

TUKUJANA NGANYJURRUKURA NGURRA

All of us looking after country together

Literature Review for Terrestrial & Marine Environments

on

Karajarri Land and Sea Country

COMPILED BY TIM WILLING 2014



THE
PEW
ENVIRONMENT GROUP



Australian Government

Department of Sustainability, Environment,
Water, Population and Communities

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PLEASE NOTE

Words that appear **RED** throughout this report are consistent with current Karajarri orthography.

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The primary source for Karajarri language contained in this report was taken from the dictionary published by the Wangka Maya Pilbara Language Centre, which is available [ONLINE] accessed from **March to April 2013**:

http://www.wangkamaya.org.au/index.php?option=com_content&view=article&id=303&Itemid=409

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The Kimberley Land Council Land and Sea Management Unit commissioned this document.

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Acronyms

AGPS	Australian Government Publishing Service (Canberra)	IBRA	Interim Biogeographic Regionalisation of Australia
AIATSIS	Australian Institute of Aboriginal and Torres Strait Islander Studies (Canberra)	ILUA	Indigenous Land Use Agreement (State Government)
AIMS	Australian Institute of Marine Science (Townsville)	IMCRA	Integrated Marine and Coastal Regionalisation of Australia
ANCA	Australian Nature Conservation Authority (Canberra)	IPA	Indigenous Protected Area (Federal Government)
ANU	Australian National University (Canberra)	IUCN	International Union for the Conservation of Nature (Switzerland)
ANZAAS	Australian & New Zealand Association for the Advancement of Science (Canberra)	JAMBA	Japan Australia Migratory Bird Agreement (1974)
ATSIC	Aboriginal & Torres Strait Islander Commission (now abolished)	KALACC	Kimberley Aboriginal Law & Culture Centre (Fitzroy Crossing)
AQIS	Australian Quarantine Inspection Service (Canberra)	KCMP	Karajarri Country Management Plan (2009)
ATL	Aboriginal Trust Land (administered by DIA, Perth)	KCCMP	Karajarri Coastal Country Management Plan (2010)
BBO	Broome Bird Observatory	KFD	Karajarri Flora Database (maintained by Sarah Yu)
BOM	Bureau of Meteorology (Canberra)	KLC	Kimberley Land Council (Broome, Derby, Fitzroy Crossing & Kununurra)
BP	Before Present, a dating method in years used by archaeologists	KTI	Kimberley Training Institute – previously TAFE
CALM	Department of Conservation and Land Management (Perth) – now DEC	KTLA	Karajarri Traditional Lands Association (Bidyadanga)
CAMBA	China Australia Migratory Bird Agreement (1986)	LNG	Liquified Natural Gas
CCWA	Conservation Commission of Western Australia (Perth)	MOU	Memorandum of Understanding
CDEP	Community Development Employment Program (abolished)	MRPA	Marine Parks & Reserves Authority (Perth)
CITES	Convention on International Trade in Endangered Species (1973 treaty)	NAFI	Northern Australia Fire Information (website)
CRC	Cooperative Research Centre	NAILSMA	Northern Australian Indigenous Land & Sea Management Alliance (Darwin)
CSIRO	Commonwealth Scientific & Industrial Research Organisation (Canberra)	NAQS	Northern Australian Quarantine Strategy (administered by AQIS)
CVA	Conservation Volunteers Australia (Broome)	NPNSA	National Parks & Nature Conservation Authority (Perth) – now CCWA
DAFWA	Department of Agriculture & Food of Western Australia (Perth)	NRM	Natural Resource Management (Federal & State Govt. Program)
DEC	Department of Environment and Conservation (Perth) – replaced CALM	NSW	New South Wales
DEH	Department of Environment and Heritage (Canberra) – became DEHWA	NT	Northern Territory
DEWHA	Department of Environment, Water, Heritage & the Arts (Canberra) – now SEWPAC	PBC	Prescribed Body Corporate (legal entity for Native Title administration)
DFES	Department of Fire and Emergency Services (Perth)	RNTB	Registered Native Title Body
DIA	Department of Indigenous Affairs (Perth)	ROKAMBA	Republic of Korea (South Korea) Australia Migratory Bird Agreement (2007)
DNA	Deoxyribo-Nucleic Acid (genetic basis of life)	SEWPAC	Department of Sustainability, Environment, Water, Population & Communities (Canberra) – replaced DEWHA
EK	Environs Kimberley (Broome-based conservation group)	TAFE	Technical and Further Education (Broome)
EPA	Environmental Protection Authority (Perth)	TO	Traditional Owner
EPBC	Environment Protection & Biodiversity Conservation Act (Federal Government)	WA	Western Australia
FESA	Fire & Emergency Services Authority (Perth) – now DFES	WAI	Western Agricultural Industries (defunct)
GBRMPA	Great Barrier Reef Marine Park Authority (Townsville)	WAMSI	Western Australian Marine Science Institution (Perth)
GPS	Global Positioning System (uses satellites)	WOC	Working on Country (Federal program for supporting Indigenous Rangers)
		WWF	World Wildlife Fund
		4WD	Four Wheel Drive (Offroad Vehicle)



Community Consultation Notre Dame University, Broome May 2013

COMMUNITY CONSULTATION PROCESS

The first draft of this report was discussed at a KTLA workshop at Notre Dame University, Broome on 4 February 2013 and copies circulated for comment to Karajarri Rangers and KTLA members. A further workshop session was conducted at Notre Dame University, Broome on 5 March 2013, where some changes were made to the text, both to ensure correct Karajarri orthography and clarify aspects of Karajarri culture. A two-day workshop was held at Bidyadanga on 19-20 March 2013, during which the entire document was reviewed by senior elders and many clarifications and improvements made.



Community Consultation Bidyadanga Telecentre May 2013

Notes

1 INTRODUCTION

1.1 THE KARAJARRI CONTEXT

The Karajarri people of the south-west Kimberley region comprise three estate clans, speaking slightly different dialects: the **Nangu** from the desert north-east, the **Nawurtu** from the desert south-east with the **Naja** saltwater clan along the coast. Bagshaw (1997, p.10) estimated Karajarri country at approximately 29,000 square km., but this is probably an under-estimate. In 2004, it was estimated that there were less than 20 fluent speakers of the Karajarri language, classifying it as highly endangered. The kinship system of the Karajarri recognises four skin groups – **Panaka**, **Parrjarri**, **Karimpa** and **Purungu** (Dwyer, 2012, p.11).

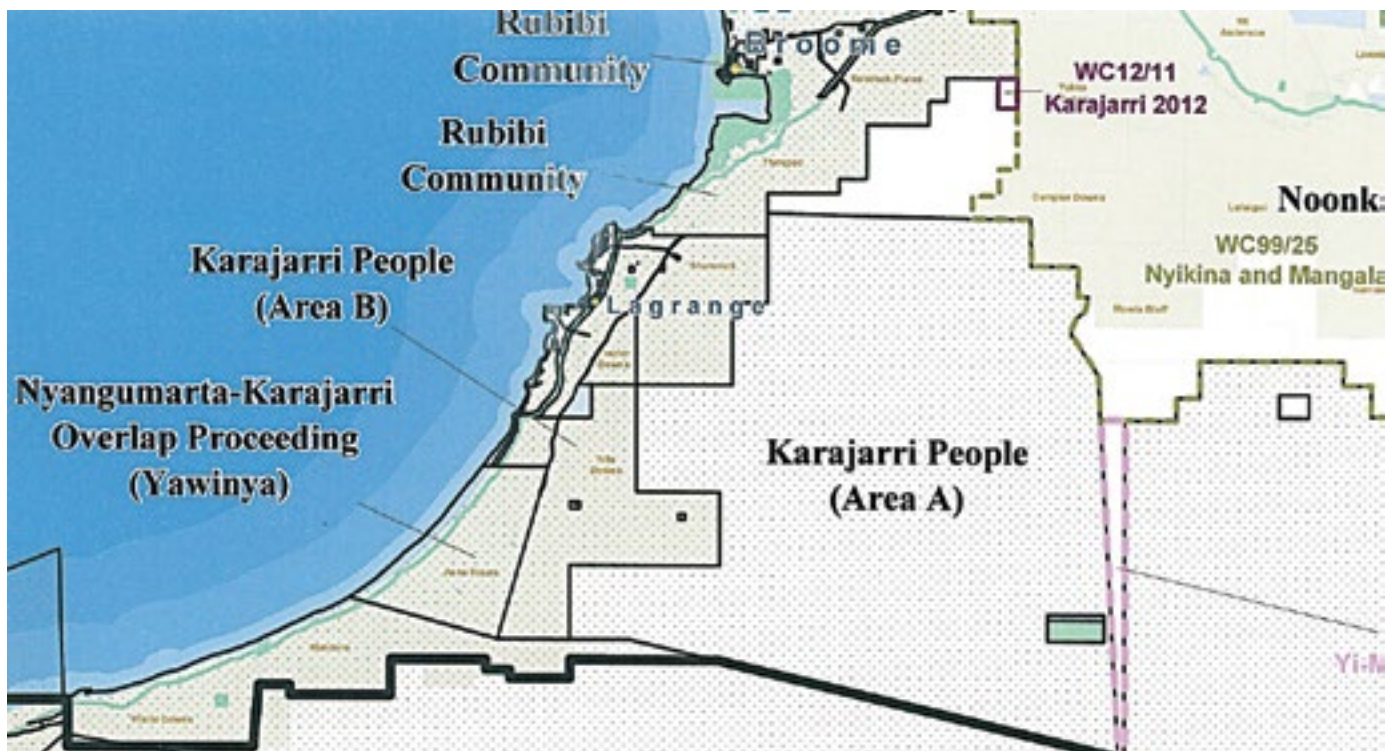
The major settlement in Karajarri country is Bidyadanga Community, reportedly the largest Indigenous community in Western Australia. The closest town is Broome, lying 200 kilometres to the north, which is the largest centre in the Kimberley region and another stronghold of Karajarri people. From the mid-1950s up to 1974, many neighbouring desert and coastal countrymen – principally Mangala, Juwaliny, Yulparija and Nyungumarta – re-located to the former La Grange Catholic Mission, making Karajarri

people a minority at their principal settlement. In 1981, administrative management transferred from the Mission to the Aboriginal community.

The 2006 Census reported that 426 people lived at Bidyadanga Community. However, the operational population is now probably closer to 800. Around 160 people (one-fifth of the population) regard themselves as Karajarri people (Edgar 2011). In the 2006 Census at Bidyadanga Community, seven people reported that they spoke Karajarri at home, while 78% of the Community spoke English (or Kriol) at home and/or other local languages.

In June 1996 Karajarri Elders filed an application before the Federal Court of Australia seeking recognition of their Native Title rights.

The Karajarri 'A' Native Title claim was determined in February 2002, granting the Karajarri people exclusive possession over 24,725 square kilometres of their lands. Essentially, this covered **Kuwiyimpirna**/Frazier Downs Station and Unallocated Crown Lands (UCL), with especially large areas on the eastern or desert side.



MAP 1 National Native Title Tribunal (2013)

In September 2004, Karajarri people were recognised as the Traditional Owners of an additional 5,647 square kilometres of land, mostly pastoral leases, known as “Area B”. This included the whole of Nita Downs and Shamrock [now Munro Springs] Stations, the extreme north and east of Anna Plains Station and the northern (post 1994) portion of Dragon Tree Soak Nature Reserve. The non-exclusive Native Title rights granted in 2004 include the right to enter and remain on land, camp, take flora and fauna, access natural resources and water, engage in rituals and ceremony as well as maintain and protect sites of significance (Edgar, 2011, p.59).

In 2012, further Karajarri rights were recognised - jointly with Nyungumarta people - over Anna Plains and Mandora Stations, and ILUAs were signed with both pastoral leases. An additional area in the far north of Karajarri country, straddling the Broome-Dampier Downs access track, is currently under claim. There are now around eleven outstations in Karajarri country with several more planned (KCMP, p.19).

In 2002, the **Karajarri Traditional Lands Association** (KTLA) was accepted as the Prescribed Body Corporate (PBC) to manage Karajarri lands. One of its principal achievements has been the establishment of the **Karajarri Rangers** in 2006, with assistance from the Kimberley Land Council’s Land and Sea Management Unit. The Ranger Program currently employs a co-ordinator and six rangers. The key task of the rangers is to protect the natural and cultural heritage of their traditional lands. Day-to-day activities include: visitor management with regular coastal patrols; biosecurity work for AQIS (Australian Quarantine Inspection Service – including ants, mosquito and disease monitoring); weed management; biodiversity surveys and monitoring; cultural site protection; maintain effective

cultural advisory committee; transmission of Traditional Ecological Knowledge and fire management. Rangers also study Certificate II and III Conservation and Land Management units at the Kimberley Training Institute (KTI) formerly TAFE at Broome.

1.2 HEALTHY COUNTRY AND CARING FOR COUNTRY

In the world-view of the Karajarri people, the landscape, its features and all forms of life are imbued with cultural meaning (Skyring *et al.* 2008, p.63). As a Senior Elder explained in 1999:

“Everything – all the animals, birds, people, seasonal changes, comes from the country, and the country is **Pukarrikarrajangka** (from the Dreaming)”.

Pukarrikarra refers to the world-creative epoch and to the supernatural beings active therein. These beings are believed to be responsible not only for the formation of the world and its physical content, but also for the introduction of social laws and principles governing all subsequent human existence. **Pukarrikarra** beings are also credited with the introduction and differentiation of regional languages, naming places and often transforming themselves into environmental features (Yu, 2000, p.37-38).

According to Yu (2002, p.45-46), Karajarri people characterise their environmental responsibilities as “**Palanapayana Tujukana Ngurra** (sic)” or ‘everybody looking after country properly’. She relates that:

“By virtue of spiritual conception (one’s **Yatangal**), the Karajarri believe they are born with a binding and inviolate responsibility to care for the country, which by definition includes the **Ngapa**/water sources. Furthermore, the Karajarri assert that they are able to look after country without physically being there.”

A senior lawman went on to say that since white settlement, people were often unable to visit their country.

However, stories of the country, singing the country and Law ceremonies hold the country here (pointing to his stomach).

It is a spiritual connection **Pilyurr**. However, when visiting water places, Karajarri and other visitors follow certain protocols and ritual practice. For example, the **Kuwaiyinpijala** ritual involves spraying spring water from the mouth to cautiously introduce oneself to the **Pulany**/mythical watersnake, which resides in **Jila's**/springs. When deemed necessary, senior **Pirrka**/Lawmen or **Yiliwirri**/rainmakers are able to interact with **Pulany**, some of which are considered 'cheeky' or dangerous – particularly to children - and unpredictable.

The KTLA's landmark **Karajarri Country Management Plan** (December 2009) detailed a wide range of targets, issues and management strategies, adopting an ambitious whole-of-country approach to managing Karajarri lands. The Plan also identified further planning requirements as including partnerships with neighbours, e.g. **Punturrpunturr**/Port Smith Caravan Park, and agencies, e.g. DEC in respect to joint management for the existing Dragon Tree Soak Nature Reserve, and its proposed **Malampurr**/Eighty-Mile Beach Marine Park.

At a two day conference held at Bungarun, near Derby in September 2004, Kimberley Aboriginal people came together to talk about priorities for looking after land and sea country and to work out the best way to speak up for country. A Karajarri woman's detailed perspective of these discussions has been recently presented by Dwyer (2012). People sat together in four groups – Saltwater, Desert, Rivers and Rangelands and discussed in detail what makes country healthy and what projects were needed to keep country healthy ("Looking after Country" Workshop Report, 2004).

Karajarri people know when country is healthy because:

- The country sustains life (country healthy, we're healthy)
- Bushfires never go through;
- Culture understood by kartiyas [white people];
- Bush foods, dreaming, and bush medicine are still there;
- Plenty of bush foods;
- Plenty of fish, oyster, shellfish, turtle, dugong, crab and stingray;
- Kartiyas (White people) are recognising the values of our country;
- Kartiyas coming to learn about our culture, so they can respect us;
- Respect for owners of country;
- This comes from our Dreamtime, from our old people and we have to leave something for future generations;

These ideas have since been incorporated into the regionally based **Kimberley Aboriginal Caring for Country Plan**, released in January 2011.

In the meantime, the KTLA completed its 75 page **Karajarri Coastal Country Management Plan** in December 2010 (Yu and Driscoll). This comprehensive document outlined Karajarri values and aspirations in respect to **Jurarr** or coastal country, examined threats and pressures and set in place key management strategies across five identified coastal zones from **Pangarangara**/Gourdon Bay in the north to **Malampurr**/Eighty-Mile Beach in the south.

One of the KTLA's major ambitions, now close to realisation, is to declare an **Indigenous Protected Area** (IPA) over the major portion of their **Kuwiyimpirna**/Frazier Downs lease.

1.3 SEASONAL CALENDARS

Yu (2000, p.40-44) noted that for Karajarri people, “time is measured in a cycle of changing seasonal patterns, which roughly correlate to a European year”. According to Yu, Karajarri people recognize **four major seasons** with **two short transitional seasons** - see figure 1.

Marul (April-May)

Season after the rain when the country begins to dry out. The weather is hot with high humidity, little wind and occasional showers. **Kuwi** are ‘fat’, while reef fish are ‘skinny’. **Kunturung**/grey mangrove (*Avicennia marina mangrove*) is in fruit. Valued bush-fruits such as **Makapala**/bush banana (*Marsdenia viridiflora*), **Minyjuru**/wild prune (*Sersalisia sericea*) and **Ranyja**/sandpaper fig (*Ficus aculeata*) are ripe. It is ‘bird time’. Culturally, this is the season for **Pirtimaru**/increase ceremonies for **Panganu**/salmon.

Wiralpuru (May-June)

Season when the first cool southeast winds, **Wiralpuru**, begin to blow. Rains are finished. The Seven Sisters constellation, **Kumanypa**, can be seen in the evening sky. The sea becomes muddy. **Kuwi** become ‘skinny’ from vomiting green seeds and grass, while reef fish remain ‘skinny’. Salmon and mullet are running in shoals. **Yari**/humpback whales begin to breach. Lizards and snakes, **Jalkarna**, go into hibernation, but are still ‘fat’. Ducks are breeding in wetlands; bloodwood eucalypts (*Corymbia spp.*) and wattles (*Acacia spp.*) are flowering. **Yarrinyarri**/bush onion bulbs (*Cyperus bulbosus*) can be harvested.

Parrkana (July-August)

‘Winter time’ when cold southeast winds, **Wiralpuru** blow. The star **Wiriny** is visible in the morning sky. In some years, a few days of winter rains, **Mujungu**, may occur. This is the season when country is usually burnt. No reef or poison, **Panjurita**, fishing takes place. Instead, woven fish traps, **Marrku** are used in creeks to catch **Panganu**/salmon and **Kulpany**/mullet. **Pirna**/witchetty grub or a kind of moth larvae is popular. Kangaroo, possum and bush turkey are all ‘fat’. **Kumpaja**/pindan walnuts (*Terminalia cunninghamii*) and Bush Tomato (*Solanum spp.*) are ripe for harvest, as are **Mungkarliny**/bush potato (*Ipomoea costata*) and bush onion.

Wilpuru (September)

A short warm period, before the hot weather returns. **Karanimarra**/westerly winds are starting to blow. The sea becomes clear. Reef and shellfish begin to get ‘fat’. Increase ceremonies for bluebone and other reef fish take place. Seeds are collected to make damper. Butcherbirds sing. Best time to hunt corellas.

Laja (October-November)

The ‘build up’ hot season, before the coming rains. Early morning dews occur. This is a good time to collect seed for making damper. Many plants are in fruit; **Ranyja**/sandpaper fig (*Ficus aculeata*), **Jilalka**/bush tomato, **Kuwal** (*Flueggea virosa*), **Kumpaja**/pindan walnut (*Terminalia cunninghamii*), **Jamparr**/bush orange, (*Capparis umbonata*) as well as the **Mirntirrijina** (*Personia falcata*), which is popular with Karajarri people, are in season. **Jalkarna**/goannas, lizards and snakes wake up from hibernation, but are still ‘skinny’. March flies are biting. **Karratu**/cicadas emerge from underground and can be found in wattles and samphire plants. This is the best time for stingray, shellfish and reef fish, as they are ‘fat’. **Kurrjungu**/stone fish trap and **Panjurita**/poison are employed. **Jalayapulu**/flatback turtles are laying **Jimpu**/eggs on sandy beaches.

