map of claim area - A4
Attached 17/10/96
Page 1 of 7

LEGEND

- PASTORAL LEASE
- SPECIAL LEASE
- RESERVE
- ABORIGINAL RESERVE
- CONSERVATION RESERVE
- VACANT CROWN LAND
- CLAIM AREA

0 5 10 15 20 25
KILOMETRES



WALIS

94_2 A3I prepared by Land Claims Mapping Unit, WALIS

Appendix 4 Miriuwung Gajerrong No.2 Native Title Claimants and Claim Area

Ord River Floodplain

Register of Native Title Claims

Registration Number: C00018

Body Application Lodged With: National Native Title Tribunal **Ref.No.:** WC94/6

Date Lodged: 10 August 1994 **Date Accepted:** 27 March 1995

Date Registered: 10 August 1994

Status: Mediation commenced 31 October 1995

Registered Native Title Claimant: Ben Ward, John Toby and others (see Attachment B)

Address for Service: C/- Greg Benn
Aboriginal Legal Service of Western Australia
Land & Heritage Unit
PO Box 8194
Stirling Street
PERTH WA 6849
Tel.No.: (09) 265 6666 Fax.No.: (09) 221 1767

Description of Persons Claimed to Hold Native Title:
The Miriuwunga people, The Gajerronga people

Area Covered

State/s: Western Australia

ATSIC Region/s or TSRA: Wunan Regional Council

Local Government Area/s: Wyndham-East Kimberley Shire

Location: Land, inland waters and parts of the coast in and around Kununurra comprised primarily of pastoral leases

Description: Carlton Hill Pastoral Lease, Ivanhoe Pastoral Lease, Special Lease Molly Springs, Special Lease Ningbingi, Special Lease Cumbarumba, Special Lease Flying Fox Water Hole and Rosewood Pastoral Lease.
A6 The area covered by the Application is clearly indicated in the 3 attached A4 cadastral maps (Appendix A)
The boundary of the area covered by the Application is marked with a red line and includes all the coloured land within the red lines.
The Application includes land, inland waters and coast as marked.
The status of the land is Pastoral lease and is shaded Red.
The following is a specific identification of the areas covered by the Application in relation to each cadastral map:
1. MEDUSA BANKS SD 52-10, 1:250,000
a) Carlton Hill Pastoral Lease, King Location 709, Lease number 3114/1176
2. CAMBRIDGE GULF SD 52-14, 1:250,000
a) Carlton Hill Pastoral Lease, King Location 709, Lease Number 3114/1176
b) Ivanhoe Pastoral Lease, King Location 710 and 711, Lease No 3114/640
c) Special Lease Molly Springs, King Location 695
d) Special Lease Ningingi, King LOcation 696
e) Special Lease Cumbarumba, King Location 724
f) Special Lease Flying Fox Water Hole, King Location 725, 36 to 141, 143 to 156, 158 to 166, 168 to 178
3. LISSADELL SD 52-2, 1:250,000
a) Ivanhoe Pastoral Lease, King Location 710, Lease Number 3114/640

b) Rosewood Pastoral Lease, King Location 700, Lease number 3114/599
Please note that Reserve no. 41617 was withdrawn from the claim area on
16 August 1995.

Size: 7,625 sq. km.

Land and/or Waters: Land and Waters

Native Title Rights and Interest Claimed:
The native title rights and interests claimed by this Application are the maintenance of traditional law and culture of the Land, namely the possession, occupation, use and enjoyment of the whole of the Land and Waters, save and except for the areas of former Pastoral Lease and current Pastoral Lease, in respect of which the claimed native title rights and interest are limited to those rights and interests which are consistent with the reservations contained in the Land Acts of 1989 and 1933 (A), as amended, including Section 106(1)(f) and (2) of the Land Act 1933 and contained in the Pastoral Leases granted over the Land at various times.