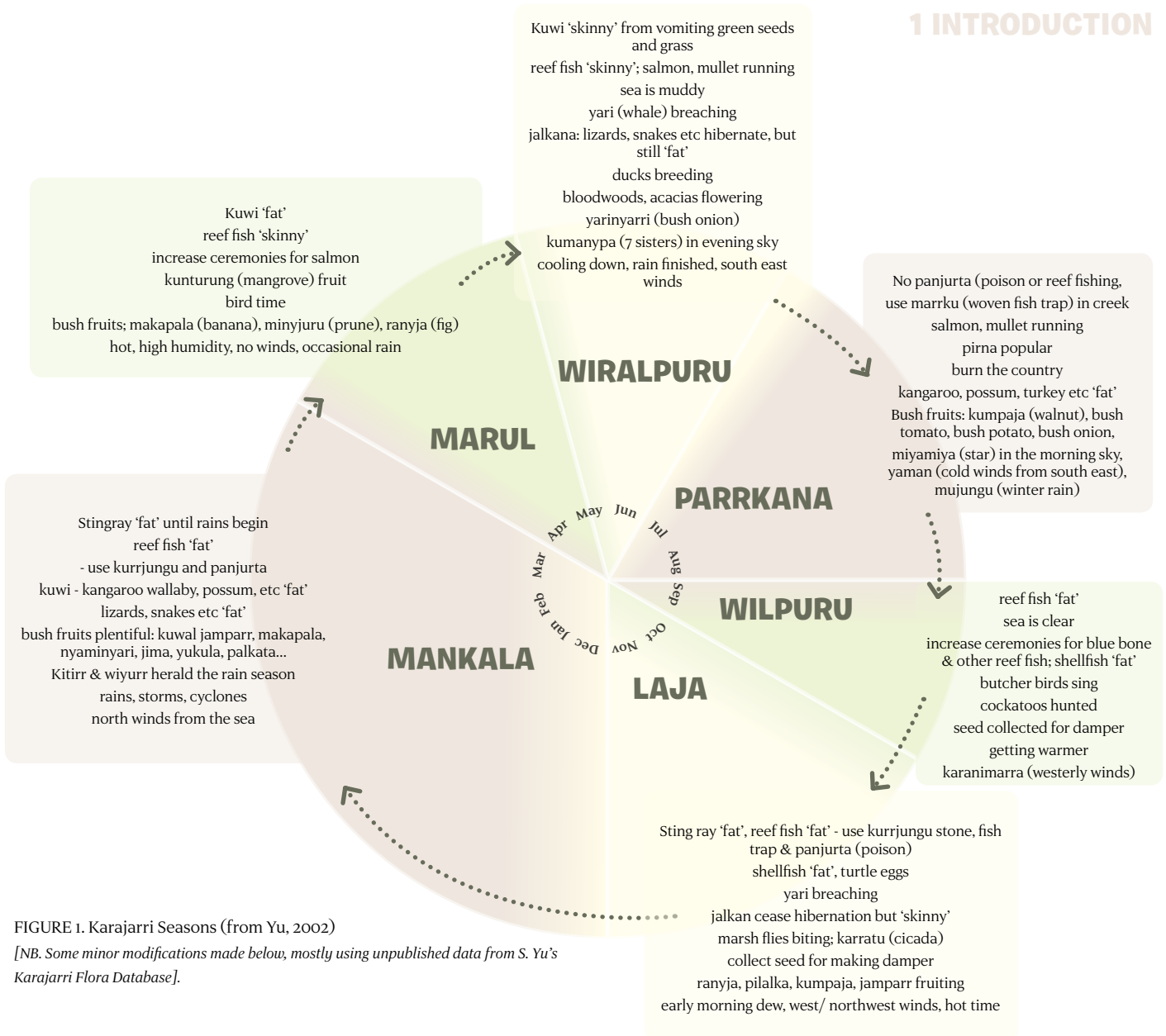


FIGURE 1. Karajarri Seasons (from Yu, 2002)

[NB. Some minor modifications made below, mostly using unpublished data from S. Yu's Karajarri Flora Database].

Mankala (December-March)

Rainy season, when storms and cyclones can deliver heavy rain. Northerly winds blow from the sea. The appearance of **Kitirr**/fork-tailed swifts (*Apus pacificus*) and **Wiyurr**/barn swallows (*Hirundo rustica*) signifies the coming rain. Many bush fruits are harvested – **Jilalka**, **Jamparr**, **Makapala**, **Nyaminyari**/gubinge, (*Terminalia ferdinandiana*), **Jima**/conkerberry (*Carissa lanceolata*), **Yukulu**/dodder, (*Cassytha filiformis*), **Palkata**/zigzag vine (*Capparis lasiantha*). **Mayi**/edible plant food is abundant, as are **Kuwi**/all types of flesh food - including kangaroo, wallaby and possum. Lizards and snakes are 'fat' again. Stingrays remain fat until the wet starts. Reef fish are fat and targeted with **Panjurta**/poison and **Kurrjunga**/stone fish traps.

Yu (2000, p.41) noted that traditional Karajarri migration between coast and hinterland followed a seasonal pattern,

dependent upon the supply of water and the availability of bush and sea resources. She relates:

“During **Mankala** – the rain time – and after the wet, groups would travel out on **Makurr** (well-worn routes) to scattered **Lirri** [soaks] that had been replenished by rain. This pattern of movement would continue right through to the end of **Parrkana**, the cold time, and into **Wilpuru** when it began to get hot again. There are well-known soaks, **Jila** and springs which never dry up and in **Laja**, when the country gets hot, people would congregate in these areas until the rains came again. These latter areas are often referred to in Aboriginal English as ‘reserves’”.

Yu (Expert Report, 2000, p.12-13) further commented that when travelling on **Makurr**, Karajarri women would carry water in a special coolaman or **Manyjarta**, to sustain them at the dry camps or **Purayi** between waterholes.

2 MARINE ENVIRONMENTS

The Karajarri word for ocean or deep sea is *Wankurru* (KCCMP, p. 29).

2.1 OCEANOGRAPHY

The “Indonesian Throughflow” is a system of surface currents that directs seawater from the western Pacific Ocean into the Indian Ocean via Indonesia, where high rainfall modifies the waters to become increasingly warm, oligotrophic [low in nutrients] and of reduced salinity. Part of the Throughflow moves southwest from the Banda and Arafura Seas, across the shallow Timor Sea, before passing along the Kimberley coast as the Holloway Current. This current typically strengthens at the end of the Northwest Monsoon, which generally terminates in March. Surface current strength varies considerably from year to year, being affected by El Nino/Southern Oscillation and La Nina events, emanating in the Pacific Ocean. The Holloway Current flows strongest in La Nina years, which are also associated with above average wet seasons. However, scientific understanding of the current is still rudimentary (DEWHA, 2008).

Karajarri sea country features relatively large tides along a coastline adjoining an open ocean environment. Tidal amplitude is closely related to the broad width of the continental shelf. Tides in the region can be broadly categorised as semi-diurnal (i.e. two high tides and two low tides per day) with a spring/neap cycle having approximately seven day intervals between spring tides.

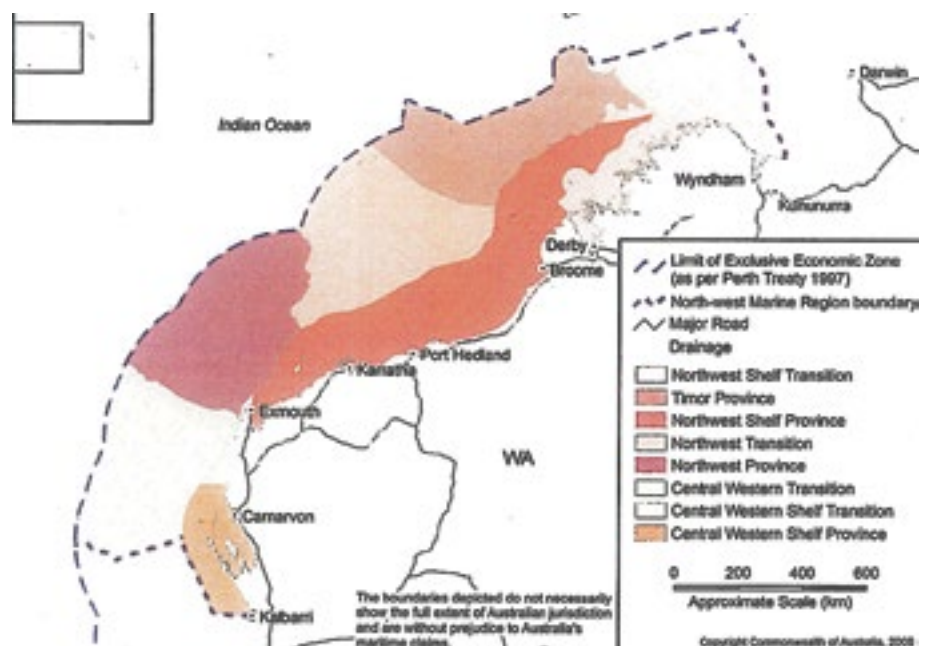
2.2 IMCRA BIOREGIONS: NORTHWEST SHELF PROVINCE

The bioregional IMCRA (Integrated Marine and Coastal Regionalisation of Australia) process characterises Karajarri waters as part of the Northwest Shelf Province (total area 238,759 square km).

Surface waters in the latter bioregion are tropical year round, averaging 26 degrees C in summer and 22 degrees C in winter. Water circulation in the Northwest Shelf Province is highly seasonal. During winter, when the Throughflow currents are greatest, it dominates the water column. During summer, when the Throughflow is weaker, strong winds from the Southwest may cause intermittent reversals of the currents and are occasionally associated with weak upwellings of colder, deeper water on to the Shelf.

Large tides contribute to vertical mixing of surface seawater layers and sediments, especially in shallower, inshore waters. Furthermore, high evaporation rates inshore result in the slow offshore migration of denser, more saline waters as a bottom layer out westward across the Shelf. Inshore mangrove and algal mat communities are sites of nitrogen fixation and nutrient recycling, providing nutrients for shallow water communities that are transported out across the Shelf via currents and tides.

MAP 2 IMCRA Bioregions



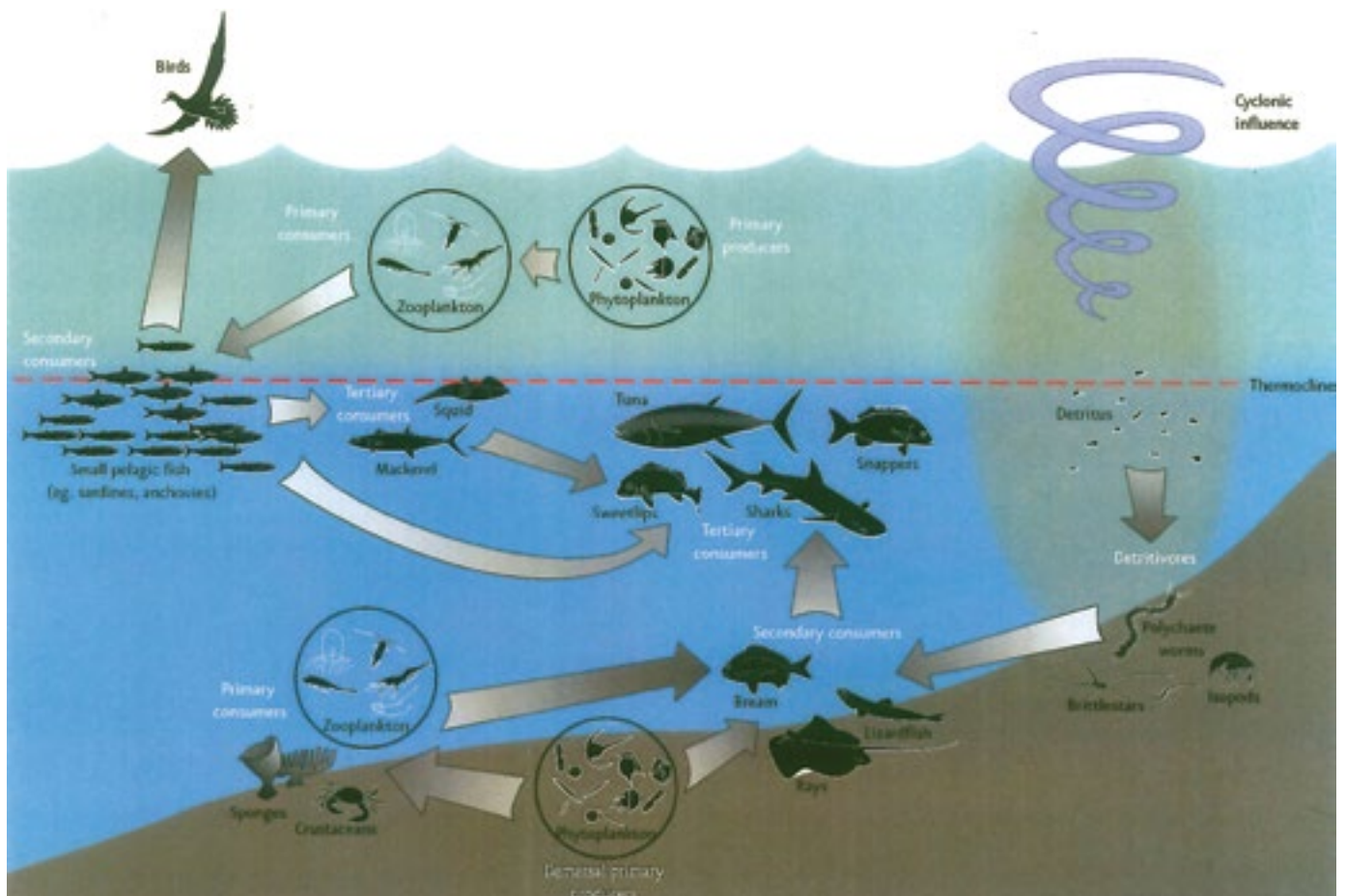


FIGURE 2 Trophic structures of the Northwest Shelf Province (after CSIRO)

An average of four cyclones per year cross the Shelf, with two making landfall. Winds associated with Category 5 cyclones can reach speeds of up to 240 km/hr, causing significant sediment movement on the seafloor as well as vertical mixing of the seawater column.

2.3 OFFSHORE ENVIRONMENTS

Sandy substrates on the Shelf are believed to support low-density benthic communities of bryozoans, molluscs and echinoids. Sponge communities are sparsely distributed, found only in areas of hard substrate. Important benthic [seafloor-dwelling] and demersal [bottom-dwelling] species include sea cucumbers, urchins, prawns and squid. Sharks, whale sharks and dugong migrate through this bioregion.

Primary productivity on the Northwest Shelf is thought to occur mainly in pelagic environments. Here phytoplankton species rapidly multiply in response to bursts in nutrient availability, are consumed by zooplankton and become food for small pelagic fish. Higher order tertiary consumers – typically squid, mackerel and seabirds – feed in turn on the pelagic fish. Scavengers include crabs, shrimps and demersal sharks. Larger fish such as queenfish, salmon and barramundi are important in coastal waters. Transient tertiary consumers such as tuna, snapper and dolphins

provide a link between the pelagic and benthic systems, as they prey on demersal and pelagic species. Small amounts of detritus falling to the seafloor provide another link between the pelagic and demersal systems and are utilised by sparse benthic communities of sponges and sessile filter-feeders (DEWHA 2008).

2.4 BENTHIC HABITAT SURVEYS

In June 2008, benthic habitat surveys were conducted in **Pangaragara**/Gourdon Bay, in connection with investigations for a possible LNG hub. Keesing et al. (2011) reported on the four epibenthic dredge operations conducted here.

However, the total area of surveyed seabed amounted to only 927 square metres. Detailed fauna results are covered in **Section 4.9**.

The only other area where benthic studies have taken place is at **Malampurr**/Eighty-Mile Beach, in an attempt to understand what benthic fauna sustains the major populations of migratory waders found there (Piersma et al. 2005, Hoonkoop et al. 2006).

At the present time, there is clearly inadequate knowledge about much of the inshore seabed in Karajarri country.

3 INTERTIDAL SYSTEMS

3.1 KARAJARRI KNOWLEDGE OF JURARR/TIDES

The Karajarri Dictionary gives the following words:

Kulpa kaninyara jawa lirr yintan receding or ebbing tide

Punya paraman incoming or flooding tide

Warrangkula big spring tide (Yu, Expert Report, 2000, p.21)

These additional words were recorded at the Bidyadanga Workshop:

Wanta Jarri Jurarr neap tide

Parala water resting in the creek when the tide is out

Moya Smith (1997, p.10) noted that onshore and offshore fishing are carefully timed to coincide with appropriate tides. The construction of **Kurrjunggu**/stone wall fishtraps, the use of fish poisons, spearing fish, using lines and nets, as well as dinghy trips are all considered most effective in conjunction with different tides.

3.2 CORAL AND PARNANY/REEF COMMUNITIES

Coral reefs are living carbonate structures with a skeletal framework of coral colonies, which grow upwards and sometimes reach the sea surface. Coral reefs can influence ocean hydrodynamics and reduce coastal energy by dissipating wave energy (Mustoe and Edmunds 2008, p.38). They provide habitat for many important commercial and other prized fish species, often at particular stages of their lifecycle. Ironically, the best-studied coral reefs in the region are those lying far offshore (e.g. shelf edge atolls such as Scott Reef, Rowley Shoals), which lie in nutrient-deficient but clear oceanic seas and experience relatively modest tides. The reason for this has been the oil and gas industry's need to conduct extensive environmental assessments to satisfy the Environmental Protection Authority (EPA), prior to drilling and/or developing wells and new fields. A consequence of this has been that relatively little work has been conducted on nearshore fringing reefs along the Kimberley mainland and nearby islands. Their overall extent, distribution and ecology remains therefore inadequately studied.

Fringing reefs, which have built out from and around sandstone and limestone headlands are an important

feature of Karajarri country, for example at Cape Latouche Treville and Cape Bossut.

Cultural Use

Reef systems are vitally important to Karajarri people for fish such as bluebone, **Wilarr**/turtles, crabs, shellfish, **Riiji** or **Jakuli**/pearl-shell, oysters, **Pinka**/baler shells and **Mangarr**/clams (KCCMP, p.29). Other species associated with reefs include **Walmirimiri**/octopus (also known as **Pakanpuru**) and **Rukuruku**/sponge.

3.3 WURRJA/SEAWEED COMMUNITIES

Walker (1995, p.58) noted that little had been recorded on the distribution and abundance of macroalgae in northwest Australia. However, brown algae are usually the most abundant group in the region with *Sargassum spp.*, *Dictyopteris spp.*, and *Padina spp.* being the dominant species. The most common green algae are the articulate *Halimeda spp.*, while prominent red algal species include crustose corallines, non-corallines and algal turf.

Cultural Use

The Karajarri appear to make no direct use of seaweeds, although these communities may shelter sought-after marine resources. Green turtle (*Chelonia mydas*) are important grazers of seaweed communities at high tide.

3.4 WINTIRRI/SEAGRASS COMMUNITIES

Seagrasses are biologically important for four reasons:

- As plants for their primary production;
- As habitat for invertebrates, prawns and small fish which live among the seagrasses;
- As a principal food source for green turtle and dugong (both major resources for communities), as well as many small creatures which feed on the breakdown of seagrass;
- In helping to stabilise the seabed, by acting as a sediment trap and inducing a wave-dampening effect. However, they are particularly vulnerable to cyclone impacts.

Seagrasses are biologically interesting because they are the only flowering plants to complete their life cycle, including flowering and fruiting, while totally submerged in a marine environment. Accordingly, their pollen is specially adapted for underwater pollination (Kenneally et al. 1996, p.39-40).

Walker & Prince (1987) provided the first list of seagrass species for Karajarri sea country. Around the coast of the Dampier Peninsula two families, seven genera and 11 species of seagrass were recorded. Genera they recorded were *Cymodocea*, *Halodule*, *Syringodium* and *Thalassodendron* in the family Cymodoceaceae together with *Enhalus*, *Halophila* and *Thalassia* in the family Hydrocharitaceae. The majority of these species are illustrated in Kenneally et al. (1996). However, the best available illustrated guide to tropical seagrasses of the Indian and West Pacific Oceans is Waycott et al. (2004).