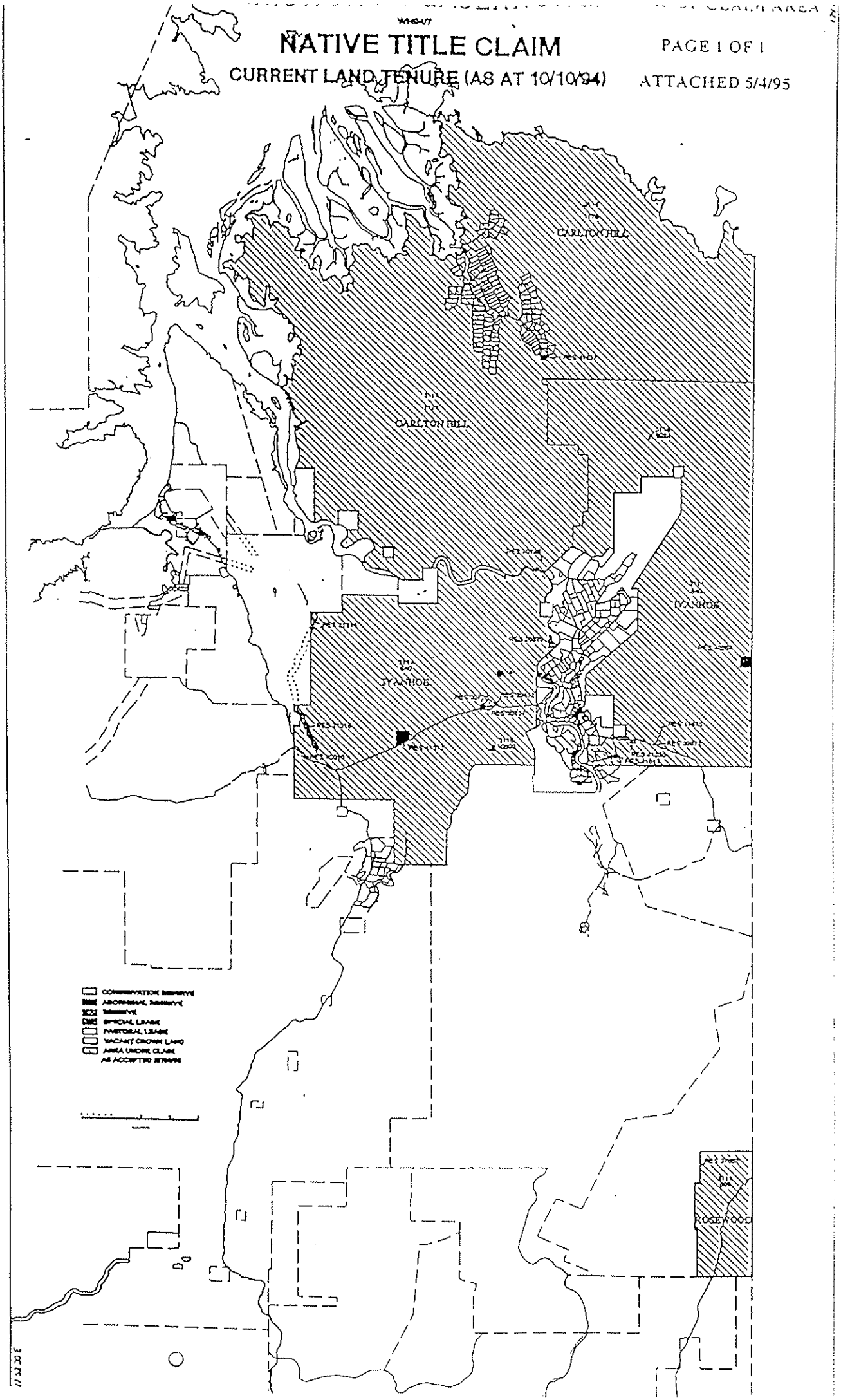
Draft Determination Sought:

NATIVE TITLE CLAIM

PAGE 1 OF 1

CURRENT LAND TENURE (AS AT 10/10/94)

ATTACHED 5/4/95



Appendix 5 Tjurabalan Native Title Claimants and Claim Area

Lake Gregory

Register of Native Title Claims

Registration Number: C00145

Body Application Lodged With: National Native Title Tribunal **Ref.No.:** WC95/74

Date Lodged: 25 October 1995 **Date Accepted:** 22 March 1996

Date Registered: 25 October 1995

Status: Notification Period Ends 17 June 1996

Registered Native Title Claimant: Palmer Gordon Ngalpil

Address for Service: C/- Michael O'Donnell
Kimberley Land Council
PO Box 377
DERBY WA 6728
Tel.No.: (091) 931 118 Fax.No.: (091) 931 163

Description of Persons Claimed to Hold Native Title:
Palmer Gordon Ngalpil, Sandy Cox, Rex John, Jamali (Chum Lee), Paraku (George Wallaby), David Skeen, Milnger Sturt, Kilampi, Boxer Milgner, Ivy Robertson, Gracie Long, Clancy Sturt, Mona Green, Wirrimanu (Robert Rallah), Nora Harry, Tomato Gordon, Bessie Doonday, Jimmy Smith, Speeler Sturt, Frank Lala, Winnie Wein, Veronica Lulu, Reggie Chungulla, Raymond Chungulla, Boxer Jalarku, Linda Yandanalli, Sambo Gordon Jampat, Chamia Napurulla, Ned Cox Yanpiri, Violet Campbell Barangnali, and Walmajarri or Jaru/Nyinin people

Area Covered

State/s: Western Australia

ATSIC Region/s or TSRA: Wunan Regional Council

Local Government Area/s: Shire of Halls Creek

Location: Land and waters south of Halls Creek in the Tanami Desert region of Western Australia

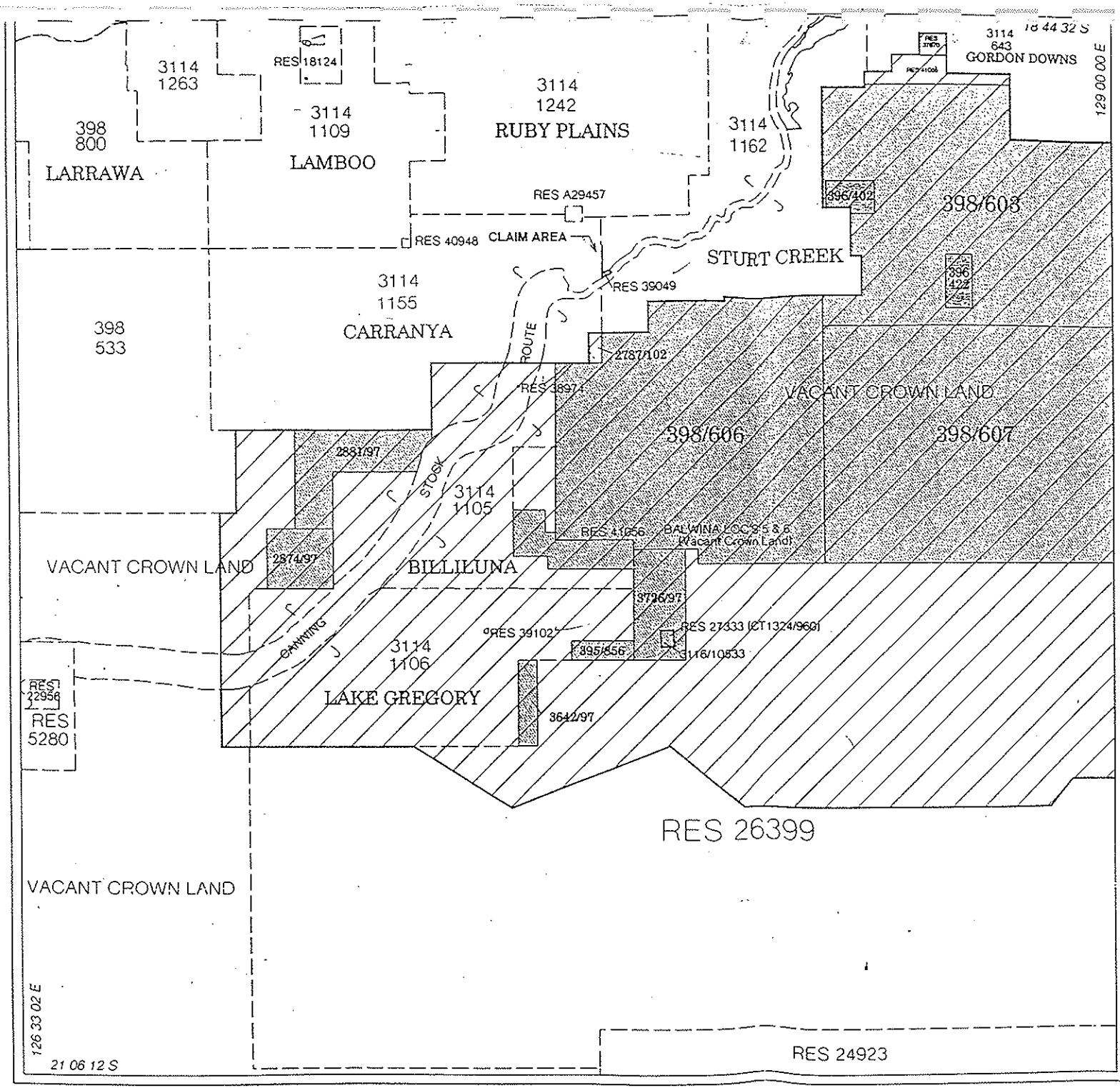
Description: The area covered by this application is wholly within the State of Western Australia. It is adjacent to the border between Western Australia and the Northern Territory.
The map is attached and marked with the letter"A" which accurately locates the boundaries of the area and which generally locates the area within the boundaries of the State of Western Australia.
The south western boundary is located at co-ordinate 127o00'00" / 20o21'42". From that point the boundary proceeds in a straight line in a northerly direction to the boundary of the Yougga Walla Pastoral Lease and then in an easterly direction along the said boundary to its south eastern corner and then in a northerly direction along the boundary of the Yougga Walla Pastoral Lease to the boundary of the Carranya Pastoral Lease and then in an easterly direction along the boundary of the Carranya Pastoral Lease to the boundary of the Billiluna Pastoral Lease and then follows the boundary line between the Billiluna and Carranya Pastoral Leases to the South Western boundary of the Sturt Creek Pastoral Lease and then along the boundary of the Sturt Creek Pastoral Lease to the South Western boundary of the Gordon Downs Pastoral Lease and then along the southern boundary of the Gordon Downs Pastoral Lease to the border of the State of Western Australia and the Northern Territory. The Eastern boundary runs along the border of the State of Western Australia and the Northern Territory to co-ordinate 129o00'00" / 20o26'18". The Southern boundary runs in a straight line from co-ordinate 129o00'00" / 20o26'28" to co-ordinate