Benthic habitat surveys conducted in 2008 found seasonally abundant **subtidal seagrass communities** patchily distributed around the Dampier Peninsula from lower intertidal areas out to a depth of approximately 20m. However, they failed to locate seagrass communities at **Pangarangara**/Gourdon Bay, although these are well known to Karajarri people.

Cultural Use

Karajarri men used to spear turtle and dugong in shallow water from rocks using harpoons/big spears. There was more emphasis on hunting turtle rather than dugong, but neither are principal foci of Karajarri culture (Joseph Edgar, pers. comm.).

3.5 KUNTURUNKARRA/MANGROVE COMMUNITIES









Of the 17 mangrove species recorded for Western Australia (Semenuk et al. 1978), ten are known from the Karajarri coast.

Mangroves grow best in areas with a tropical climate, protected shores, salt water, muddy substrates and a high tidal range (Kenneally et al. 1996, p.39).

These conditions are best developed in Karajarri country in estuaries and creeks such as **Punturrpunturr**/Port Smith and at Lagrange Bay.

The remarkable **inland mangrove community** at **Walyarta**/Mandora Marsh is discussed in Section 9.4.

Pedretti & Paling (2001) undertook a desktop assessment of the State’s mangroves and estimated the total area of mangroves at eight sites on Karajarri country:

Site	Name	Mangrove area
058	Cape Jaubert North	 50 ha
059	Pinnacle Rock South	 43.5 ha
060	Admiral Bay	 35 ha
061.1	Lagrange Bay complex (Cape Bossut Creek)	 138.5 ha
061.2	Lagrange Bay complex (Middle Creek)	 187 ha
061.3	Lagrange Bay complex (Cowan Creek)	 203.5 ha
062	False Cape Creek	 199.5 ha
063	Punturrpunturr/Port Smith	 673 ha

3 INTERTIDAL SYSTEMS

TOTAL AREA CALCULATED = 1,530 ha

To put this in perspective, Pedretti & Paling estimated that the Kimberley has over 140,000 ha of mangroves, so the Karajarri coastline has around 1.09 % of the Kimberley total area of mangroves. However, as these calculations were based on an aerial survey, they are likely to be an underestimate of the actual extent of mangroves, because areas of scattered mangroves would have been omitted.

Typical **zonation** of Dampier Peninsula mangroves has been well described by Kenneally et al. (1996, p.39). However, the best site description for Karajarri country was made by Johnstone (1990, p.27-28) at Cape Bossut:

“This mangal fringes a small creek running out of a samphire flat; its mouth is protected by a rocky headland and coastal dunes. The seaward zone comprises a few scattered *Sonneratia* with *Camptostemon*, *Avicennia* and *Aegialitis*. The central zone is low closed forest of *Rhizophora* and in some areas mixed woodland of *Avicennia*, *Bruguiera* and *Rhizophora*.

The landward zone contains stands of *Camptostemon* (to 5 m), low open *Avicennia* and thickets of *Ceriops* (to 3 m). A stunted line of *Avicennia* follows the main tidal creek back on to the mudflat. There is a small stand of about 1 hectare of pure whipstick *Ceriops* (1.5-2 m) growing nearly 1 km away from the main mangal on a bare mudflat. The substrate is white sand and grey mud, and the mangroves are backed by a dune with *Spinifex longifolius* and mudflats and samphire flats.”

Johnstone also briefly described mangrove zonation at Lagrange Bay, Rocky Creek and Whistle Creek.

Only one species of **mangrove mistletoe** occurs in Karajarri country:

Wanjira Wanjira (*Amyema thalassia*), found on **Kunturung** (*Avicennia marina*). This mistletoe occurs as far south as Cape Keraudren. According to Yu (KFD unpublished), the mistletoe berries are eaten by Karajarri people.

Ecological Importance of **Kunturungkarra/ Mangroves**

Mangrove communities play a key role by providing nursery grounds for commercially and recreationally important fish species – notably **Tiluntartu**/barramundi (*Lates calcarifer*), **Panganu**/threadfin salmon (*Eleutheronema tetradactylum*), Mangrove Jack (*Lutjanus argentimaculatus*), as well as **Wangkaja**/mud crabs (*Scylla olivacea*, *S. serrata*) and Banana Prawns (*Penaeus merguensis*), Mustoe & Edmunds, 2008, p. 39.

The extensive root systems of mangroves stabilises the substrate and provides shelter for many molluscs and crabs. By buffering the coast, mangroves help to lessen the erosive power of cyclones and storm surges. By forming a barrier, capable of trapping sediments washed from the land by monsoonal rain and storms, mangroves reduce sediment input into creeks and bays. This helps to maintain water quality for seagrass and reef habitats nearby.

Day-roosting colonies of black flying fox (*Pteropus alecto*), often with some Red Flying Fox (*P. scapulatus*) typically occupy central, dense areas of mangrove communities – usually the *Rhizophora* zone – from where they forage at night to feed on eucalypt and paperbark flowers (McKenzie & Rolfe, 1986). Such flying fox colonies sometimes attract the attention of occasional saltwater crocodiles (*Crocodylus porosus*), which are called **Linkura** or **Kuwarniya** in Karajarri language. The white-bellied mangrove snake (*Fordonia leucobalia*) lives in crab holes, feeding almost exclusively on crustaceans.

The crab-eating **Jilku**/water rat (*Hydromys chrysogaster*) is thought to inhabit mangrove communities, but its current status on the Karajarri coast is unknown (Bidyadanga Workshop).

The white flowers of *Sonneratia alba* are known to be an important food source for the northern blossom bat (*Macroglossus minimus*) (McKenzie 1983, p.4). The mangrove freetail bat (*Mormopterus* sp. undescribed) and the mangrove pipistrelle (*Pipistrellus westralis*) are two insectivorous bats closely associated with this habitat.

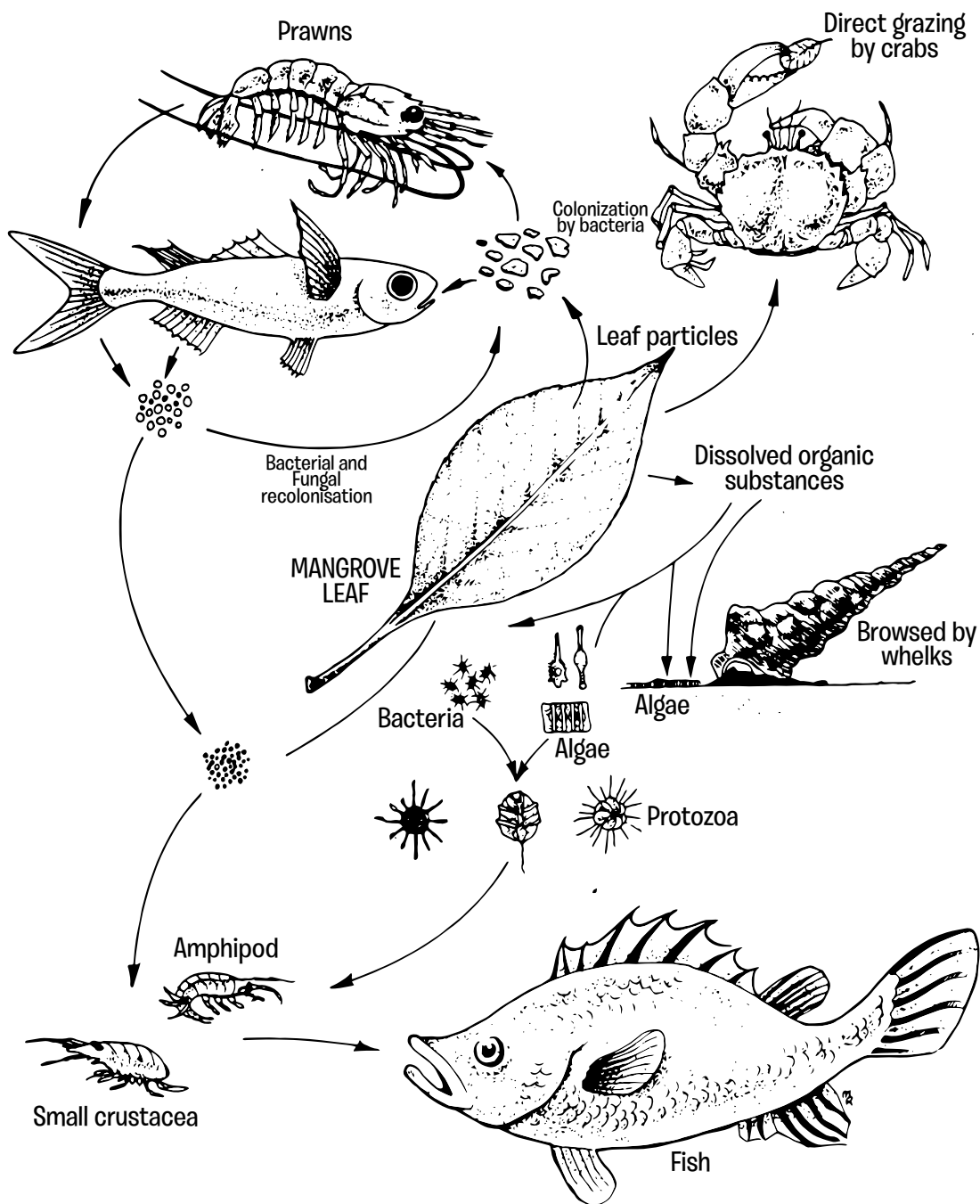


FIGURE 3 Ecological role of mangrove leaf in food chain (after Semeniuk 1972)

Mangrove Birds

According to Johnstone (1990) Western Australia has 22 species of bird which are virtually confined to mangrove communities; 13 of these occur in Karajarri country:

Striated Heron (*Butorides striatus*), which typically nests around December with a platform of sticks placed high in mangroves;

Bar-shouldered Dove (*Geopelia humeralis*), which typically nests around April with a flimsy nest of twigs in mangroves;

Mangrove Kingfisher (*Halcyon chloris*), which feeds mainly on fiddler crabs and nests around October in hollow mangrove trees;

Mangrove Golden Whistler (*Pachycephala melanura*), an insect-feeder which nests over the wet season with a cup-shaped nest in the fork of mangroves;

White-breasted Whistler (*Pachycephala lanioides*), an insect-feeder which nests over the wet season with a cup-shaped nest in the fork of mangroves;

Mangrove Grey Fantail (*Rhipidura phasiana*), an insect-feeder which nests over the wet season with a cup-shaped nest in the fork of mangroves;

Broad-billed Flycatcher (*Myiagra ruficollis*), an insect and spider-eater which nests over the wet season with a cup-shaped nest in the fork of mangroves. *Kuwiyimpirna*/Frazier Downs is regarded as its southern limit of distribution;

3 INTERTIDAL SYSTEMS

Shining Flycatcher (*Myiagra alecto*), an insect and spider-eater which nests over the wet season with a cup-shaped nest in the fork of mangroves;

Mangrove Gerygone (*Gerygone levigaster*), an insect-eater which nests after the wet season with a dome-shaped nest in hanging leaves of mangroves;

Dusky Gerygone (*Gerygone tenebrosa*), which eats mainly moths and butterflies and nests in the dry season with a dome-shaped nest;

Yellow White-eye (*Zosterops lutea*), an insect-eater which nests over the wet season, usually in the foliage of mangroves;

Red-headed Honeyeater (*Myzomela erythrocephala*), a nectar and insect-eater, which nests in March and September usually in the foliage of mangroves.

Panganunganyjarl is the name for a hill at Whistle Creek and **Jungkurljartiny** is a soak near Whistle Creek that is regarded at its southern limit of distribution;

White-breasted Woodswallow (*Artamus leucorhynchus*), an insect-eater which nests around September with a cup-shaped nest in mangroves;

Apart from many of the above birds, Black-necked Stork (*Ephippiorhynchus asiaticus*) and Brahminy Kite/**Jirru** (*Haliastur indus*) are further examples of birds, which typically nest in mangroves. Flocks of Whimbrel (*Numenius phaeopus*) often use mangrove branches for their high tide roosts.

Cultural Use of **Kunturungkarra**/Mangroves

The following names and uses of mangroves have been sourced from Lands (1987) and Yu (KFD, unpublished)

<i>Aegialitis annulata</i>	club mangrove
<i>Aegiceras corniculatum</i>	(leaves, wood and bark used for stupefying fish in pools)
<i>Avicennia marina</i>	Kunturung /grey mangrove (Lands, p.24). Fruits edible after soaking in mangrove mud until black, then boiling or roasting; usage has declined in the modern era
<i>Bruguiera exaristata</i>	(stems used for harpoons, spears and fishing boomerangs)
<i>Camptostemon schultzei</i>	Piyarlpiyarl /raft or kapok mangrove. Miyul is a type of mangrove worm that is found in the trunks (Joseph Edgar, pers. comm)
<i>Ceriops tagal</i>	Wirim /buttress mangrove. Wood used for fishing boomerangs (Yu, KFD unpublished)
<i>Excoecaria agallocha</i>	Kalkal /blind-your-eye mangrove (Yu, KFD unpublished). Sap poisonous, but wood used for shields; can't be used for cooking, as smoke is toxic (Joseph Edgar pers. comm.)
<i>Osbornia octodonta</i>	myrtle mangrove (branches used for making shelters)
<i>Rhizophora stylosa</i>	(prop roots, wood used for fishing boomerangs, spears, shields, firewood)
<i>Sonneratia alba</i>	(sweet nectar sucked from flowers; wood used for shields)

Purrku is an unidentified mangrove at Cape Bossut (Yu, KFD unpublished)

Mangroves are an important habitat for Karajarri people; because they provide numerous food resources including many species of fish, mud crabs, *Janga*/mangrove oysters and *Nirrn*/mud whelks or “long bum” snails.

3.6 WIRRNKI/SALTMARSH COMMUNITIES

Kenneally *et al.* (1996 p.38) separated these communities into “Samphire Flats” and “Saline Grasslands”. Either way, these typically occur behind mangrove communities in estuarine areas as broad saline tidal mudflats. The tidal areas generally feature broad expanses of bare mud devoid of vegetation because of excessive salinity. In contrast, supratidal areas support dwarf shrublands, dominated by species of *Tecticornia* [formerly *Halosarcia* spp], known as **samphires or glassworts**. Such plants are referred to collectively as *Wirrnki* by Karajarri people (Yu, 2000, p.35). These shrubs are sometimes reddish, purple or blue in colour and often feature swollen succulent internodes, giving plants a curious articulated appearance. Typical species are: *Jiliwiri* (*Tecticornia halocnemoides*), *T. indica*, *Neobassia astrocarpa*, *Suaeda arbusculoides*, *Sesuvium portulacastrum*, *Hemichroa diandra* and *Muellerolimon salicornaceum*.

The transition from succulent samphires to **saline grasslands**, dominated by *Kupan*/ saltwater couch (*Sporobolus virginicus*) is often marked by the presence of rice grass (*Xerochloa imberbis*) and the spreading dwarf shrub *Frankenia ambita* (Kenneally *et al.*). Saltwater couch is readily grazed by cattle at all stages of its growth, while rice grass is grazed at the end of the wet season. Other grasses in this community include *Dicanthium fecundum*, *Eragrostis eriopoda* and *E. falcata*. Common small shrubs of the marsh edge include *Ngurrpi*/marsh stemodia (*Stemodia grossa*), *Flaveria australasica*, *Hibiscus apodus* [formerly *H. panduriformis*], *Pluchea rubelliflora*, an undescribed *Pluchea* [sp. B. Kimberley Flora], *Streptoglossa odora* and the mat-forming *Phyla nodiflora*. Saltmarsh communities are subject to shallow sheet flooding, following heavy monsoon rains and/or equinoctial “king tides” – as a result, they are notorious for bogging 4WD vehicles. During the wet season, when saltmarsh is often flooded, birds such as black-winged stilts (*Himantops himantops*) often nest on top of samphires.

However, during the late dry season, when dried out and parched, they are a favoured location for mating *Kurturr*/brolgas (*Grus rubicundus*), which can often be seen dancing in a shimmering heat haze.

Cultural Use

Warrwarrjanka are freshwater seepages found in mudflats in the intertidal zone, which are only accessible at low tide (KCMP, p.15).

The fringes of saltmarsh are a favoured habitat for *Yarrinyarri*/bush onion (*Cyperus bulbosus*), whose small bulbs can be eaten raw, roasted in warm ashes or made into damper. They are also sought out by *Kurturr*/brolgas.

Pungent *Ngurpi*/marsh stemodia (*Stemodia grossa*) leaves are heated and rubbed on babies to relieve coldsick in a ‘smoking’ process known as *Parrpana*. Its leaf infusion can also be poured into ears to cure earache (Yu, KFD, unpublished).

Sarah Yu noted that certain samphires – probably *Jiliwiri* (*Tecticornia* spp.) - were chewed for moisture by thirsty travellers in past days.

The *Kalurn Kalurn*/saltmarsh shrub (*Trianthema* sp.) is noted for its edible *Karrutu* or cicada larvae, a type of *Pirna*, which are found in its roots. The larvae can be either roasted or boiled (Yu, KFD, unpublished).

4 MARINE FAUNA

4.1 YARI/WHALES AND NGARARR/DOLPHINS

Another Karajarri name for whale is *Putatan*.

The Kimberley coast is the tropical migration destination and calving ground for the largest population of humpback whales (*Megaptera novaeangliae*) in the world with a population estimated at 20,000 individuals. The annual northbound humpback whale migration pathway (June-July) passes west of the Lacepede Islands and skirts north of the Buccaneer Archipelago, as the mammals converge on Camden Sound, thought to be the principal calving and mating grounds in Western Australia. However, the southbound migration pathway followed by mothers with dependent calves (August-September) follows the coastline closely along the 20-30 m depth contour (Jenner, Jenner and McCabe, 2001). The annual humpback migration is increasingly important for ecotourism operators during the dry season in the Broome area and there is probably further scope to develop this from *Punturrpunturr*/Port Smith.

Coastal bays are known to support significant populations of bottlenose dolphins (*Tursiops* spp.), Indo-Pacific humpback dolphins (*Sousa chinensis*) and Australian snubfin dolphins (*Orcaella heinsohnii*) (Thiele, 2008). The latter are definitely present at *Pangarangara*/Gourdon Bay (Joseph Edgar, pers. comm). Snubfins were previously thought to be Irrawaddy dolphins (*Orcaella brevirostris*), now known to be an Asian relative. Australian snubfin dolphins feature a short, stubby dorsal fin with a melon-shaped head and lack a beak. Averaging only 2 m in length, they are typically found in groups of 6-15 individuals and squirt water in jets to catch fish, squid and crabs. As they favour turbid inshore waters with poor visibility, they are difficult to study.

Cultural Use

According to Yu (Expert Report, 2000, p. 22), Karajarri old people believe that breaching whales wake up all goannas and lizards from hibernation. The sound of a whale is said to resemble a baby crying; it is said to be the same sound a *Pulany* or Water Serpent makes.

According to the anthropologist Ralph Piddington (1935) there is a porpoise increase site at Lagrange Bay, in which

blood is attributed with magical powers. *Nanmarr* is the name for porpoise according to the Karajarri Dictionary.

4.2 NANARRU/DUGONG

Dugongs (*Dugong dugon*) were once found in tropical waters from the shores of East Africa to the western Pacific Ocean. Individuals typically reach 3 m in length and can live to 70 years; they become sexually mature at around ten years of age.

Dugongs are very social animals and typically travel in groups and, sometimes, large herds. At *Pangarangara*/Gourdon Bay, dugong may be seen traveling in mobs of 30 or more (Joseph Edgar, pers. comm.). Pregnancy lasts 13-14 months and mothers stay with their calves from three to as long as seven years. Their slow reproduction rate makes dugongs particularly vulnerable to over-hunting. Worldwide, many populations have declined for this reason. However, Western Australia probably has the largest remaining populations of dugongs. Shark Bay is a particular stronghold of the species.

Dugongs are herbivores, feeding primarily on sea grass: both leaves and rhizomes/roots. Although dugongs can dive to 15 m depth, most feeding takes place at around 3-5 m. Typical dives last 8 minutes, but when feeding they tend to surface every 1.5 minutes. The environmental impact of large herds of dugong can be tremendous and is an important factor in understanding their feeding behaviour and need to undertake migrations. It is known that cyclones often decimate sea-grass beds, causing dugongs to starve and this may be a factor in encouraging migration to less-impacted sea-grass beds.