128o54'15" / 20o26'18" and then in a straight line to co-ordinate
128o51'15" / 20o30'00" and then in a straight line to co-ordinate
128o10'00" / 20o30'00" and then in a straight line to co-ordinate
128o00'00" / 20o21'42" and then in a straight line to co-ordinate
127o38'54" / 20o30'00" and then in a straight line to co-ordinate
127o25'48" / 20o21'42" and then in a straight line to the commencement point.
The area also includes Reserve 37670 and Reserve 39049 as depicted in the map attached and marked with the letter "B".
The area does not include the lands held on trust for a native mission station at Balgo registered in the name the Roman Catholic Bishop of Broome and being all the land described in Certificate of Title 1324/960. It also does not include the area covered by and described in Special Lease No.3116/10533.
Indigenous named places that exist within the area include Mulan, Kururrungu, Kundat Djaru, Tartpu, Kampinj, Lirrankarni, Mintipungu and Paruku.

Size: 25902 sq kms

Land and/or Waters: Land and Waters

Native Title Rights and Interest Claimed:
The Applicants and other persons with whom they claim to hold native title over the area covered by the application continue to follow the traditional law and customs and maintain the traditional connection with the land that those laws and customs require and which their ancestors followed before the acquisition of sovereignity over the land by the British Crown.
The applicants assert as follows:
a) Pastoral Lease 3114/1005 (Billiluna) and Pastoral Lease 3114/1106 (Lake Gregory) are held by a trustee on trust for the applicants. The applicants rely on section 47 of the Act in relation to these parts of the claimed area and seek a determination accordingly.
b) Prior Pastoral leasehold interest did not wholly extinguish or impair native title and as they have now expired or been forfeited prior to the 1st January 1994 are not validated by the Native Title Act,1993 nor by any relevant Western Australian Statute. The native title rights and interests held by the applicants and those with whom they claim to hold native title are:
1) The right to possession, occupation, use and enjoyment of the claimed land and waters to the exclusion of all others; and
2) Further or in the alternative, the right to:
a) possession of the land, waters and resources;
b) occupation of the land, waters and resources;
c) use and enjoyment of the land, waters and resources;
d) own and control information comprising and concerning the traditional laws and customs of the native title holders in relation to the land, waters and resources;
e) conduct ceremonies on the land and in relation to the land, waters and resources;
f) live on and erect residences and other infracstructure on the land;
h) hunt and fish on and from the land and waters and otherwise collect food from the land and waters;
i) take from the land and use, the resources of the land, including the plants and animals (including forest products) of the land and all other components and attributes of the land;
j) take from the waters and use, the resources of the waters, including the plants and animals (including fisheries) of the waters and all other components and attributes of the waters;
k) dig for, take from the land and waters and use minerals and ores, and extractive minerals and quarry minerals such as flints, clays, soil, sand, gravel, rock and all like resources;
l) manufacture materials, tools and weapons from the products of the land, waters and resources;
m) dispose of products of the land, waters and resources, and manufactured products, by trade or exchange;
n) manage, conserve, care for the land, waters and resources;
o) grant or refuse permission to any person to do some or all of (a) - (n) either at all or subject to terms and conditions;
p) inherit native title rights and interests;
q) bestow and acquire native title rights and interests; and
r) resolve as amongst themselves any disputes concerning land, waters and resources.



TJURABALAN NO 2

NATIVE TITLE CLAIM

WC95/74

DRAFT

CURRENT LAND TENURE

(AS AT 17/08/95)

HISTORICAL LAND TENURE

HISTORICAL PASTORAL LEASES WITH NO ABORIGINAL RESERVATION

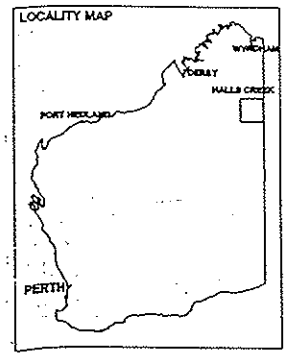
superceded by map received 21/3/96

CLAIM AREA

0 30 60

KILOMETRES

LOCALITY MAP



WALIS

LAND CLAIMS MAPPING UNIT

Appendix 6 Yawuru Native Title Claimants and Claim Area

Roebuck Bay

Register of Native Title Claims

Registration Number: C00007

Body Application Lodged With: National Native Title Tribunal **Ref.No.:** WC94/1

Date Lodged: 2 February 1994 **Date Accepted:** 26 May 1994

Date Registered: 2 February 1994

Status: Mediation commenced 9 June 1994

Registered Native Title Claimant: Francis Djaigween, Frank Sebastian, Jack Edgar,
Matthew Gilbert, Elsie Edgar.

Address for Service: C/- Mr George Irving
Kimberley Land Council
PO Box 2145
BROOME WA 6725
Tel.No.: (091) 936 199 Fax.No.: (091) 936 279

Description of Persons Claimed to Hold Native Title:
Phillip Corpus, Margaret Robinson, Gerard Matsumoto, Fred Corpus, and the Yawuru People, Francis Djaigween, Frank Sebastian, Jack Edgar, Matthew Gilbert, Elsie Edgar

Area Covered

State/s: Western Australia

ATSIC Region/s or TSRA: Kullarri Regional Council

Local Government Area/s: Shire of Broome

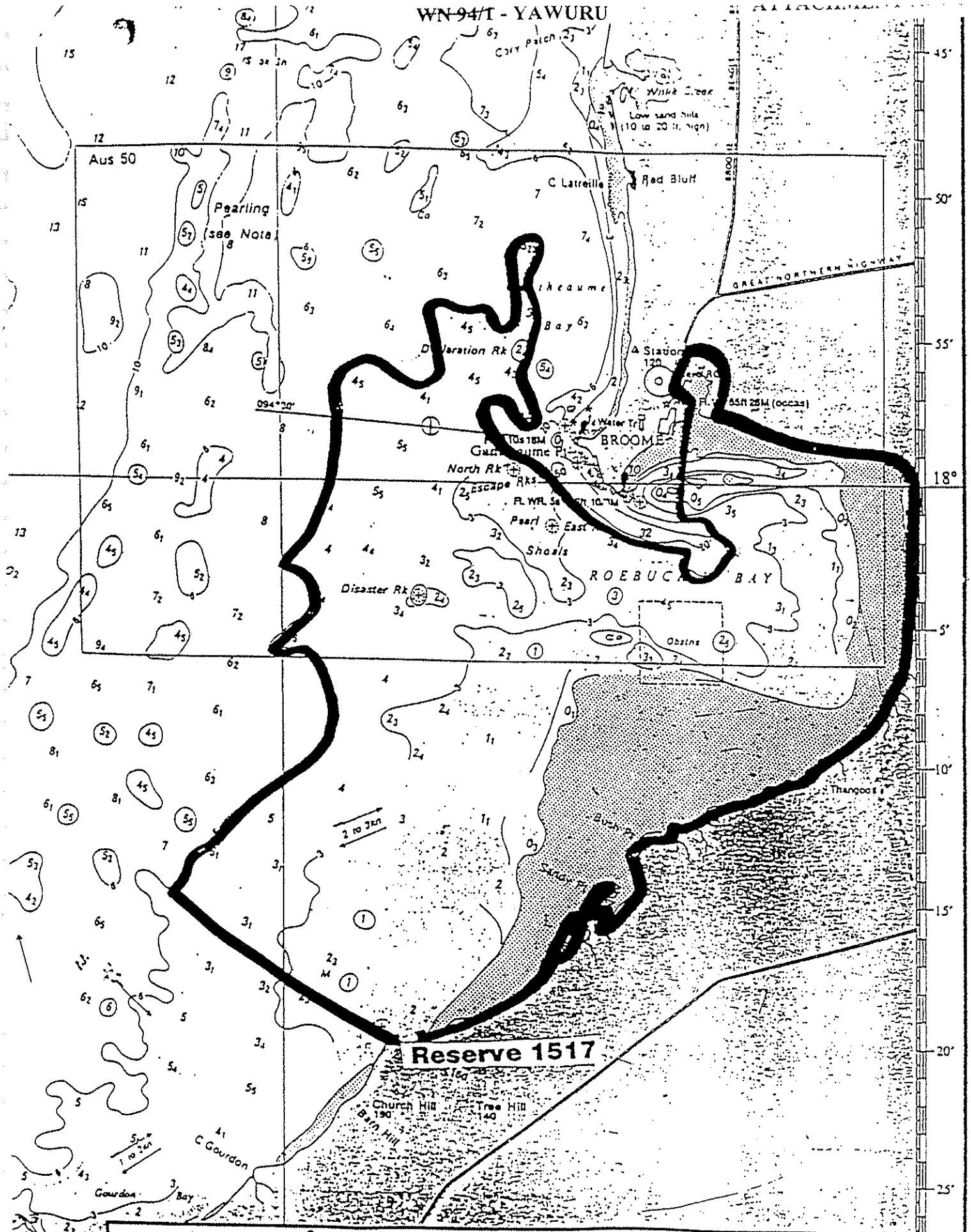
Location: In and around Roebuck Bay near Broome in Western Australia.