In recent years, the advent of satellite tracking has enabled improved recording of local dugong migration patterns: a development in which Bardi Jawi rangers have actively participated since 2007 (Holley and Meister, 2010). In 2009, the Bardi Jawi Rangers expanded the project south, to include Nyul Nyul traditional owners from Beagle Bay. Four dugongs were tagged – three remained around Beagle Bay, while one was tracked south towards Port Hedland.

Ideally, a decade of data needs to be collected to better understand patterns of dugong migration along the Karajarri coast then interpret the data and develop predictive models.

Cultural Use

The Karajarri name **Nanarru**/dugong was supplied by Mervyn Mulardy to Tom Vigilante.

Dugongs do not have a major role in Karajarri culture and do not appear to have been particularly targeted for hunting. Yu (Expert Report, 2000, p. 22, 32 and 34) mentions that dugongs were occasionally captured in **Kurrjunggu**/stone fish traps or were sometimes found stranded during **Warrangkula**/big spring tides. On such occasions, they would always be carefully divided up amongst family members.

4.3 WILARR/TURTLES

Some other Karajarri names for turtles from the Dictionary are: **Jalayapulu**, **Kulupil** and **Wayarti**. Small turtles are **Kularapul** and **Nilamilkin**. A turtle flipper is **Jampan**.

Six species of marine turtle occur in Karajarri waters and all are listed as specially protected species under WA and Commonwealth legislation. **Jalayapulu**/flatback turtle (*Natator depressus*) is endemic to Australian waters and the principal species nesting on Karajarri beaches. Along the Kimberley coast, the most abundant marine turtles are typically the green turtle (*Chelonia mydas*) and the flatback turtle (Prince 1994). The former likes to nest on offshore islands such as the Lacepede Islands, Sandy Island at Scott Reef and Browse Island, while the flatback turtle nests on many mainland and island beaches along the Kimberley coast. While juvenile green turtles are carnivorous, once adults they graze almost exclusively on sea-grasses and seaweeds.

Even mangrove leaves are sometimes nibbled. In contrast, the flatback turtle is carnivorous for its entire life, feeding on soft-bodied prey such as sea cucumbers (trepan), soft corals and jellyfish.

From tagging studies carried out by R.I.T. (Bob) Prince and associates over many years at the Lacepede Islands, it is clear that this population of green turtles migrates long distances into eastern Indonesia, to the Arnhem Land coast and the Gulf of Carpentaria. However they never venture into Pacific Ocean waters through Torres Strait.

The advent of satellite tracking technology means that it is now possible to accurately track the migration path taken by turtles over long distances, rather than rely on endpoint tag recovery data. In November 2011, CVA with Woodside funding, deployed 6 KiwiSat 101 transmitters attached to flatback turtles at **Malampurr**/Eighty-Mile Beach (Conservation Volunteers Australia, 2012). The results showed that some turtles went south as far as Exmouth, but rather more proceeded up the west side of the Dampier Peninsula, going to Adele Island and as far north as the Holothuria Bank in the Timor Sea, which is now thought to be an important feeding ground.

There is a large flatback turtle nesting ground at Cape Missiessy (Joe Edgar, pers. comm.) and other major nesting areas in the Nyungamarta zone of **Malampurr**/Eighty-Mile Beach. November to December is peak nesting with peak hatching in February-March.

Many juvenile turtles live on Karajarri reefs (Joseph Edgar, pers.comm.)

Cultural Use

Turtles were sometimes captured in **Kurrjunggu**/stone fish traps or hunted on moonlit nights. Large turtles are always carefully divided up among family members.

The eggs of the flatback turtle are called **Jimpu** and are considered a delicacy by Karajarri people; they are harvested in **Laja** season (Yu, Expert Report, p.22).

The Karajarri people dig up and eat the eggs of flatback turtles, but it is not a big focus; it is more of a supplementary food (Joseph Edgar, Shirley Spratt and Anna Dwyer, pers. comm.).

Petri-Odermann (1963, p.12) records the following Karajarri song, associated with turtle hunting:



“**Wilarr Gantijanaia Wilarrpa**/turtle hit turtle - **Palpala Palpala Palpala**/baldy head, baldy head, baldy head - **Wilarr Maru Kinjangkani Kunkulu**/turtle hit on head - **Wilarr Jinkanu**/turtle hit - **Palpala Palpala Palpala**/baldy head, baldy head, baldy head”

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4.4 TARRTARR/SEABIRDS AND WADERS

Some of the fish-dependent seabirds known to frequent Karajarri sea country include:

Wedge-tailed Shearwater (*Ardenna pacifica*) – tends to forage well out to sea;

Lesser Frigatebird (*Fregata ariel*) – robs other seabirds; nests at Bedout Island and West Island, Lacepedes;

Brown Booby (*Sula leucogaster*) - nests at Bedout Island and the Lacepedes;

Lesser Crested Tern (*Thalasseus bengalensis*);

Little Tern (*Sternula albifrons*) – typically nests on sand-spits and creek mouths;

Roseate Tern (*Sterna dougallii*) – a population of about 3,000 individuals resides at the northern end of **Malampurr/Eighty-Mile Beach** (SEWPAC, 2012, p.9).

Silver Gull (*Larus novaehollandiae*) is called **Wintiri Taturu** in Karajarri. Their closest nesting site appears to be the Lacepede Islands.

Elkin (1933) refers to **Mulan** as being a **diving bird**, found at the coast: its identity is unclear. The Karajarri Dictionary (p. 65) gives **Kutilykutily** as the name for a “banded plover”.

The southern Kimberley coast is known to be an internationally important destination for many wader species, which nest in Siberia and Mongolia and disperse to summer feeding areas via the East Asian Australasian Flyway. Research to date has focused strongly on **Malampurr/Eighty-Mile Beach** and Roebuck Bay, which have both been designated as “Wetlands of International Importance” under the Ramsar Convention, signed by Australia in 1971. The Australian Commonwealth Government signed international treaties with Japan (JAMBA, 1974), China (CAMBA, 1986) and South Korea (ROKAMBA, 2007) to protect the habitat of migratory waders. Wader species of extreme importance in the southern Kimberley include: **Bar-tailed Godwit** (*Limosa lapponica*), **Terek Sandpiper** (*Xenus cinereus*), **Grey-tailed Tattler** (*Heteroscelus brevipes*) and **Great Knot** (*Chadrius leschenaultii*).

Malampurr/Eighty-Mile Beach

This area is believed to support around 450,000 intertidal shorebirds with 19 species found in internationally-significant numbers (Rogers *et al.* 2011, p.384). Bird counts over the past several decades have established beyond doubt that it is the single most important shorebird site in the whole of Australasia! Some of the maximum counts recorded there since 1999 are:

Great Knot	169,044
Bar-tailed Godwit	110,290
Greater Sand Plover	64,584
Red Knot	29,679
Red-necked Stint	28,443
Grey-tailed Tattler	14,647
Terek Sandpiper	9,820
Curlew Sandpiper	7,984
Red-capped Plover	6,752 [non-migratory resident, nests here].

In addition, the **short grass coastal plains** – typical of **Yawinya/Anna Plains Station** – support three significant migratory species that depend on this habitat. These are: Oriental Pratincole (*Glareola maldivorum*) which made the headlines in 2004, when an incredible 2.88 million birds were counted (Sitters *et al.*); Oriental Plover (*Charadrius veredus*) with 144,300 birds and Little Curlew (*Numenius minuta*) with 14,200 birds.

The combination of high quality estuarine feeding habitat and adjacent undisturbed high tide roosts have been identified by researchers such as Rogers *et al.* (2006) as critical to the viability of wader populations. Reclamation of mudflats for industry in China and Korea, especially around the Yellow Sea, where many waders stage their migration (e.g. Great Knot) is a major concern for the long-term viability of populations (van de Kam, 2010).

The whole Karajarri coast warrants further summer-focused survey effort to (a) describe and ascertain the importance of their intertidal habitats; (b) identify and quantify the migratory wader populations utilising these areas and associated high tide roosts; and (c) make recommendations for local conservation initiatives/ecotourism opportunities.

4.5 FISH

There is no generic word for fish in the Karajarri language.

Fauna Surveys

Karajarri waters support a very diverse range of tropical finfish species. A survey in 2000-2002 across the region recorded 352 species from 194 genera in 82 families (Travers *et al.*, 2003). The most common families were: Carangidae (trevally and queenfish), Serranidae (cods), Bothidae (flounders), Lutjanidae (snappers) and Tetraodontidae (puffers).

Cultural Use

The Karajarri Dictionary has a vast vocabulary of fish names:

Jangkatany	eel
Jayumartaji	stone fish (venomous)
Jijajartukapu	whiting
Jijangarnkapu	whiting (King George whiting)
Jilwitingurru	short mullet
Julunimin	whitefish
Kalil	bonefish
Kapuru	small-mouth catfish
Kirrpiti	boxfish (venomous)
Kulparn	mid-size sea-mullet
Kunapu	flathead
Kunkunpiny	bream
Kunkununu	toadfish or blowfish
Kuparu	little mullet
Lamparrngapa	gropser
Larrkalinykaliny	large sea-mullet
Layajartu	sardine
Lujuka	flat fish
Makanya	sergeant-major fish
Mangarryiti	stonefish (venomous)
Mangkanyiti	giant herring
Manti	barramundi
Matinyangu	barramundi

Mungku	bream (with yellow tail)
Munjirrti	rock cod
Nikilpatinya	eel
Ngapanakan	bluebone
Ngarayulu	flathead
Ngarikurany	catfish
Nyuni	young salmon
Palkurr	large rock cod
Panganu	salmon
Pararr	long tom
Parntirrpantirr	striped rifle-fish
Pinkamaran	big catfish
Pirala	whiskery salmon
Rirrkalinya	whiting
Tiluntartu	barramundi
Tirrka	mulloway or kingfish; (Yu, 1998, p.10) gives this as 'queenfish' and notes its connection to Tirrkangurru, the creek at False Cape Bossut.
Tukujala	poisonous fish
Walka	bream
Wanmiji	poisonous fish
Warringurru	queenfish
Winjilparri	flathead
Wirrkalinya	long-nose whiting (sand whiting)
Witany	blue-tail catfish
Witiyiti	pearl perch
Wulu	small bluebone
Yalpalparinyangu	rock fish
Yangalu	garfish
Yantalaraku	poisonous fish
Yapananya	butterfish
Yatanginya	flathead
Yilany	red snapper
Yilinjinri	small skipjack
Yingaliwa	bluebone

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Karajarri Fishing Culture

According to Yu (Expert Report, 2000, p.29) when the **Panganu**/salmon were running in **Parrkana** season, even inland people would come down to the coast.

Deep pools are known as **Parrala** or 'resting waters' and are considered good places for bluebone, snapper and turtle (Doris Edgar in Yu, 1998, p.9).

According to Smith (1997, p.85) there are significant gender-based differences in Karajarri customary fishing practise. Typically men target larger fish, while women focus on marine foraging and catching smaller fish. Piddington (1932, p.344) observed at Lagrange Bay that "crabs, cockles and oysters are collected by women, but the larger fish are caught by men". Smith noted that there has been a decrease in the collection of shellfish, crabs, birds' eggs and *Avicennia* mangrove fruits over several decades. Women especially continue to collect shellfish and crabs. Oysters and mud crabs tend to be popular with older women. Shellfish appear to be the preferred food only when fish are scarce, otherwise shellfish and crab are more likely to be used as bait to catch more highly-prized fish.

Petri-Odermann (1963, p.8) noted: "men and women mostly went on their forays separately...men and women fished at different spots. Also many more women than men fished". The reason for this is that more men than women are in formal employment and thus have less time for daily fishing, while women are tied by having children in school. Routine fishing excursions are typically led by older women, who look after pre-school children and typically walk to favoured fishing spots. Men, either alone, in small groups - or accompanying family - typically fish on weekends or holidays.

At holiday time, families frequently use vehicles and camp for several nights at favourite fishing spots. In 1996 Smith (p.79-80) noted that **Yimparangoo** near Red Point north of Cape Frezier, **Panganunganyjarl**/Whistle Creek, **Nantanarr**/Black Rock Point, and Chinaman's Beach were especially favoured. She contrasts this with 1950s data listing **Lirinangapa**/Post Office Creek, **Mantarnar**/Rocky Point, and **Pitirngapa**/Black Rock Point and **Lalurrjartu**/False Cape Bossut Creek as being the most popular spots.

An extremely significant role of women in Karajarri culture lies in the transmission and retention of customary knowledge of fishing skills. Most coastal dwellers are introduced to fishing and crabbing under the guidance of adult women in extended family groups, when they are young children. Typically, a child learns from their aunt or grandmother. Children begin by playing, but observe their elders closely. By age five, they are often attempting to use handlines in imitation of elders (Smith, 1997, p.90).

An important role of fishing is that it supplements store-bought food and typically meagre community incomes (Smith 1997, p.89). Fishing is also important in maintaining a sense of identity as a Saltwater Person. Marine foods are both prized and the preferred food of many coastal people, who depend both physically and psychologically upon them.

Elkin (1933, p.292-293) detailed **Talu**/increase ceremonies conducted for **Panganu**/salmon at **Jungkurljartiny**/Whistle Creek and **Panganunganyjarl**/Whistle Creek hill, **Luja**/a small flat-fish at **Pangarangara**/Gourdon Bay lagoon and for an unidentified fish at a place south from Bidyadanga community.

Yu (Expert Report, 2000, p.21) mentions **Wintanayi** as a bluebone increase place, where a stone is rubbed or **Karulpunya**.

Nganku or Putukunata/Sharks

There is a wide range of sharks in Karajarri waters. It is believed that shallow waters off **Malampurr**/Eighty-Mile Beach are significant nursery areas for some shark species. All four species of **sawfish** found in Australia also occur in Karajarri waters (*Pristis clavata*, *P. microdon*, *P. zijsron* and *Anoxypristis cuspidata*).

Sharks are a prized food for Karajarri people. According to Yu (Expert Report, 2000, p.22) during **Laja** season, **Jurrwayi**, the slit-eye shark is **Manga** for fat and considered a particular delicacy.

The Karajarri Dictionary gives the following:

Larraparri	hammerhead shark
Nganpil	shovelnose shark (also called Palari and Pinjana)
Pilkiliny	tiger shark

Pintany/Rays During the dry season, shallow waters off **Malampurr**/Eighty-Mile Beach are often the focus for large aggregations of plankton-eating Manta Rays. **Pintany**/Stingrays are prized by Karajarri people and the following kinds are recognised:

Jangaparri	stingray with shell on its back
Jaya	spotted stingray
Kalukalupiki	short-tailed stingray
Kamari	stingray with barbed tail
Kinkin	blue-spotted stingray with a short tail
Makawal	big long brown stingray
Manyural	big long stingray
Pintany	brown stingray (prized as food)
Puwarr	fat stingray
Yarapa	fat stingray
Yupukuru	black stingray with a flat tail

Other recognised species include:

Yamiyarra	spotted eagle ray
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Yu (Expert Report, 2000, p. 22-23) states that the four principal types of stingray considered edible by Karajarri and speared in the shallows during **Laja** season are:

Jaya	white-spotted back
Jangaparri	large oyster back
Wakajartu	large, cowtail (with bitter-tasting fat)
Yupukurru	brown-spotted back

She also notes that Karajarri people do not eat the **Kirnkim**/small blue-spotted ray, which is found in reef pools. After cleaning, edible stingray are thrown on coals, quickly cooked and eaten straight away.

Kurrjunggu/Stone Fish Traps

Moya Smith (1997, pages 20-43) investigated and measured these structures at nine sites on the Karajarri coast, but suggested additional sites would be found with more fieldwork. These were once the most popular and effective methods of catching fish along the Kimberley coastline with its large tidal cycle. Few stone traps have been in use on the Karajarri coast since the 1960s (Smith, p.88). All trap types utilise locally available stones, ranging in size from 10-60 cm diameter. Fish, feeding on a rising tide, are stranded behind walls or in enclosures, which block natural drainage channels as the tide recedes.

Yu (Expert Report, 2000, p.6) remarked that **Kurrjunggu** are no longer in use “because fishing lines, nets and steel-tipped spears are more portable, effective and less labour-intensive”.

Joseph Edgar (pers. comm.) noted that **Kurrjunggu** effectively create reef habitats and rock pools over time. Typical catches from **Kurrjunggu** include: salmon, tripletail, bluebone, Chinaman fish, barramundi cod, rock cod, Spanish flag, small turtle, crabs and octopus.

Karajarri **Kurrjunggu** often feature stone lines across a sandy substrate and multiple traps – clusters of more than three or four traps being widespread.

Proceeding from south to north, the nine sites recorded (with many sketched and photographed) by Smith were:

Upanganyjarl - Cape Jaubert South (Registered site K00650), multiple traps.

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Mirrikajayirti - Cape Jaubert North - one trap.

Panakajarra - Cape Frezier (Chinaman's Beach) - 5 or 6 traps.

Nanggoona - Admiral Bay (Registered site K00652), 6 traps.

Yarrtjarra - Black Rock Point (Registered site K00656), large single trap.

Pitirragapa/False Cape Bossut (Registered site K00657), 6 traps. Culturally significant site believed to have been created by an Ancestral Being, who subsequently travelled on. Recorded by Petri-Odermann (1963) as the focus of increase ceremonies for flounder (flat fish).

Galyunga Pitirragapa/False Cape Bossut (Registered site K02772) - multiple traps. Fish increase ceremonies were held here.

Jipngurru Punturrpunturr/Port Smith - site recorded by Sue O'Connor in 1992, a single trap.

Cape Gourdon – five traps slightly east of the Cape.

Smith also noted that there were numerous natural rock pools at Japula's Beach/**Bamboo Landing**, near Bidyadanga, which are sometimes locally referred to as "fish trap".

Marrku/Mangrove Wood Weirs

Moya Smith (1997, p.24) noted that temporary weirs of woven mangrove mangroves or mangrove stakes, backed with brush or spinifex were constructed across tidal creeks to catch fish in much the same manner as **Kurrjungu**/stone traps (or commercial nets). Petri-Odermann (1963) recorded the use of three-piece woven mangrove 'fences' with a removable gate, dropped at the turn of the tide at Lagrange Bay in 1960. These weirs were only effective for short periods before the force of the tides dismantled them.

According to Yu (Expert Report, 2000, p. 20) **Marrku** were principally for catching salmon.

Kurralinj/Fishing Boomerangs

Moya Smith (1997, p.11) noted that these were originally made of light mangrove wood, typically **Wirirn** (*Ceriops tagal*), which had the advantage of floating in water after

throwing. Since European colonization, fishing boomerangs following a similar template are sometimes cut from sheet metal. Either way, they are thrown to stun fish, typically mullet, in shallow water.

Wajirri or Mirliny/Fishing Spears (wooden) or Pinjira (metal)

In 1960, Petri-Odermann described men fishing at Lagrange Bay with simple unbarbed wooden spears, which appear to have been the precursor of the metal-tipped spears found throughout the south-west Kimberley today. Moya Smith (1997, p.11) noted that the current favoured fishing spear is 3-4 m long, its wooden shaft made of *Acacia*, to which is hafted a length of wire rod approximately 7-10 mm in diameter and c. 50 cm long. While some women and girls use these fishing spears, they are more commonly made and owned by men and teenage boys.

Also in common use is a smaller wooden fishing spear c. 1 m long and 1-2 cm in diameter with both ends pointed. These are typically used as jabbing spears for inshore fishing and reefing by women.

Many older women prefer to use "wires" or digging sticks made of metal rod, typically 8-10 mm in diameter and 1 – 1.3 m long. These usually have one end filed to a point and have multiple uses. They are ideal for prising shellfish off rocks, stabbing crabs, digging and can be used as a walking stick or for warding off dogs.

Harpoons

According to Moya Smith (1997, p.11), harpoons used by Karajarri males are similar to fishing spears, but made from heavier and thicker eucalypt saplings. Likewise, the metal rod is thicker and longer and typically is bound to the shaft with metal wire, usually c. 1 mm in diameter.

Fish Dissection and Distribution

Karajarri protocols are still alive today, even though some customary practices have deteriorated over time. Usually, the in-law family members get the best portion and old people too (Bidyadanga Workshop).

Fishing with **Panjurta**/Natural Poisons

Panjurta (*Tephrosia rosea*) is a small leguminous shrub with mauve flowers, common in coastal sand dunes. The roots contain a powerful chemical, rotenone, which is toxic to fish. Usual practise is to grind up the roots, roll them in sand and put the mixture into rock pools. The released toxins effectively stun the fish, so that they rise to the surface, where they are easily secured by hand or spear.