Description: The area covered by the application is the land and waters indicated on the four attached maps - attachment A and includes: An area of vacant Crown land lying on the eastern side of the town boundary; an area of vacant Crown land on the western side of the town boundary; an area of vacant Crown land below the southern boundary; an area of vacant Crown land below the southern boundary of Roebuck Plains pastoral reserve; an area of sea within Roebuck Plains pastoral reserve; an area of sea within Roebuck Bay; an area of Crown land between the boundary of Thangoo Station pastoral lease and the high water mark which is believed to be 40 metres; water reserve No 1517; and an area of sea to the west of the coastline. It excludes Reserve No 41066/254 the bird sanctuary, and Aboriginal Reserve No 30906/79.
Excluded from the area the subject of the application as described above is the following land:
* an area sufficient to extend Short Street, Broome, to a new roundabout to be constructed at the proposed intersection of Bagot Road, Broome Road and Short Street as depicted in annexure B;
* a triangular area bordered on one side by part of the northern edge of Short Street;
* the north-western "dead-end" of Gray Street;
* a six sided area totalling 5061 square metres as depicted in attachment D.

Size: 1,300 sq km

Land and/or Waters: Land and Waters

Native Title Rights and Interest Claimed:
The right to possess, occupy, use and enjoy the whole of the area claimed.



MAP FOUR

Area of claim lies within lines marked in brown.

Includes reserve 1517

Appendix 7 Karajarri Native Title Claimants and Claim Area

Eighty Mile Beach and Mandora Marshes Area

Register of Native Title Claims

Registration Number: C00277

Body Application Lodged With: National Native Title Tribunal **Ref.No.:** WC96/68

Date Lodged: 13 June 1996 **Date Accepted:** 19 July 1996

Date Registered: 13 June 1996

Status: Notification Period Ends 18 November 1996

Registered Native Title Claimant: John Dodo and others (see Attachment A)

Address for Service: C/- Lisa Wright
Kimberley Land Council
PO Box 377
DERBY WA 6728
Tel.No.: 091 931 118 Fax.No.: 091 931 163

Description of Persons Claimed to Hold Native Title:
the applicants and others as claimants, all of whom are connected to the claim area in accordance with their acknowledged laws and customs and all of whom describe themselves as Karajarri, John Dodo, Alec McKay, Edna Hopiga, Amy King, Donald Grey, Norman Munro, Cissy Everett, Michael Everett, Steven Possum, Wittidong Mulardy, Joseph Wandi, Elsie White, Flora Dean, Doris Edgar

Area Covered

State/s: Western Australia

ATSIC Region/s or TSRA: Kullarri Regional Council

Local Government Area/s: Shire of Broome

Location: Claim area is in the West Kimberley in W.A., comprising Shamrock Station, Nita Downs Station, and vacant crown land adjoining Anna Plains Station .