Smith (1997, p.87) noted that very few people now routinely use fish poisons, but sporadic use is sufficiently common that most teenagers know where, how and when to collect and use them. This technique is mostly used in rockpools to get bluebone and bream.

Yu (Expert Report, 2000, p.35) notes that there is a prohibition on using **Panjurta** during **Wiralpurru** and **Parrkana** seasons, when **Jurarr Yuli**/muddy water prevails and **Panganu**/salmon are present. This is due to a belief that salmon might smell the poison and become frightened away. **Panjurta** should be deployed during **Wilpuru** season (p.21).

Fishing with **Wiliwili**/Lines

Moya Smith (1997, p.17) noted that men, women and children commonly carry from two to six hand reels with fishing lines. Men usually have heavier duty lines as they seek larger fish, while women and children carry lighter tackle suitable for beaches, tidal pools and creeks. Fishing gear (such as lines, hooks and lead sinkers) is generally sourced at the community store or in shops in Broome.

Line fishing is nowadays the primary fishing activity for both men and women (Smith 1997, p.87). Every individual has several handlines wound either onto plastic reels or around small branches. Every woman carries a fishing bag with lines, spare sinkers, hooks, a sharp knife and often a tomahawk for smashing bait. Younger and middle-aged women tend to favour large knives in contrast to older women's favoured "wires". Men do not generally carry fishing bags.

Fishing with Nets

Smith (1997, p.18) related that both men and women are adept at using small throw nets with c.15-40 mm mesh to collect baitfish.

Larger gill nets with 70 mm mesh and 25-50 m long can be found in most communities and seem to have been in use since about the 1950s when Petri-Odermann (1963) recorded their first use at Lagrange Bay. However, they are quite expensive to purchase and require considerable effort to maintain and repair. Sometimes they are secured to star pickets, effectively replacing **Kurrjungu**/stone wall fish traps. John Dudu advised Moya Smith that most Karajarri people "were not really interested in fishing with [stone] traps any more but used nets instead".

Night Fishing with **Ngatura**, **Yurra**/Paperbark Torches

Moya Smith (1997, p.12) relates that before the arrival of battery-powered torches and gas lanterns, Karajarri people used paperbark torches. Petri-Odermann (1963, p.11) relates:

"The men used to enjoy going out at night to catch fish when the surf was not too strong. They would attract fish with large firebrands. In 1954 we took part in a nocturnal fishing expedition. Large fires were lit on the beach at which the women sat, whilst the men, standing up to their knees in water, threw one fish after another on to the shore: north-west salmon, more than half a metre long and a few sharks, either speared or hooked".

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4.6 WANTAJIRR/SEA-SNAKES

Sea-snakes are air-breathing reptiles. The majority of species have shallow benthic feeding patterns, rarely venturing into water deeper than 30 m. However, a few pelagic species can possibly descend to 100 m depths (Heatwole, 1999). All species are listed under the EPBC Act.

Ashmore Reef and the Kimberley coast support an unusually high diversity of marine sea snakes, making the area internationally significant for them, although the ecology of many species remains poorly known (Guinea, 2007). Many species are potentially threatened by trawling operations. For example, olive sea snakes (*Aipysurus laevis*) live for more than 15 years and take longer to reach sexual maturity than other sea snakes. Populations have declined over the last 10-30 years and severely declined at Ashmore Reef, but for reasons which are not understood.

The Karajarri Dictionary (p.91) gives three words for sea-snakes: **Jikatany**, **Wantanjirr**, **Yatanya**. However it is unclear which species these are.

Senior elders clarified that **Jikatany** is actually the mangrove snake (*Fordonia leucobalia*) and is good for eating. **Wantajirr** is the spectacled sea-snake (*Disteira kingii*), which gives a vicious headache and bad luck for fishing. **Yatanya** is very common on **Malampurr**/Eighty-Mile Beach but not edible (Bidyadanga Workshop).

Yiralyi/Cape Jaubert is an important site scientifically for sea-snakes, as the Swedish zoologists Lonnberg and Andersson collected the type specimen of Mjoberg's or the brown-lined sea-snake (*Aipysurus tenuis*) here in 1913. The WA Museum also holds specimens of the horned sea-snake (*Acalyptophis peronii*) and the spectacled sea-snake (*Disteira kingii*) from **Yiralyi**/Cape Jaubert, as well as two specimens of the north-western mangrove sea-snake (*Ephalophis greyi*) from La Grange (Smith, 1974).

4.7 MARLAR/SHELLFISH

Cultural Use

According to Yu (Expert Report, 2000, p.21) **Wilpuru** is considered the best season for Karajarri people to get shellfish. Sandy areas produce **Yirrnanany**/cockles and **Marla**/conch or trumpet shell. Reefs are best for **Jakuli**/small pearl shell, **Punymin**/hairy mussel, **Jingkarapanti** and **Pinka**/baler shell, while in the mangroves are found **Yirrngan**/cockles and **Janga**/small oysters and **Nirrn**/bum snails or mud-whelks and long **Pangalu** which have hermit crab inside them, [Anna Dwyer, pers. comm.]

Yu notes that shellfish are either cooked on coals or by a method called **Tampal**, whereby stones are heated in a fire, then removed with the shellfish placed on hot stones and covered in sheets of paperbark.

Large baler shells or **Pirrnka** were traditionally highly valued as water containers and often left inland at water holes, (Anna Dwyer and Shirley Spratt, pers. comm.).

Mangarr/clams or were collected from reef areas for food. **Jami Jami**/razor shell is not a usual food source for Karajarri people, but is sometimes consumed by people who have tasted it while visiting the Dampier Peninsula (Bidyadanga Workshop).

Riiji/pearl shell (*Pinctada maxima*) is valued for its meat. Shells are also expertly engraved with elaborate geometric designs and rubbed with red ochre. Such shells are traditionally worn by men on a hairbelt covering the pubic region at Law ceremonies. Akerman and Stanton (1994, p.14-17) examined Aboriginal trade in pearl shell and noted that engraved shells had been bartered as far afield as Carnarvon and central Australia.

4.8 WANGKATJA/CRABS

The Karajarri Dictionary lists the following:

Mantarn	ghost crab (<i>Ocypode</i> spp.)
Mayakaya	hermit crab
Pangalu	“small black crab found in mangroves in shells”
Wangkaja	mud crab
Wunjurru	“a red, black and white crab - with a flipper like a crayfish”
Yilinpajangka	“green crab with black hands”

Sand-bubbler crabs (*Scopimera inflata*) are not used for anything while soldier crabs (*Mictyris longicarpus*) are good bait for reef fishing (Bidyadanga Workshop).

Cultural Usage

Beach-dwelling *Mayakaya*/hermit crab (*Coenibita* spp.) are often used as handline bait for catching bluebone. Moya Smith (1997, p.86) noted that blue swimmers and ghost crabs are used almost exclusively as bait.

Wangkaja and *Warrpalu*/mud crabs are a valued food, associated with mangrove habitats (Yu, Expert Report, 2000, p.21). Two species (*Scylla serrata*, *S. olivacea*) occur in Karajarri waters. Moya Smith (1997, p.86) noted their popularity as a food by older women.

4.9 BENTHIC FAUNA

Keesing *et al.* (2011) reported on four epibenthic dredge operations conducted at *Pangarangara*/Gourdon Bay in June 2008. The total area of surveyed seabed amounted to 927 square metres. A high biomass of corals – notably branched and unbranched Gorgonians - were recorded. Eight species of hard corals were present. Seventeen “other Anthozoans” were collected. Twenty-one species of macroalgae were collected, but surprisingly no seagrass beds were noted. *Caulerpa* and *Halimeda* were the most abundant of the green algae (Chlorophyta). Seven species of brown algae (Phaeophyceae) were collected, as well as a single species of red algae (*Asteromenia exanimans*). Sponge (Porifera) diversity was high with 23 species while Ascidiaceans numbered 19 species. Five species of hydroids formed large colonies, attached to shallow-water reef and rubble bottoms. They are reportedly adapted to fairly turbid conditions and mild to strong current flows.

Thirty-nine species of Crustacea were identified at *Pangarangara*/Gourdon Bay, some of which were undescribed. Bivalve mollusc diversity was relatively high with 30 species present. Echinoderms were abundant on soft bottom substrates with unusually large numbers of heart urchins (*Breynia desorii* and *Lovenia elongata*) present.

Polychaete worms are a ubiquitous component of the fauna of virtually every marine habitat in the Kimberley. In sand or mud-dominated habitats they are frequently both the most diverse component of the invertebrate fauna and the most abundant. Unfortunately, the taxonomy of Kimberley marine polychaetes is still woeful. Benthic research at Roebuck Bay has revealed that intertidal polychaetes can be an important food source for some species of migratory waders, e.g. curlew sandpiper and red-necked stint (Pepping *et al.* 1999, p.158-160).

5 MARINE CONSERVATION

5.1 MARINE THREATS

Tsunamis

Australia's highest tsunami hazard region is northwest Australia, where a low-lying coast is exposed to occasional tsunamis generated off the coast of Indonesia. Following the Krakatoa volcanic eruption in 1883, adjacent to Java, there is anecdotal information that tsunami waves were experienced at Derby (where the woolclip was washed away) and at Broome. In 1977, an earthquake SW of Sumbawa Island generated a 6 m tsunami at Cape Leveque, while in 1994 an earthquake in the Java Trench generated a 4 m tsunami at the same location. Recognition of tsunami risks to the Australian population has been relatively recent (Anon. 2010).

Invasive Species

Increased shipping associated with the growth of the resources sector in the north-west has potential implications for the marine environment. Apart from obvious risks such as oil spills (e.g. Montara in the Timor Sea, August 2009), the possibility exists for the introduction of marine pests through ballast water discharge and contaminated ship hulls. The latter is believed to have been responsible for the introduction of black-striped mussel (*Mytilopsis sallei*) into Cullen Bay marina at Darwin in 1999. This pest posed such a major hazard to the pearling industry (then worth \$225 million annually) that the N.T. and Federal Governments were forced to chemically treat all of Darwin's marinas to successfully eradicate the pest.

Climate Change

Increases in sea level are already being observed and greater increases are anticipated in coming decades. The exact amount will depend largely on the speed of polar ice melt in Greenland and Antarctica. Impacts on the Kimberley coast are expected to be most visible on low-lying islands such as Adele and the Lacepedes. Their huge seabird colonies and, in the case of the Lacepede Islands, nesting beaches for green turtle are expected to be severely impacted (Burbidge 2010, p.17-19). Other impacted environments are expected to be beaches, mudflats and mangroves (Semeniuk, 1994).

Further implications:

- More cyclones and storms;
- More female turtles born than males;
- Fewer sandy beaches for turtle and coastal birds to nest;
- Damage and loss of coastal cultural sites;
- Damage to seagrass beds reduces populations of green turtle and dugongs;
- Changes to numbers and species of fish;
- Increased coral bleaching and death of reef corals;
- Loss of mangroves;
- Sea spreading further inland, making coastal wells brackish or saline;

Oceanic Acidification

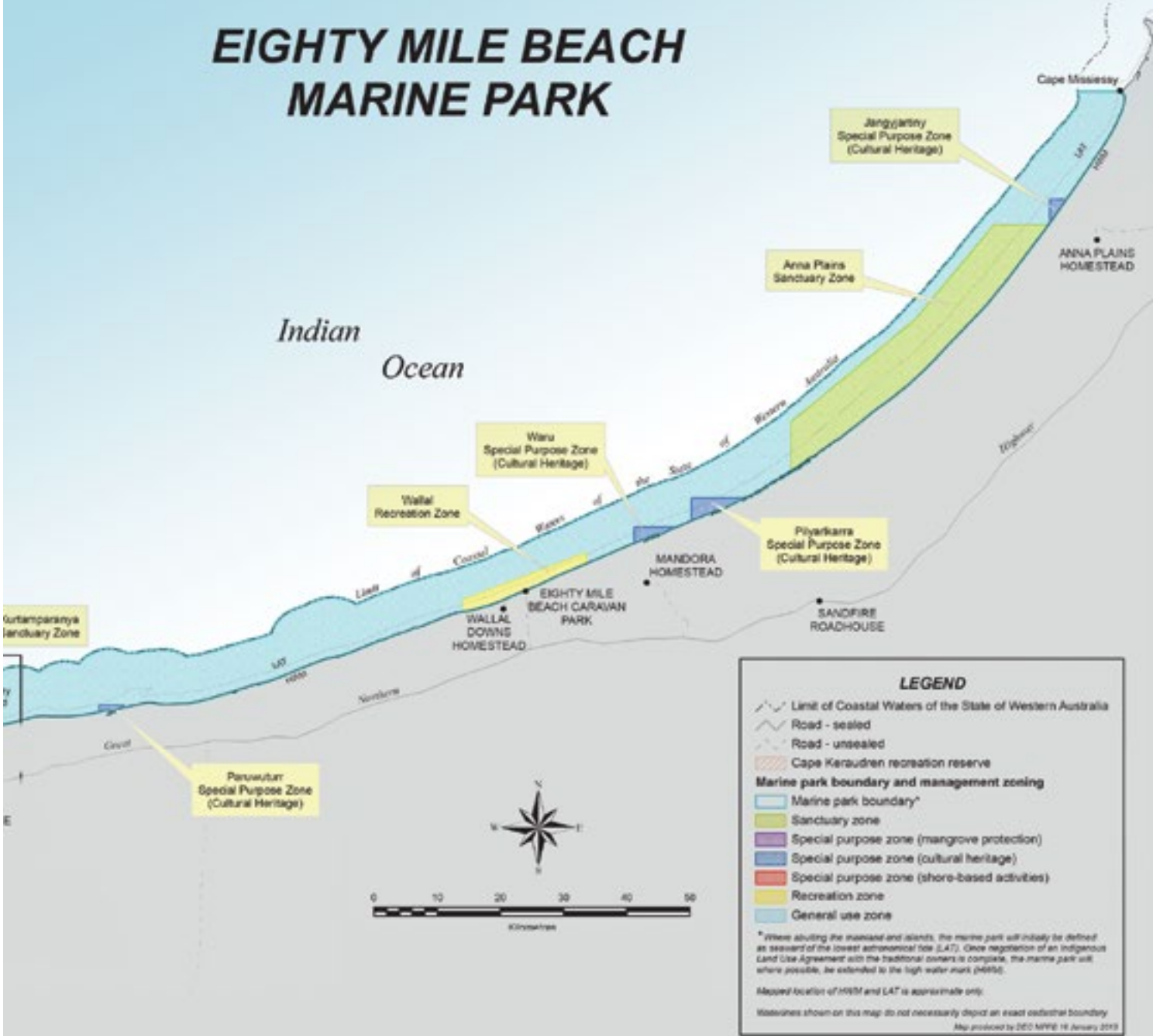
The burning of fossil fuels is not only driving climate change, but also increasing the acidity of the world's oceans. The effects of increased oceanic acidity on marine ecosystems are rather worrying. The resultant decrease in the carbonate saturation state of seawater has the potential to damage coral reefs, calcium-dependent organisms and marine ecosystems generally. Some scientists believe it may initiate a shift from coral-dominated ecosystems in the tropics to seaweed-dominated systems. Latitudinal shifts in coral reef species southward are also likely, as tropical reef communities decline in the north (Australian Coral Reef Society Conference, 2007).

5.2 MALAMPURR/EIGHTY-MILE BEACH MARINE PARK

In June 2011, the State Government released its \$63 m Kimberley Science and Conservation Strategy. One of the key components of this was to create a new Marine Park for Malampurr/Eighty-mile Beach. An Indicative Management Plan was accordingly released for public comment, with submissions considered up to January 2012.

For the first time in WA history, the Marine Park proposed zoning to include **cultural heritage zones** for the three Indigenous Native Title holders: Karajarri, Nyangumarta and Ngarla as part of joint management arrangements

EIGHTY MILE BEACH MARINE PARK



MAP 3 Zoning proposed (January 2013)

5 MARINE CONSERVATION

envisaged through ILUAs. The Karajarri area, near Anna Plains homestead, is called the **Kalanyjartiny Special Purpose Zone**. Traditional hunting is permitted. However, Karajarri are understood to be the last of the three groups to be formally engaged in negotiations (Alan Byrne, DEC Broome, pers. comm.).

The new Marine Park, covering 210,000 ha, was formally launched in January 2013 by Environment Minister Bill Marmion. Some 71% of the Marine Park comprises general use zones, which means that commercial pearling and recreational fishing continue as previously. Around 25% of the Marine Park comprises sanctuary zones, designed to protect habitat, e.g the **Anna Plains Sanctuary Zone** protects key parts of the Ramsar Wetland including the intertidal zone, supporting the largest populations of migratory waders.

The budget announced to establish and manage the Marine Park is \$5.3 million over four years, channelled through DEC and the Dept. of Fisheries. From 2014-5 onwards, the annual budget is supposed to be \$1.4 million.

5.3 PROPOSED MARINE PROTECTED AREA

In Western Australia, the Marine Parks and Reserves Authority (MPRA) is the statutory vesting authority for marine conservation. It has identified the Kimberley region as requiring priority attention in respect to the future establishment of marine parks. The current State Premier, Colin Barnett, has been a strong advocate of this process being hastened, but much of the focus has recently been on the north-west Kimberley coast.

The WA Government supposedly remains committed to establishing a state-wide representative marine conservation reserve system, based on the Wilson Report (1994), which recommended potential areas for consideration as marine conservation reserves or parks.

Proposed Lagrange Bay Marine Park

In respect to Karajarri sea country, the Wilson Report (Part III, p.22) recommended:

“That there be further study of the flora, fauna and habitats of the coastal waters, tidal creeks and supra-tidal flats between Cape Latouche Treville and Cape Bossut including Lagrange Bay, and an assessment made of the present commercial and recreational uses of these areas, with a view to the selection of the most suitable sections for reservation for the purposes of public recreation and protection of flora and fauna”.

Despite the passage of nearly 20 years, nothing seems to have been done to advance this recommendation, suggesting that it has a low priority with both the State Government and the Marine Conservation Branch of the Dept of Environment and Conservation.



MAP 4 Proposed Lagrange Bay Marine Park (Wilson Report 1994)

6 TERRESTRIAL ENVIRONMENTS

6.1 CUSTOMARY LAND TENURE AND TOTEMS

According to Elkin (1933, p.265), Karajarri country is divided into a number of “horde countries” or estates called **Ngurra**, which are for the most part patrilineal and patrilocal.

In other words, a man belongs to the horde of his father and has free access to the horde-countries of his mother and his father’s mother. Each horde has associated with it one or more dreaming-totems or **Pukarrikarra Janga**. The term **Ngurra** is also applied to a person’s spirit-home: the place in which he was “found” by his father. Elkin (1933, p. 272-275) recorded the totems associated with 45 Karajarri **Ngurra**, which he located on a map (p. 277). Karajarri totems are diverse including many plants, animals, birds, snakes, fish, cockles, stingray, thunder, whirlwinds and rainbow.

According to Elkin, a particular totem is generally thought to be abundant in its associated **Ngurra** and there is an increase centre for the majority of totems. Some of these can be standing stones or holes in either the ground or rock, where special ceremonies are performed, which include the recital of words expressing desire for the spirits of the totemic species to go forth and increase. Elkin noted that men of the **Purungu-Karimba** [i.e **Karimpa**] moiety “own” and lead ceremonial rites, **Talu**, for bluebone, sugarbag, cockles, garfish, ants, “native plums”, locusts, galah, wallaby, rock-fish, porpoise, crab and salmon. In contrast, the men of the **Panaka-Paldjeri** moiety play the lead role for stingray, quoll, goanna, crow, flounder (flat-fish), eels, wedgetail eagle, pearl-shell, calm weather, possum and bandicoot. Many of these ceremonies were prohibited to women, though not all. Elkin (1933, p.289-290) noted that the timing of **Talu** was always dictated by Karajarri seasons e.g. **Wilpuru** is associated with **Talu** for stingray, ants, locusts, goanna, wallaby, eels and bluebone.

Elkin noted that camping arrangements around the former Feeding Station at La Grange followed the pattern of people’s estates. Thus coastal families camped on the **Kara**/west, southerners or **Kuljangkarti** [“Kulandjadi mob”] on the south, the [“Linjagading mob”] on the south-east and the **Mangala** [“Manala mob”] on the east (revised at Bidyadanga Workshop).