Description: The area claimed in is in the State of Western Australia in the west Kimberley Region. It is comprised of:
a) all the land contained within the boundaries of pastoral lease numbers 3114/604 (Shamrock Station) and 3114/789, 398/682 and 398/770 (Nita Downs Station);
b) the strip of vacant Crown land which lies between the western boundary of Nita Downs Station lease 398/770, the south-western corner of 3114/789 (Nita Downs Station) and the eastern boundary of pastoral lease number 3114/1154 (Anna Plains Station);
c) all land within the pastoral lease boundaries mentioned in sub-paragraph (a) which is currently reserved, including reserve numbers 40658, 42063, 41648, 32603, 32604, 32605, 32606, 32607, and 32608; and
d) all vacant Crown land within the boundaries of Shamrock Station and Nita Downs Station.
None of the area claimed is subject to a grant of freehold title.

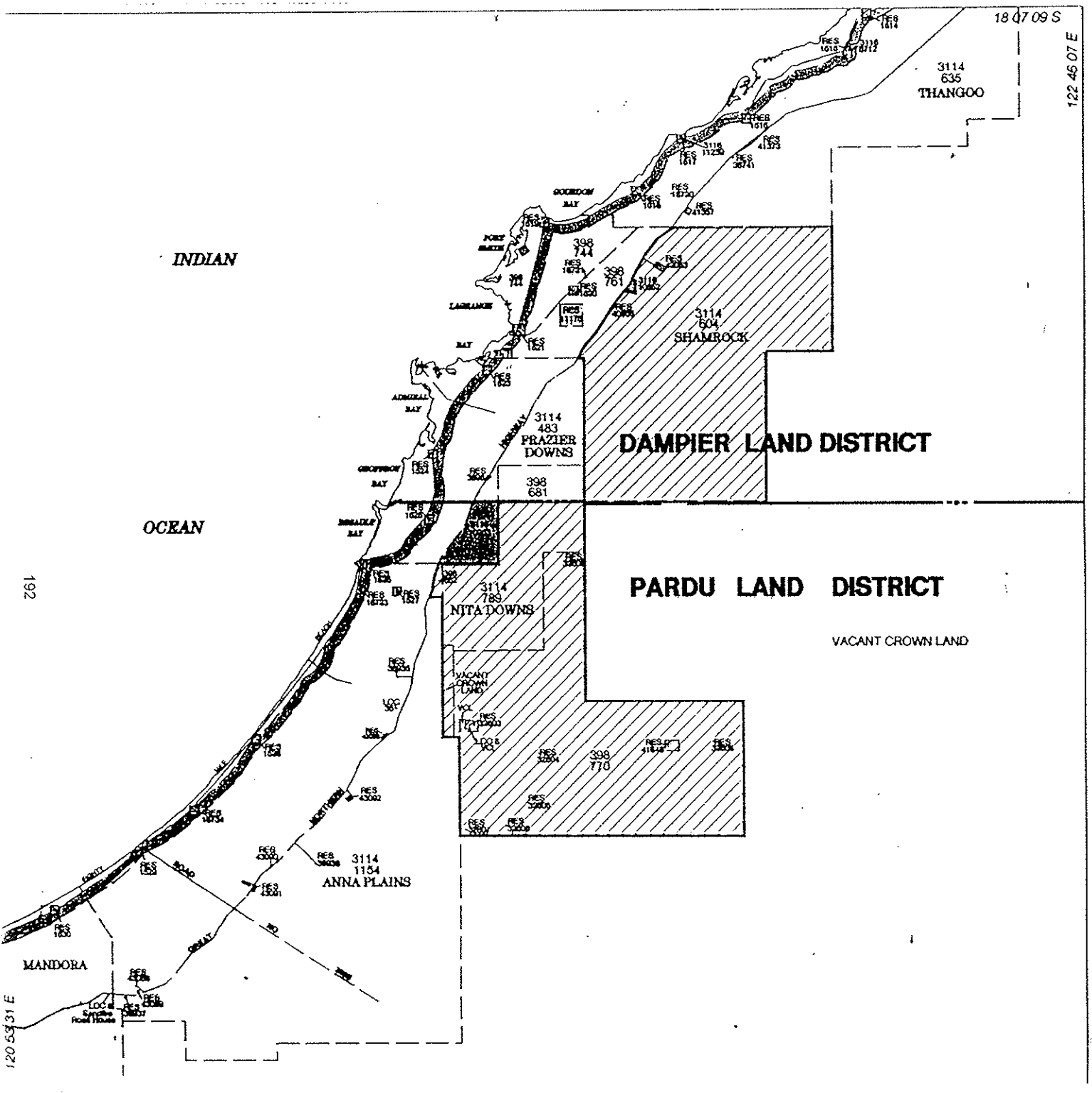
Size: 3950 sq kms

Land and/or Waters: Land

Native Title Rights and Interest Claimed:
The Applicants and other persons with whom they claim to hold native title over the area covered by the application:
1) continue to follow and observe the traditional laws which were acknowledged and the customs which were observed by their ancestors prior to the acquisition

of sovereignty over the land by the British Crown;
2) maintain their connection with the land in accordance with the laws and customs mentioned in A9 (1); and
3) enjoy the right to possession, occupation, use and enjoyment of the claimed land and waters to the exclusion of al others in accordance with the laws and customs mentioned in A9(1);
Further or in the alternative:
4) Enjoy the right to:
a) possession of the land, waters, and resources;
b) occupation of the land, waters and resources;
c) use and enjoyment of the land, waters and resources;
d) own and control information comprising and concerning the traditional laws and customs of the native title holders in relation to the land, waters and resources;
(e) conduct ceremonies on and in relation to the land, waters and resources and to attend to sites of cultural and religious significance;
(f) live on and erect residences and other infrastructure on the land;
(g) move freely about the land and waters;
(h) hunt and fish on the land and in the waters and otherwise collect food from the land and waters;