6.2 CLIMATE

Karajarri country has a tropical climate with a distinct wet season from December to March, during which almost all the annual rainfall is received and humidity is usually high. Total rainfall varies markedly from year to year.

The median annual rainfall at Bidyadanga is 506.6 mm (Bureau of Meteorology 2008). Much of the heavy rainfall received during the wet season is associated with thunderstorms and the near proximity of cyclones. Typically, these begin west of Darwin in the Timor Sea and run along the seaward side of the Kimberley, before making landfall in the Pilbara region or drifting off into the Indian Ocean. Gale force winds during cyclones can reach 160 km per hour (or more for Category 5 cyclones).

Cyclones can cause major damage to infrastructure and natural ecosystems – especially sea grass beds, mangroves and large trees. In a cyclone during April 1884, 140 persons drowned when 40 pearling luggers sank off **Malampurr**/Eighty-Mile Beach. La Grange Mission was devastated in 1964 when Cyclone “Bessie” dumped 483 mm of rain in twenty-four hours. The school and hospital were flattened and there was extensive damage to staff quarters, dormitories and huts in the “native camp” (Zucker, p.145). In December 2000, Bidyadanga community had to be evacuated and sustained major infrastructure damage from a Category 5 Cyclone “Sam”.

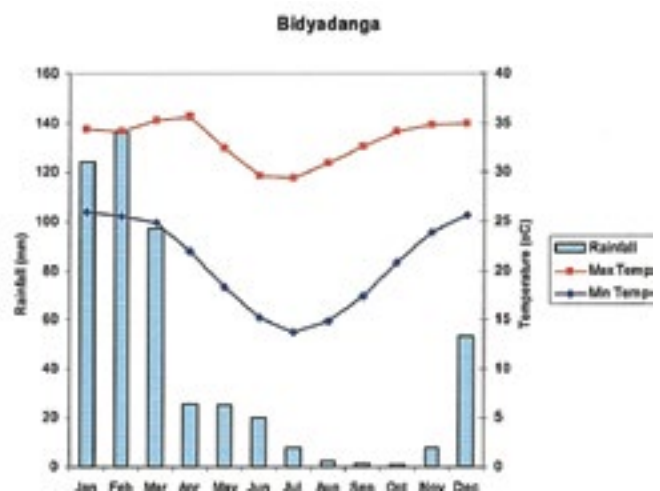


FIGURE 4 Bidyadanga Climate Graph

6 TERRESTRIAL ENVIRONMENTS

A large percentage of the season's rainfall is effectively lost through evaporation. Average evaporation for Broome is estimated at 2,860 mm per year.

Mean daily maximum temperature at Bidyadanga is 33.2 degrees C, while the mean daily minimum is 20.8 degrees C. Extreme recorded temperatures at Bidyadanga are 47 degrees C and 3.9 degrees C. Occasional winter frosts are likely to be experienced inland e.g. at Dragon Tree Soak. On the Karajarri coast, sea fogs and mist sometimes occur in the winter months.

Cultural Use

Yu (2002, p. 42) gives:

Kuju Kuju (changed)	willy-willy or dust-devil
Wiriliwirili	clouds raked up, causing big dust

Yu (Expert Report, 2000) gives:

Japurr	early morning "dew" clouds (associated with Laja) (p.22); also fog, attributed to Pulany or Water Serpents (p.48)
Jitama	lightning (p.53). Also thunder [Bidyadanga Workshop]
Marrkarla	long, dark rain-cloud (p.53) [spelling changed at Bidyadanga Workshop]
Mulanan	first rains (p.24)
Wangal Jarangu	cyclone (p.24)
Wangal	breezy wind
Yaman	sea-breeze

Rainmaking

Yu (2002, p.45) noted that in a bad season, Karajarri go to **Jila** to make rain. Under the direction of a **Yiliwirri** – a senior man who holds knowledge relating to the water source and the knowledge to make rain – people perform rituals at the **Jila** to induce rain. Particular songs and body designs are employed as people dig the **Jila** in a prescribed way, throwing the mud out to attract the rain. Some of the body designs represent **Wilany**/small boomerang-shaped clouds,

while others represent the "rain birds" **Kitirr** and **Wiyurr**. On completion of the ceremony, there is celebration and the **Yiliwirri** places an eagle's feather in his headband. Rain is believed to then follow the feather and fill up the soaks. The prestige of a **Yiliwirri** increases with his ability to generate **Mujungu**/winter rain, large thunderstorms and lightning. A powerful **Yiliwirri** can even steer cyclones - either away from or towards - particular areas.

6.3 GEOLOGY, GEOMORPHOLOGY AND RANGELAND LAND SYSTEMS

Geology

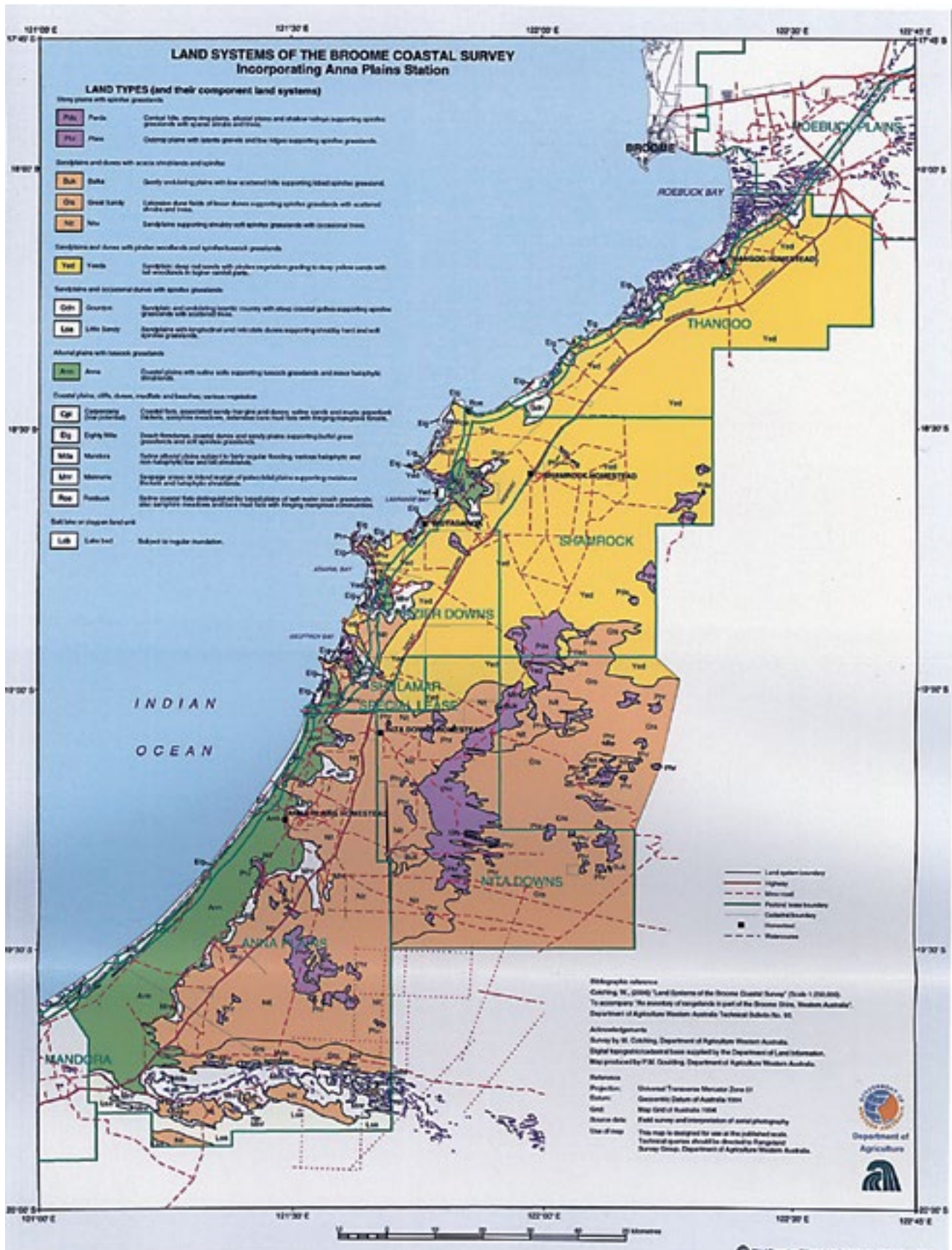
All Karajarri country lies in an area of sedimentary deposition known as the Canning Basin, which has been submerged by the sea in four geological epochs (Towner, 1982; Gibson, 1983). Aspects of the geology of the Canning Basin – especially its potential for oil and gas- have been explored in detail by Purcell (1984).

During the Cretaceous period, a shallow sea covered the area, depositing mud and fine sand as deltaic sediments. These Cretaceous sediments are now exposed at isolated, eroding mesas such as Parda Hill, Willara Hill and Mt Phire. During the Tertiary, following land emergence, deep weathering took place resulting in extensive laterite formation (known locally as "coffee rock").

The major event in Quaternary times has been the creation of a vast sandplain with inland dunefields of long, parallel red sand dunes. It is thought that when these dunes formed (25-14,000 years ago), the climate was extremely arid with desert winds 30% stronger than now. The Quaternary sea level was slightly higher than present. During this time, estuarine sediments were deposited along the coast: especially at **Malampurr**/Eighty-Mile Beach, creating the wide coastal plains.

Geomorphology

Cotching (2005, p.9-12) identified five "geomorphic districts" in Karajarri country. Only one, the **Kimberley Surface**, is erosional and runs in a narrow belt across Shamrock and Nita Downs. He identified four depositional units: **Sandplain**, [Inland] **Dune Fields**, **Coastal Dunes** and **Coastal Plain**.



MAP 5 Lands Systems of Karajarri Country (Cotching, 2005)

Eliot and Eliot (2008, p.53-60) briefly examined coastal geomorphology at Pangarangara/ Gourdon Bay and Purnturrpurnturr/Port Smith, when the former area was under investigation as a possible LNG hub. Semeniuk (2008) explored coastal sedimentation during the Holocene in enormous detail, describing a number of new stratigraphic units from the area.

Rangeland Land Systems

During the 1950s, CSIRO scientists first used this methodology to describe the key characteristics of country, in terms of landforms, soils and vegetation. Cotching (2005) identified 14 Land Systems in Karajarri country, eleven of which he described in detail with estimated carrying capacity for cattle. Only one Land System (Anna) was

6 TERRESTRIAL ENVIRONMENTS

identified as having high pastoral value with a carrying capacity of 9 hectares per cattle unit. Two others (Roebuck and Mannerie) were rated as having moderate pasture value with Roebuck having a carrying capacity of 24 hectares per cattle unit and Mannerie as 19 hectares per cattle unit. It should be noted that Roebuck Land System, dominated by **Kulpan**/saltwater couch (*Sporobolus virginicus*) occupies the most productive areas of KTLA's own **Kuwiyimpirna**/Frazier Downs.

More recently, Payne and Schoknecht (2011) described all 111 land systems of the Kimberley alphabetically in a standard format with improved photographs and mapping.

Cultural Use

O'Connor and Veth (1993, p.30) noted the presence of pieces of yellow ochre, derived from lenses in pale sandstone, at a coastal midden (Site 4) near Cape Gourdon. The Karajarri Dictionary gives two words for yellow ochre: **Karntawarra** and **Kumpari**.

Ngurrkul is red ochre. **Purrku** is black ochre. **Kalji** is white ochre and a type of clay. All of these ochres are used in ceremonies and are found on Karajarri country (Bidyadanga Workshop). There is also **Papakuna**, which is blueish-grey ochre, and another type of white ochre used in ceremonies is called **Lali** (Wittadong Mulardy, interviewed by Anna Dwyer).

6.4 KURTANY/GROUNDWATER

According to Yu (2002, p. 42), **Kurtany** means literally the 'mother of all water'. According to a Senior Elder:

"The big water, the mother of water, **Kurtany**, keeps the water level. It keeps the water alive. Same like the mother of a human being. That's the mother of the water level. The water is from the **Pukarikarra** – it's underneath. The water underneath doesn't live free – it travels underneath, from the high country to the sea."

Yu (2002, p. 53) also noted that the Karajarri further distinguish "bottom water" or **Jarurru** which is described as

a "big stream" which travels underground and emerges as artesian or free-flowing bores. Such waters are invariably brackish.

The **La Grange Basin** is one of the state's largest groundwater resources. Prior to planning, licensed water use was 1.8 gigalitres per year (human use) and 3.0 gigalitres per year (stock use). The latter modest, mainly pastoral usage has been the pattern since the 1880s. In the 1990s, Western Agricultural Industries (WAI) proposed growing broad-scale irrigated cotton on 20,000 ha of Karajarri land, seeking 90% of the known groundwater: a terrifying prospect to Traditional Owners!

In 1998, WAI signed an MOU with the State Government to progress this proposal. WAI was instructed by the Waters and Rivers Commission [now Dept. of Water] to fund further studies into the aquifer. In 1999, WAI commenced cotton trials at Shamrock, which had been purchased by WAI, along with Nita Downs. At this time, Karajarri people were pursuing their Native Title struggle. In 2001, WAI decided to cease aquifer investigations until Native Title issues were determined. However, the Karajarri people have been distressed to discover that, despite winning Native Title for their lands, their say over water rights is quite limited by current legislation (Weir, Stone and Mulardy, 2012). Fortunately for Karajarri, WAI's groundwater investigation licence expired late in 2004 and they neglected to renew it.

As part of water planning, three key studies were undertaken:

- Scoping of issues from key stakeholders (Beckwith and Associates 1999);
- An anthropological report on Aboriginal cultural values of groundwater by Sarah Yu (2000); [from which also derived Yu (2002)]
- A report on the hydrology and geomorphology of wetlands by the Semeniuks (2000).

The key **stakeholder issues** emerged as: likely negative impact on pastoral bores (drawdown effect and accelerated saline intrusion); leaching of fertiliser and pesticides into groundwater and the lack of any remaining groundwater for other future uses!

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A notable innovation was that Yu and the Semeniuks were instructed to undertake fieldwork together, which resulted in Karajarri people collaborating with scientists, from which both parties received many benefits. The Karajarri were able to guide and pass on a wealth of local knowledge and years of observations, which saved the scientists both time and money. At the same time, Karajarri were able to ensure the scientists complied with cultural protocols and gained insights into understanding the hydrology of their own country. What particularly impressed Mervyn Mulardy Junior was:

“The old people had names for different levels of groundwater, and how it moves. At the end of the day, everything the old people were saying matched up with the scientific version. So the scientific knowledge and traditional knowledge were the same.”
(Interview at Bidadanga, 14 October 2008)

Yu (2002, p. 38) detailed Karajarri’s profound **cultural connection** to groundwater in all its forms. For example, she describes how most ‘living waters’ or **Ngapa Kunangkul** are believed to be inhabited by **Pulany**, metaphysical Water Snakes or Serpents, which both created and still reside in permanent water sources. Some **Pulany** are said to live in the sea. **Pulany** may also be referred to as **Jurru**, which is the generic word for all snakes, while young **Pulany** are called **Mila**. The term **Pulany** is sometimes also used for **Jila**. Indeed, some **Jila** are said to have once been men who roamed in the **Pukarrikarra** and then transformed themselves into **Pulany** by going into the ground. They exist as powerful living presences in the country with the unique capacity to transform elements. They are seen in the heavens as stars; in the skies as clouds, wind, rain or dew; in the ground as water and under the ground as **Jalkana** or burrowing reptiles. For example at Narrkanja, Luma, the blue-tongue lizard transformed into a **Jila** with the power to make **Jitama** or forked lightning.

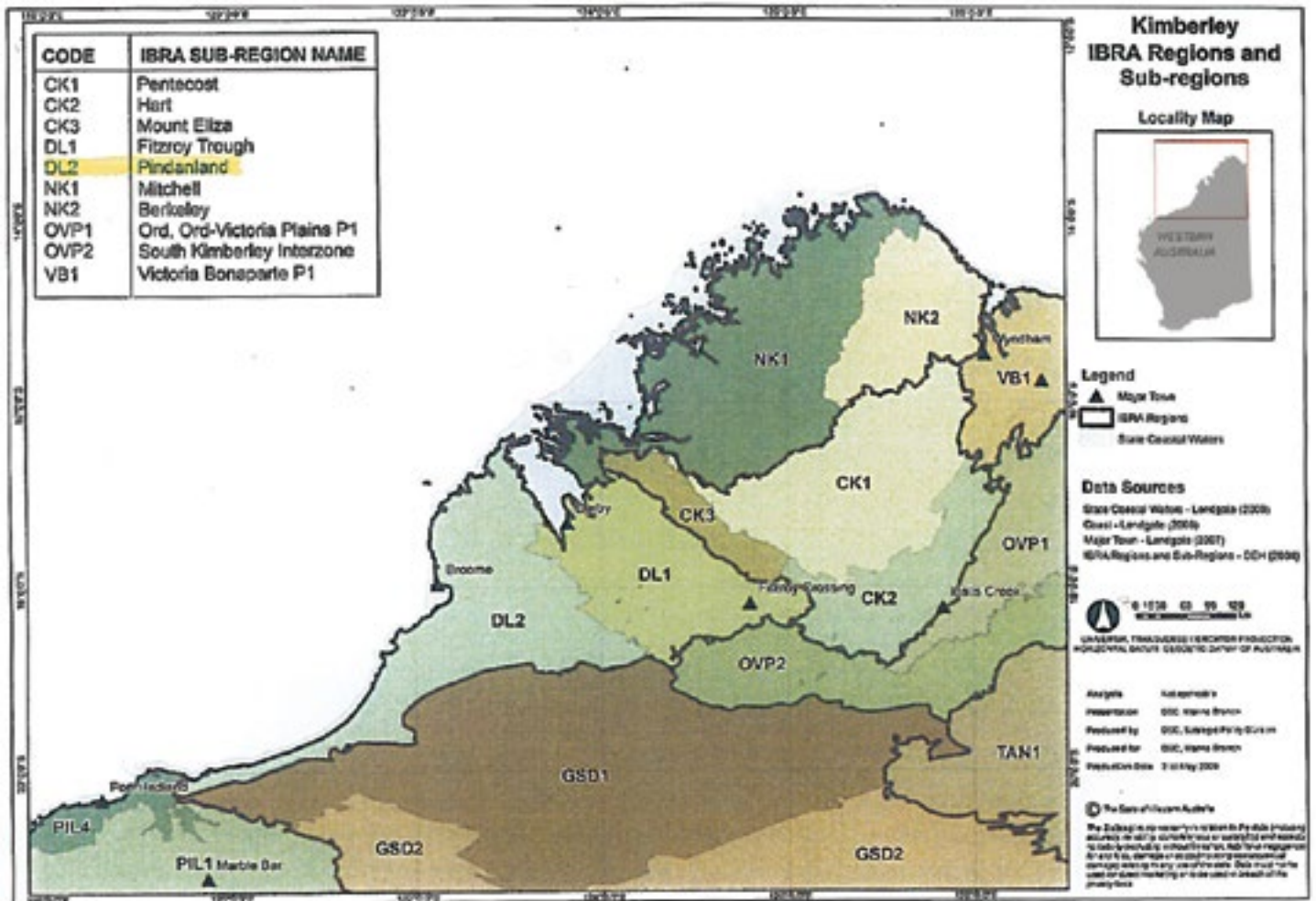
The Semeniuks report (2000) found that there were **three distinct hydrological zones** in Karajarri country:

- The northern area, where mainly fresh groundwater resides at depths below surface in excess of 10 m in the Broome Sandstone;
- The southern area, where fresh, brackish and saline groundwater lies at shallow depths and emerges (as at **Walyarta**/Mandora Marsh) from beneath calcrete limestone sheets;
- The coastal fringe, where fresh to saline groundwater is expressed as scattered springs or belts of **Jurnkul**/paperbarks (*Melaleuca alsophila*), forced up by Quaternary white coastal muds, known as **Kalji**.

In 2008, the **draft La Grange groundwater allocation plan** was released for public comment. A Karajarri-Kriol version was prepared as a film (Mathews, 2008). This level of engagement has set a benchmark for future engagement between water planners and Traditional Owners in WA, or for that matter, nationally.

Finally in 2010, the **La Grange groundwater allocation plan** was finalised. The plan sets the allocation of water for consumptive purposes at about 25% of what was estimated when the WAI saga began! The total allocation limit is now 50 gigalitres per year for all extractive uses in the La Grange sub-basin. However, the basis of allocation is still a “first come, first allocated” basis, which favours incoming developers over resident Traditional Owners with different values of country (Weir, Stone and Mulardy, 2012).

In late 2012, the WA Dept. of Agriculture and Food announced an **aerial survey of groundwater resources** in the La Grange sub basin, funded by the State Government’s Royalties for Regions program to “scope the feasibility of mosaic irrigation developments” (press release, 6 November 2012).



Terrestrial Bioregions and Sub-regions of the Kimberley. NK = North Kimberley, CK = Central Kimberley, DL = Dampierland, VB = Victoria-Bonaparte and OVP = Ord Victoria Plains.

MAP 6 Terrestrial Bioregions and Sub-Regions (IBRA)

Data from the Airborne Electromagnetic (AEM) survey is expected to provide 3D data of the groundwater, which will be followed up by ground-based drilling. Project manager Chris Ham was quoted as saying:

“We are interested in defining the salt and freshwater interface near the coast, water quality distribution and the hydraulic properties of the Broome sandstone on a regional scale”.

However, some Karajarri people worry that this project will – once again - inevitably increase pressure for expanded irrigated agriculture in their country.

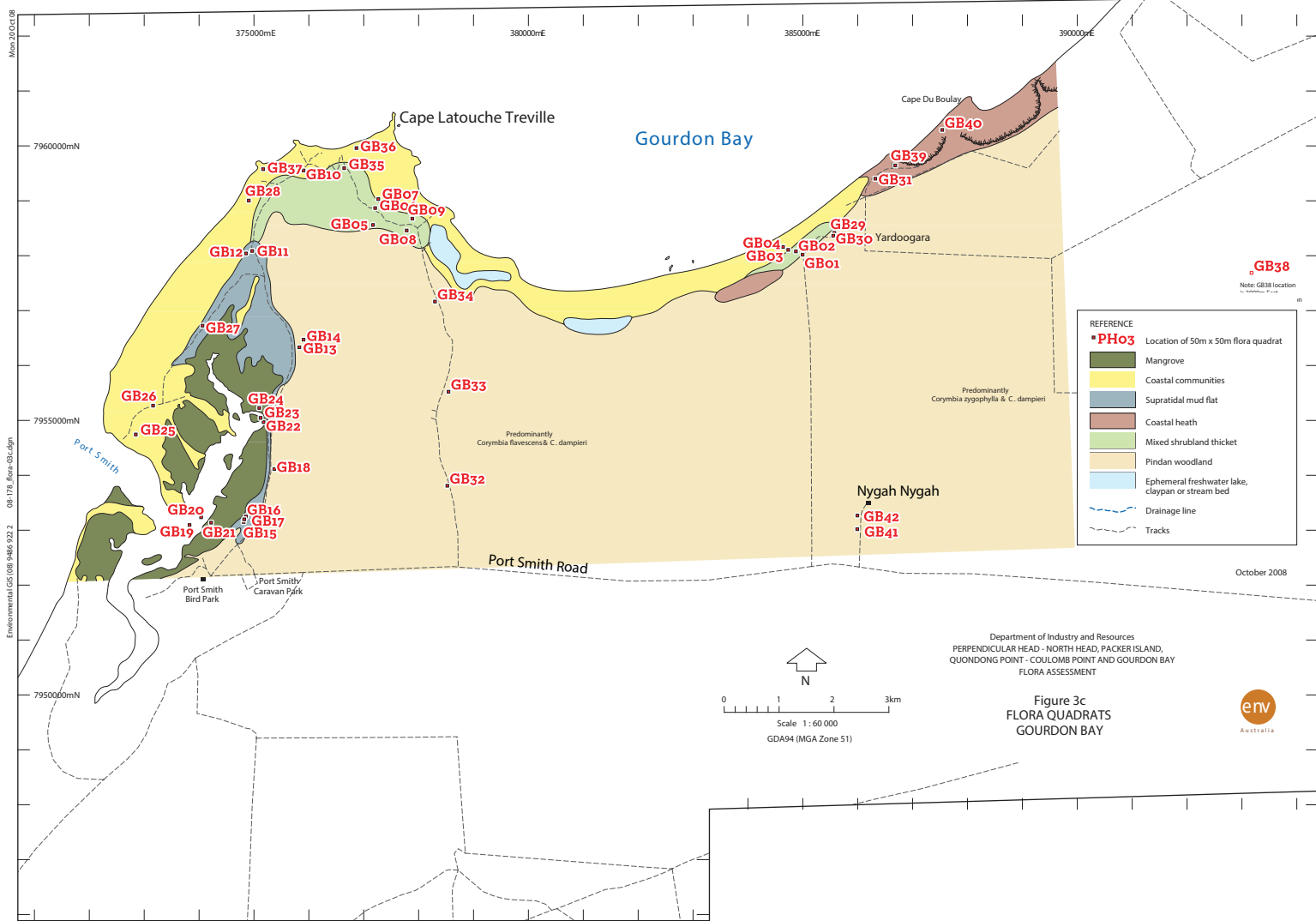
6.5 IBRA SUB-REGIONS:

In 2002, a biodiversity audit was conducted of W.A.'s 53 Biogeographical Subregions by May and McKenzie. These Subregions had previously been identified by the Interim Biogeographic Regionalisation of Australia (IBRA) initiative.

Dampierland 2 (DL2 – Pindanland Subregion)

Most of the settled portion of Karajarri country lies at the southern end of the **Pindanland Subregion**, a vast area (5,198,904 ha) extending from **Malampurr/Eighty-Mile Beach** to the Fitzroy River. The Subregion is dominated by sandplains supporting a variety of pindan vegetation types.

Graham (2002) identified 13 vegetation types as occurring within this unit, which included a number of riparian and floodplain communities, associated with the Fitzroy River catchment. Accordingly, fewer vegetation types are present on Karajarri country.



MAP 7 Vegetation Communities and Flora Quadrats at Gourdon Bay (2008)

Great Sandy Desert 1 (GSD1 - McLarty Subregion)

Much of the more arid eastern and southern portions of Karajarri country fall within the **McLarty subregion**, which covers 13,173,266 ha. The dominant vegetation is hummock grassland of spinifex (*Triodia* spp.) with scattered wattles and bloodwoods. Extensive dunefields with red, parallel dunes are characteristic. Occasional low hills such as the McLarty Range and laterite surfaces also occur. Claypans are few, while Dragon Tree Soak is a rare true oasis. In the far south of Karajarri country, the Mandora Palaeoriver system supports a chain of salt and gypsum lakes (such as **Walyarta**) where calcrete and evaporate surfaces are significant. A complex swarm of mound springs (such as Eil Eil) lies on the southern side of these, supporting an unusual closed forest of tall paperbarks (*Melaleuca leucadendra*). At the present time, knowledge about the biodiversity values of much of this subregion remains patchy and inadequate.

6.6 HABITAT MAPPING

The vegetation communities of the Kimberley region were mapped by Beard (1979), but at a scale of little value for land management purposes. Since then the only published mapping of vegetation communities in Karajarri lands was that undertaken by Kenneally *et al.* (2008) for the **Pangarangara/Gourdon Bay** hinterland, at a time when the area was under possible consideration for a LNG hub.

Fine-scale vegetation mapping at 1:50 000 or greater is a high priority for improved land management planning in Karajarri country.

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The Karajarri make a major distinction between habitats on the **Jurarr** or coastal side and those on **Pirra** - the inland or 'bush side' of country (KCMP, p.13).

By far the most detailed account of vegetation communities in Karajarri country was compiled for the **Pangarangara**/Gourdon Bay and **Purnturrpurnturr**/Port Smith area in 2008 (Kenneally, Willing and McIntyre; McIntyre and McCann). The first report identified, briefly described and mapped seven vegetation communities, while the second report goes into great detail, identifying 171 plant species recorded from quadrat surveys at 42 locations. It also identified species of conservation significance and weeds.

7.1 WINTIRRI/COASTAL DUNE AND WARNKU/LIMESTONE COMMUNITIES

Unlike many tropical coastlines, the Karajarri coast apparently receives rather few tropical drift seeds, which have floated over long distances.

Foredunes behind sandy beaches are generally sparsely vegetated with the coastal grass *Spinifex longifolius* and more patchily with the hardy sedges *Fimbristylis cymosa* and *F. sericea*. These species are adapted to tolerate sand burial, salt spray and wind-blast. Often present are the **Waljaru**/beach morning glory (*Ipomoea pes-caprae*), a creeper with long pliable stems, **Jantara**/rolypoly shrub (*Salsola tragus*) and a low herb *Euphorbia* sp.

Sandy beaches are an important nesting habitat for **Kurttil** **Kurttil**/little tern (*Sterna albifrons*), red-capped plovers (*Charadrius ruficapillus*), and **Wiluru**/beach stone curlew (*Esacus neglectus*), all of which have proved vulnerable to 4WD vehicles accessing beaches. This is because these species have camouflaged eggs and favour nesting in lines of seaweed or broken shells.

The 2008 papers noted that at **Pangarangara**/Gourdon Bay **stabilised dunes** are dominated by **Nilarrangka** (*Acacia bivenosa*) with scattered **Palnga** (*Crotalaria cunninghamii*). Other shrubs included *Mallotus nesophilus*, *Myoporum montanum* and *Terminalia ferdinandiana*. **Pratirpratir**/mulla-mulla (*Ptilotus exaltatus*) and **Panjurta**/flinders river poison (*Tephrosia rosea*) were significant herbs. Introduced buffel grass (*Cenchrus ciliaris*) is actively colonizing dune vegetation.

Cultural Use

Many burial sites are located in coastal sand dunes. The southern end of **Pangarangara**/Gourdon Bay is renowned for having large **Riiji**/pearl shell, used for ceremony and trade (KCCMP, p. 52). **Warnkurru Jina**/fossilised human footprints occur at several locations in coastal limestone rock. Scientists say these could be 4,500 years old (KCCMP, p. 60). Yu (1998, p.9) noted that small caves in the limestone, known as **Turrpu**, served as shelter during the wet season.

Marraja are bough shelters, made from paperbark, used for shade on coastal dunes, for people resting between spells of reefing (Yu, Expert Report, 2000, p.21).

Archaeology of coastal middens

In 1991, archaeologists Sue O'Connor and Peter Veth (1993) examined middens at **Pangarangara**/Gourdon Bay, Cape Du Boulay and Cape Gourdon. Shell scatter sites returned dates between 3100 BP [Before Present] and 1390 years BP. The Cape Gourdon Site (site 4) yielded *Barbatia* cockles, mussel, baler, pearl shell and thiad, as well as sandstone grinding and processing stones. A radiocarbon date obtained for the *Barbatia* was 1800 plus or minus 70 years BP.

Two types of grinding stones are recognised by Karajarri people, **Kurtanyanu** (bottom stone) and **Jungari** (top stone). Also frequent in middens are **Wiluru**: a sort of oilstone used for sharpening spear-heads, axes and flakes (Yu, 2002, p. 54).

At **Pangarangara**/Gourdon Bay, two sites were examined – one on a crescent-shaped red Pleistocene dune (site 19) and the other in a hollow in white Holocene sand dunes (site 20). Site 19 yielded the mudwhelks *Terebralia* and *Telescopium telescopium*, oyster, thiad, pearl shell, *Barbatia* sp., *Tapes variegata*, baler, *Anadara granosa* and *Tridacna* clamshell. *Terebralia* shells were assayed at 3060 plus or minus 50 years BP. Site 20 contained *Nerita undata*, mussel, the cockles *Barbatia* sp., *Tapes variegata* and *Paphia* sp., baler, *Saccostrea* oyster, *Hexaplex stainforthi*, giant *Tridachna* clam, trochus and mudwhelk (*Terebralia* sp.). Several broken sandstone-grinding stones were also noted, as well as post-contact flaked glass. A *Terebralia* sample returned a date of 1700 plus or minus 60 years BP. Interestingly, the presence of mudwhelks along this open coast suggests the

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former presence of shallow lagoons with mangroves, where now no mangroves exist.

Plant Use

Yarrinyarri/bush onion (*Cyperus bulbosus*), a small sedge, often grows on coastal dunes. In April-May, when the plant shrivels up, the bulbs are ideal for digging and eating. They can also be cooked in hot ashes. Bulb skins can be removed by rubbing the bulbs between the palms of one's hands. This practise is called **Wiranya** in Karajarri (Lands, 1987, p.29).

Palnga/Mangarr/green birdflower (*Crotalaria cunninghamii*), a frequent dune shrub, has both medicinal and practical uses. Crushed leaves can be boiled to make a wash for coldsick and earache, as well as juice for eyedrops. The bark provides rope and can be fashioned into bush sandals, to protect the feet from hot sand.

Panjurta (*Tephrosia rosea*), a shrub in the pea family, often grows on coastal dunes. Its roots are a culturally important fish poison, used in reef pools.

7.2 COASTAL SWALE THICKET COMMUNITIES

This community is closely associated with **relict pink Pleistocene sand dunes**, lying immediately south from **Pangarangara**/Gourdon Bay. The typical tree groves include **Jikily** (*Bauhinia cunninghamii*), **Mirta**/Helicopter Tree (*Gyrocarpus americanus*) and **Nyaminyari**/Gubinge (*Terminalia ferdinandiana*). The locally important bushfood **Makapala**/bush banana/ (*Marsdenia viridiflora*) climbs into the canopy. Kenneally *et al.* (2008, p.9) note that this community occupies the same ecological niche as vine thicket, occurring at or north of Broome, but lacks the species diversity and assemblage structure of those communities.

Cultural Use

Jikily (*Bauhinia cunninghamii*) is valued for its edible gum, called **Minta**. Sugarbag or **walaja**/ bush honey is often found in the trunk. The **Jirrpiliny**/red flowers can be sucked for their sweet nectar in the early morning. The boiled bark is considered good for bathing skin sores, while the firewood is valued for burning without smoke.

Makapala/bush banana (*Marsdenia viridiflora*) is a climber bearing large green fruit, which are collected during the wet season and eaten raw; texture is crisp and the immature seeds taste much like young green peas (Lands, 1987, p.7; Kenneally *et al.* 1996, p.63).

Mirta (*Gyrocarpus americanus*) is valued for its soft, yellowish wood, which was traditionally used for coolamans and shields. The wood is avoided for cooking because it imparts an unsavoury taste to food. Powdered charcoal was applied directly to wounds to assist healing, while an infusion of the bark was applied to old or partially healed cuts and sores.

7.3 COASTAL HEATH COMMUNITIES

The 2008 **Pangarangara**/Gourdon Bay study (Kenneally *et al.*) noted that this community was dominated by low, wind-pruned shrubs of **Parlmangu**/poverty bush (*Acacia stellaticeps*, which for many years was known as *A. translucens*). This community was noted only around Cape Du Boulay on ferruginised gravels and sandstone.

Cultural Use

Parlmangu (*Acacia stellaticeps*) is used for medical purposes by Karajarri people. The foliage can be crushed and boiled to provide a skin balm, good for sores and itches. People sometimes get smoked using the leaves, as it helps relieve "coldsick" or **Kinkirrita**.

7.4 JURNKURL/SALTWATER PAPERBARK COMMUNITIES

Kenneally *et al.* (1996, p.37-38) noted that this vegetation community commonly occurs along the inner, landward margin of saline grasslands, i.e above the reach of most tides, although not necessarily above equinoctial or “king tides”. The transition may be abrupt or gradual and its width and density varies greatly from a discontinuous line of trees to a closed canopy thicket, up to half a kilometre wide with a deep layer of leaf litter and minimal undergrowth. The saltwater **Jurnkurl**/paperbark tree (*Melaleuca alsophila*) was formerly known as *M. acacioides*. It grows in characteristic multi-stemmed clumps with a dense evergreen crown, typically from 4 to 8 m high. Occasional climbers such as *Cynanchum carnosum*, *Gymnanthera oblonga* or the parasitic **Yukurlu** (*Cassytha filiformis*) scramble among the canopies. The trees burn readily, releasing dense clouds of black smoke. Thickets impacted by fire are often invaded by the weed *Passiflora foetida*.

Jurnkurl/Saltwater paperbark thickets with their cool shade tend to attract mosquitoes, as well as clouds of crow butterflies (*Euploea core*). When in flower around September, numerous insects and honeyeaters are attracted to the creamy flower spikes. This habitat is also the favoured niche for nailtail wallaby (*Onychogalea unguifera*), which tend to emerge around dawn and dusk to feed on adjacent saline grasslands. Feral cattle often seek out the shade of these thickets to escape midday heat.

Brophy *et al.* (1987) examined the volatile fragrant oil, exuded by the leaves of this plant. They found high levels of terpinene-4-ol and citral (neral/geranial) and suggested that the species could have potential as a more fragrant alternative to commercial tea tree (*Melaleuca alternifolia*). Distillation would be required to extract such a product and require licensing/approval by several Government agencies.

Cultural Use

Yu (KFD, unpublished) noted that the fragrant leaves of saltwater **Jurnkurl**/ paperbark (*Melaleuca alsophila*) are boiled by Karajarri people for application to skin sores. Its

trunks were used in constructing the framework for huts or shelters.

Native beehives could be found in its trunks and branches. Potable water could be found by piercing bulges on the trunks of larger trees. The smoke of the burning paperbark was used to repel mosquitoes. Infusions of the fragrant, scented leaves were considered medicinal and used for “cold sick”. During the pastoral era, trunks were sometimes used for fence posts (Kenneally *et al.* 1996, p.38).

7.5 EPHEMERAL PIRAPI/ FRESHWATER LAKE, PUNTU/ CLAYPAN AND OTHER WETLAND COMMUNITIES

Kenneally *et al.* (2008, p. 10-11) identified these communities in the vicinity of **Pangarangara**/Gourdon Bay as comprising a mosaic of communities, subject to seasonal freshwater flooding and/or ponding. They included small stands of **Jurnkurl**/paperbark (*Melaleuca alsophila*) adjoining supra-tidal mudflats, as well as patches of *Lophostemon grandiflorus* and **Karnpurr** (*Melaleuca dealbata*) communities lying behind coastal sand dunes.

Cultural Use

Yu (2002, p. 35 and 52) noted that **Pajalpi**/spring country is important culturally for Karajarri people, especially around the fringes of the coast at Lagrange Bay, Admiral Bay and Geoffrey Bay. Coastal springs support the distinctive **Warrapa**/paperbarks (*Melaleuca leucadendra*) and **Karnpurr**. They typically occur on the fringes of mudflats and usually have **Janpa** or surface water available permanently.

Karajarri people make an important distinction between **Lirri**/soaks and **Jila**/permanent water sources. **Lirri** may dry up in **Laja**, the hot season, and need to be dug out. If the holes are deep, **Jarranga**/small ledges are constructed to provide steps down to the water. The surveyor James Cowle, transiting the Karajarri coast in 1866 noted that some “native wells” were 12 feet deep (Skyring, 2000, p.27).

Jila are always places of permanent water and considered

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the source of water and life for country. Because **Jila** are occupied by **Pulany**/Water Serpents, they must be approached with respect and care to avoid angering them. Lumps of **Kalji**/white clay are dug from **Jila** and taken for use in ceremonies, where they represent rain-clouds. Other water sources in Karajarri country, especially inland, are **Pirapi**/claypans and **Wirrkujja**/rockholes. These typically fill in the wet and dry up in the dry season. Another Karajarri expression is **Turrpu Ngapakra** or “rockhole with water in it”.

Terry (1931, p.36), visiting a small hill in the far south of Karajarri country in 1928 noted the presence of ‘gnamma holes’ or rock holes which had been deliberately covered over with spinifex to retard evaporation.

Yu (Expert Report, 2000, p.54) noted that Karajarri people generally camp a little way off **Jila**, to avoid angering **Pulany**. She also noted that stands of tall paperbarks at the south end of **Kuwiyimpirna**/Frazier Downs Station at **Warrapa** and **Walakarra** were a good place to get **ngamakari** or corella nestlings for food, as large numbers of the birds breed there in Wilpuru season (p.21)

Plant use

Karnpur/paperbark (*Melaleuca dealbata*) is a tree, sometimes considered to be occupied by **Rayi**/spirits. The sweet flowers, called **Pupu**, are either sucked directly for nectar or soaked in water to make a sweet drink. The leaves can also be crushed and steeped in water and used to bathe skin sores and cure ‘coldsick’. Sugarbag/bush honey is sometimes found in this tree. The paperbark sheets are called **Karnu** or **Tirnirr** and can be used as bush plates for food or for creating shelter as small huts.