(i) take and use the resources of the land, including water, plants, animals, fisheries and forest products and all other components and attributes of the land;
(j) dig for, take from the land and waters and use minerals and ores, and extractive minerals and quarry materials such as flints, clays, soil, sand, gravel, rock, and all like resources;
(k) manufacture materials, tools and weapons from the products of the land, waters and resources;
(1) dispose of products of the land, waters and resources, and manufactured products, by trade or exchange;
(m) manage, conserve, and care for the land, waters and resources;
(n) set fires;
(o) grant or refuse permission to any other person to do some or all of subparagraphs 3(a) to(n) inclusive either at all or subject to terms and conditions;
(p) inherit native title rights and interests;
(q) bestow and acquire native title rights and interests;
(r) resolve as amongst themselves any disputes concerning land, waters and resources.
(s) exclude strangers from the land;
(t) permit persons other than the native title holders to enter the land; and
(u) exclude persons other than the native title holders from the land.
Further or in the alternative
(5) enjoy the right to possession, occupation and enjoyment of the land and waters claimed to the extent of any consistency with any valid pastoral leases or to the extent

Draft Determination Sought:
The Applicants will seek a determination in the following terms if the Application is unopposed:
Native title in relation to the land and waters claimed in Application:
(1) exists;
(2) is held by the applicants and others, all of whom are connected to that land and those waters in accordance with their acknowledged laws and customs, and who from time to time may describe themselves as Karajarri; and
(3) confers the right to possession, occupation, use and enjoyment of the land and waters on the native title holders to the exclusion of all others in accordance with the traditions and customs of the native title holders.



KARAJARRI 2

NATIVE TITLE CLAIM

WC96/68

CURRENT LAND TENURE

(AS AT 17/6/96)

Attachment B
A4 Map of Claim Area
Page 1 of 1

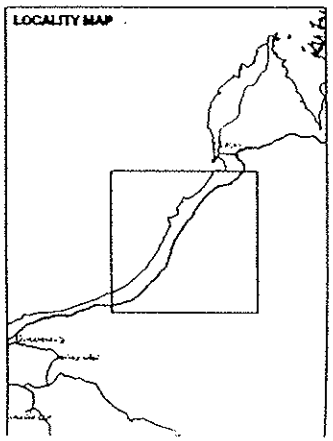
LEGEND

- FREEHOLD
- SPECIAL LEASE
- RESERVE
- ABORIGINAL RESERVE
- VACANT CROWN LAND
- PASTORAL LEASE
- CLAIM AREA

KILOMETRES

0 10 20 30 40 60

LOCALITY MAP



WALIS
LAND CLAIMS MAPPING UNIT

192