Ngalinmarr (*Sesbania formosa*) is a tall leguminous tree, noted for its large, white pea flowers. It is valued for shade around springs. An antiseptic powder can be made from its burnt, corky bark. The soft wood is used for ceremonial or dancing shields and fire-drills.

7.6 PIRRA/PINDAN SHRUBLAND COMMUNITIES

This community, which can be regarded as an arid-adapted, stunted form of savanna woodland, dominates the vast inland sand plains of Karajarri country, developed over red and yellow sandy soils. Tree cover is relatively open with a sparse upper layer (10 m) of **Jukutany**/Broome bloodwood (*Corymbia zygophylla*) and **Pilawal**/ochre bloodwood or **Langkarn** (*Corymbia dampieri*) usually present. Approaching the coast in lower-lying country - as towards **Pangarangara**/Gourdon Bay - scattered clumps of **Yanagurru/kunurru**/ghost gum (*Corymbia flavescens*) become conspicuous. **Marla** and **Kalipatany**/large reddish termite mounds are often a feature of pindan shrublands. The mounds support enormous colonies of grass-eating termites such as the spinifex termite (*Nasutitermes triodiae*). The mounds are thought to survive for up to a century (Andersen *et al.* 2005, p. 27). They provide important hibernation shelter for reptiles and a refuge for them from bushfires.

Pindan shrubland usually carries a variably dense understorey of fast-growing wattles such as **Kulparn** (*Acacia tumida*) or **Yirrakulu** (*Acacia eriopoda*). In more arid areas, other smaller wattles such as **Kalayan** (*Acacia stipuligera*), **Puntakarnu**/tabletop wattle (*Acacia hilliana*) or **parlpi**/Fitzroy wattle (*Acacia ancistrocarpa*) are generally widespread. **Lirringkin**/soap bush (*Acacia colei*) is common in disturbed areas, such as roadsides. The appearance and density of the wattle layer is usually a good indicator of time since last fire. An uninterrupted fire regeneration cycle spans 5-7 years. Stands of burnt wattle stems have a gaunt “broomstick” appearance, but recovery is generally rapid through rootstock suckering and/or prolific seedling regrowth. However, too frequent fires prevent wattles from setting seed and start a desertification process. If allowed to mature without fire, wattles are often colonised by species of parasitic mistletoe such as *Lysiana spathulata*. Elkin (1933) gives the names for **Pilagarong**/mistletoe and **Kalaen**/wattle bean, which were probably significant traditional foods.

Perennial grasses include soft **Marangurru**/spinifex (*Triodia bitextura*) and **Yurrkurlu**/razor grass (*Chrysopogon pallidus*).

Common annual grasses include spear grass (*Sorghum ecarinatum*) to 2 m, black spear grass (*Heteropogon contortus*) and corkscrew grass (*Aristida hygrometrica*). Elkin (1933) refers to **Jawarl** and **Pantjin** as “cane grass” (probably *Sorghum sp.*) and **Ngara** as “tall grass” in a discussion on totems.

A wide variety of other tree and shrub species add diversity to pindan shrublands, notably **Jikily** (*Bauhinia cunninghamii*), **Jumpurru**/lemonwood (*Dolichandrone heterophylla*), **Ranyja**/sandpaper fig (*Ficus aculeata*, formerly *F. opposita*), several Hakeas - (*H. arborescens*) and **Kurlulu** (*H. macrocarpa*), caustic tree (*Grevillea pyramidalis*), **Kanparrjibarrji**/silver-leaf (*Grevillea refracta*) and **Jakaja**/holly-leaf grevillea (*Grevillea wickhamii*). Other species include **Junju**/ironwood (*Erythrophleum chlorostachys*), **Wutarr**/turpentine tree (*Gardenia pyriformis*), **Tarlap**/kurrajong (*Brachychiton diversifolius*) and **Mirntirrjina**/wild pear (*Persoonia falcata*). After fires, the slender **Jimpirrinny**/desert poplar (*Codonocarpus cotinifolius*) is often a conspicuous, short-lived element in the landscape.

Cultural Use

Pirra or inland country has historic connotations of safety for Karajarri people. The inland was considered **Mapukarti** or ‘a good, safe place’. In the period when mixed race children were taken away by the authorities (1905-1955), many Karajarri took off inland. When Broome was attacked by the Japanese in World War Two, many Karajarri people retreated to **Parturr**, as they were frightened or **Wayini** (Yu, Expert Report, 2000, p.28-29).

Pindan shrubland provides an astonishing range of useful resources for Karajarri people. Examples include:

Yanagurru/ghost gum (*Corymbia flavescens*) produces a red gum, which can be applied to relieve sore teeth; the burnt bark provides ash used for mixing with chewing tobacco; timber has also been used for making rudders for pearling luggers (Kenneally *et al.* 1996, p.141).

Pilawal or **Langkarn**/ochre bloodwood (*Corymbia dampieri*) bears round insect galls, the inner part of which is edible, tasting like coconut; the red gum is applied to relieve sore teeth; an excellent firewood for night fires, as it burns slowly; the bark ash is mixed with bush tobacco for chewing (Kenneally *et al.* 1996, p.142).

Junju/ironwood (*Erythrophleum chlorostachys*) is renowned for its hard, dense wood, used for making fighting sticks (Kenneally *et al.* 1996, p.76).

Tarlap/kurrajong (*Brachychiton diversifolius*) has edible seeds, which are winnowed to remove irritant hairs and cooked in ashes; the root of young trees can be eaten as a yam during the wet season, after being baked in hot ashes (Lands, 1987, p.49).

Mirntirrjina (*Persoonia falcata*) bears an edible fruit, which is usually collected from the ground and eaten raw when ripe (yellow); the edible seed can be pounded and mixed with water to make a black custard-like food (Kenneally *et al.* 1996, p.171).

Wutarr (*Gardenia pyriformis*) has leaves used by Karajarri people, after chewing, as a balm to rub their feet before walking over hot sand (Lands, 1987, p.21).

Kulparn (*Acacia tumida*) wood from saplings is used for making spears and boomerangs; the green pods can be cooked in hot ashes and the seeds eaten; seeds can also be made into damper cakes and cooked; gum is edible; twigs used for spooning out honey from native stingless beehives (Kenneally *et al.* 1996, p.134).

Makapala/bush banana (*Marsdenia viridiflora*) is a climber bearing large green fruit, which are collected during the wet season and eaten raw; texture is crisp and the immature seeds taste much like young green peas (Lands, 1987, p.7; Kenneally *et al.* 1996, p.63).

Yu (2002, p.36) notes that in **Pirtany**/waterless country, Karajarri people used ingenious methods of **water harvesting**. When rainwater collects in the hollows of trees – especially bloodwood eucalypts such as **Langkarn** – small holes are drilled into the tree and plugged with sticks. Such stores are known as **Palutany**, and when people need a drink they remove the sticks and water flows out. Alternatively, **Palnga** are constructed to collect water when people are

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between water sources. A hollow log - cut in half - is set in the ground, and a section of ant-bed carved out and placed on one end to channel water into the log.

7.7 MARRANGURRU/DESERT DUNEFIELD COMMUNITIES

The vegetation of desert dunes in eastern Karajarri country near the McLarty Ranges was surveyed in 1977 and described by Burbidge and McKenzie (1983, p. 15). They noted that the **dune ridges** there (up to 5 m high) carried a richer flora than the inter-dunal swales. The sole spinifex on the dunes was *Triodia schinzii*. The shrub flora was diverse and included *Acacia tumida*, *Burtonia simplicifolia*, *Calytrix longiflora*, *Cyanostegia cyanocalyx*, *Gyrostemon tepperi*, *Dodonaea peduncularis*, *Duboisia hopwoodii*, *Grevillea eriostachya*, *G. stenobotrya*, *Jacksonia aculeata*, *Newcastelia cladotricha*, *Cullen* sp., *Solanum diversiflorum* and *Templetonia incana*. Perennial herbs included *Dampiera cinerea*, *Goodenia armitiana*, *Halgania solanacea*, *Ptilotus arthrolasius*, *Scaevola parvifolia*, *Sida* spp., *Trichodesma zeylanicum* and *Velleia panduriformis*. Scattered trees were *Gardenia pyriformis* and *Owenia reticulata*.

Plains and swales were dominated by the **Maramarr**/prickly spinifex (*Triodia pungens*). Scattered shrubs included *Acacia coriacea*, *A. stellaticeps*, *Grevillea pyramidalis*, *Grevillea wickhamii*, *Persoonia falcata*, *Pimelea ammocharis* and *Stylobasium spathulatum*.

There were occasional thickets of wattles (typically *Acacia monticola*, *A. hilliana*, *A. stipuligera*) or *Grevillea refracta*. The herbs noted were *Bonamia alatisemina*, *Cullen pustulatum*, *Senna notabilis*, *Corchorus sidoides*, *Goodenia azurea*, *Heliotropium tenuiolium*, *Keraudrenia integrifolia*, *Phyllanthus maderaspatensis* and *Ptilotus fusiformis*.

Cultural Use

Marrangurru	spinifex country
Niyamarri	red, linear sand dunes

Traditional hunting and gathering methods in the Great Sandy Desert have been described in detail by Lowe and Pike (1990). They emphasized the central role of the **Parntal**/desert walnut (*Owenia reticulata*), whereby the female trees provide large quantities of **Parlungkurr**/edible nuts, which can lie on the ground ready to eat for many years. This tree is also valued for its honey-coloured **Minta**/edible gum, good shade and firewood. Even when dead, a **Pirna**/edible grub can be extracted from under the bark (p. 39-45).

The authors also cover **Karral**/spinifex wax extraction methods and its use as a fixative for attaching a spear-head to a wooden shaft. They also detail harvesting **Wankujaku**/prickly bush tomatoes (*Solanum* sp.), the grinding of wattle (*Acacia*) seeds for food and the usage of edible fungi.

For Karajarri people, collecting grass seeds such as **Kitirr** to make damper and digging up **Munkarliny**/bush potato (*Ipomoea costata*) were other important food staples (KCMP, p.14).

7.8 WARNKU/ROCKY OUTCROP COMMUNITIES

This community is closely associated with small outcrops of **Cretaceous mudstone and shale** and the **Parda Land System**, as identified by Cotching (2005, p.38-39) [see Geology section]. According to Cotching, the dominant vegetation is lobed spinifex (*Triodia intermedia*) with a few scattered snappy gums, *Eucalyptus brevifolia*.

Further south, the **Phire Land System** features areas of stony, lateritic gravels which carry the same lobed spinifex, accompanied by scattered *Acacia stellaticeps*, *A. victoriae* and *Grevillea pyramidalis*.

Generally speaking, biodiversity values for this habitat are poorly documented.

Cultural Use

Parturr or the Parda Hills shelters a site of great significance to Karajarri culture, which includes rock art and a rock arrangement (Petri, 1966). This is an important Law place for men, associated with several cultural heroes.

Other important hills include **Wiluru** or Willara Hill and **Payarr** or Mt Phire (Yu, Expert Report, 2000, p.8).

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8.1 KUWI/INDIGENOUS MAMMALS

A number of Karajarri mammals have become locally extinct since the 1920s. For example Elkin (1933) noted that there were Karajarri totemic names for western quoll, chuditch or native cat (*Dasyurus geoffroi*), **Lantarr** or **Kuwi** for a “kangaroo rat” and **Yalwa** for the burrowing bettong or boodie (*Bettongia lesueur*).

The latter is known to have been prolific through coastal sandhills from Broome to the **Malampurr**/Eighty-Mile Beach up to about World War One. The Karajarri Dictionary gives another name for “kangaroo rat” as **Ngalkumiti**. This could possibly refer to the spinifex hopping-mouse (*Notomys alexis*), a desert-adapted species.

Karajarri Hunting Culture

Yu (Expert Report, 2000, p.31-2) notes that hunting is important for cultural identity for Karajarri people. Children are encouraged at every opportunity to learn tracking and hunting and to spear their own **Kuwi**; they are praised for conducting successful expeditions. If Karajarri visit country after a long absence, they call out to deceased relatives to bring them **Kuwi** - or fish, if they are at the coast. Successful trips are said to indicate that the ancestors are happy. Of course, local knowledge of country and season play a part in success. However, many people acknowledge that they receive insights directly ‘from country’ or from **Pukarikarra** or meaningful dreams.

Once a man has passed the second stage of male initiation or **Mirtayiriti** he does not need permission to hunt. Indeed, part of that initiation includes ritual hunting known as **Pingka**. Certain areas are set aside for this. When a younger, pre-initiate man hunts he has to give the **Kuwi** to the senior people. Hunters are generally careful to inform relevant people of their hunting intentions, as it is considered correct protocol.

White pastoralists such as Jay Simms at Shamrock and the Gray family on Thangoo have alienated many Karajarri by denying them hunting access in the past, in contrast to John Stoaite at Anna Plains, who has always permitted hunting in certain northern paddocks of the station.

Hunting expeditions invariably involve burning off an area of ground with hunters later returning to look for goanna, snakes and bush turkey. Hunting expeditions into the eastern, desert country are also often used to get special medicines such as **Pantarraku** for ‘cold sick’ or **Jima** to repel mosquitoes. Another favourite is to also collect **Pulkaru** bark to make ashes to chew with tobacco – a big favourite for old people.

Use of **Yukurru**/dogs for hunting

The Karajarri enjoy close relationships with dogs and give them skin names. Dogs are considered “like family” and are regarded as invaluable for hunting, particularly for kangaroos. In the past both certain pastoralists and many policemen have shot Karajarri dogs, making people cry (Yu, Expert Report, 2000, p.38). Doubtless, the **Kartiya**/whitefella involved did not appreciate the high value of dogs in Karajarri culture. Skyring (2000b, p. 37) describes past incidents on Nita Downs, where the pastoralists complained bitterly of the dogs of “desert natives” killing many of their **Kukunjarri**/sheep.

According to Yu, dogs are trained as youngsters to track and catch kangaroo, goanna and feral cat by rubbing the animal’s urine on their snouts. They are also taught to avoid poisonous snakes. Dogs can even be trained to locate **Walaja**/sugarbag by rubbing their noses with beeswax. **Yukurru** are also valued for protecting people at night from **Wirangu**/ evil spirits, as ‘they can smell their body odour’ and duly start barking. Piddington (1935) has more details regarding Karajarri people training dogs for hunting.

Mitimarlu/Red Kangaroo (*Macropus rufus*)

Recorded at **Pangarangara**/Gourdon Bay.

In Karajarri language, a male of this species is called **Wijunu** while the female is **Yalyarr**. A female with a joey is called **Wupanyarri**. A joey can be called either **Japurn** or **Kalmina**.

Kangaroos were traditionally hunted with **Miliny**/spears, made from **Palany**, a thin tree (Yu, Expert Report, 2000, p.16). Dogs were considered invaluable for hunting kangaroo. A successful hunt fed both people and the dogs (p.38). A hiding screen, made of leaves or paperbark, called **Mankaja** was used to lure kangaroos within spearing range

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(p.5). The surveyor James Cowle, transiting Karajarri coastal country in 1866 refers to seeing kangaroo traps (Skyring, 2000, p.28).

Pikkarta/Common Wallaroo - Euro (*Macropus robustus*)

Recorded at **Pangaragara**/Gourdon Bay. Also noted in the McLarty Hills.

Parrjaniny/Agile Wallaby (*Macropus agilis*)

There is little doubt that this is the commonest macropod species in near-coastal habitats of Karajarri country.

Recorded at **Pangaragara**/Gourdon Bay.

In Karajarri language, a male of this species is called **Kalutu** while the female is **Japinangurru**.

Karapulu/Northern Nail-tailed Wallaby (*Onychogalea unguifera*)

The type specimen of this species was shot in 1838 in Bardi country by surgeon and naturalist Benjamin Bynoe during the surveying voyage of H.M.S. *Beagle* (McKenzie 1983, p.42).

On the Dampier Peninsula, this species appears to have a narrow ecological niche, favouring open saline grasslands that are adjacent to belts of **Jurnkul**/saltwater paperbark (*Melaleuca alsophila*) and populations are apparently disjunct behind isolated estuaries (Tim Willing, personal observations).

In Karajarri language, a male of this species is called **Munu** while the female is **Jarinyjarr**.

Spectacled Hare-Wallaby (*Lagorchestes conspicillatus leichardti*)

This species has been reported from the **Purnturrpurnturr**/Port Smith area, as well as Nita Downs but its current status is unclear. It is typically associated with clumps of old, dense unburnt spinifex: an increasingly rare habitat. Old people agreed it was becoming scarce (Bidyadanga Workshop).

Mangkapan or Pirtany/Bilby (*Macrotis lagotis*)

This species is regularly observed in the **Pangaragara**/Gourdon Bay area (Welsh and Broun, 2008). It is also known from the Edgar Ranges. Populations are declining due to the impact of foxes and feral cats.

The Karajarri name for a male is **Pula** while a female is **Warangkula**. Elkin (1933, p.293) refers to a **Talu**/increase site for “bandicoot” conducted with Nyungamarta men in the southern part of Karajarri country, which most likely applies to this species.

The tails of the bilby were used by old people as a hair decoration (Mervyn Mulardy to Tom Vigilante).

Larnkurr/Northern Brushtail Possum (*Trichosaurus arnhemensis*)

Elkin (1933, p. 293) refers to a **Talu**/increase site for this species at **Wilauwilanga**.

Considered to be fat in **Parrkana** season, they were hunted at night and were located by looking for their **Wirrij** or scratches on trees.

Possum fur was prized for making hair-belts called **Minjil**, from which men suspended **Riiji** or pearl shell for ceremony (Yu, Expert Report, 2000, p.20).

Pujarrpujarr/Northern Marsupial Mole (*Notoryctes caurinus*)

This species is known from inland, especially in desert sandhill country. It is not found at the coast. Its biology remains poorly known and it is now regarded as an endangered species.

Michael Terry, travelling in **Walyarta** country in 1928, related a desert encounter:

“The Aboriginal man wore no clothes other than a hairstring belt. In his belt he had his boomerang, some iron tomahawks, a blade from some hand-held sheep shears, and twelve little mole-like creatures plus an iguana”
(Terry, 1931, p.43-44).

Jilku/Mice

Jilku/Spinifex Hopping Mouse (*Notomys alexis*)

This species is thought to still be common in inland areas of Karajarri country. Name supplied by Mervyn Mulardy to Tom Vigilante.

Delicate Mouse (*Pseudomys delicatulus*)

This nocturnal species eats seeds, fruits, plant stems and some insects. This is generally the commonest native mouse on the Dampier Peninsula. Noted from the McLarty Hills (Burbidge and McKenzie, 1983).

Western Chestnut Mouse (*Pseudomys nanus*)

This nocturnal species mainly eats grass stems.

Sandy Inland Mouse (*Pseudomys hermannsburgensis*)

This desert species is known from the Edgar Ranges.

Forrest's Mouse (*Pseudomys forresti*)

This desert species is known from the Edgar Ranges.

Lakeland Downs Mouse (*Leggadina lakedownensis*)

Also known as the Northern Short-tailed Mouse, this species was collected at Gourdon Bay in 2008. Its ecology is poorly known.

Lesser Hairy-footed Dunnart (*Sminthopsis youngsoni*)

This desert species was first collected from the Edgar Ranges, which is accordingly its "type locality". It is a small carnivorous insect-eating marsupial. Its ecology has been studied by Haythornthwaite and Dickman (2000 and 2006).

Watarrpiny/Flying Foxes (*Pteropus alecto* and *P. scapulatus*)

These species typically roost in dense stands of mangroves.

Northern Blossom Bat (*Macroglossus minimus*)

This species is closely associated with the large flowers of the mangrove *Sonneratia alba*.

Narri Minyaminya, Yapanpangu/ Insectivorous Bats

More information is required from surveys to determine the local status of the following microbats:

- Yellow-bellied Sheath-tail Bat (*Taphozous flaviventris*)
- Mangrove Freetail Bat (*Mormopterus* sp. Undescribed) *loriae cobourgiana* recorded at Gourdon Bay (Welsh and Broun, 2008).
- North Queensland Long-eared Bat (*Nyctophilus bifax*)
- Arnhemland Long-eared Bat (*Nyctophilus arnhemensis*)
- Lesser Long-eared Bat (*Nyctophyllus geoffroyi*) has been recorded at Dragon Tree Soak (Burbidge and McKenzie, 1983, p. 76).
- Bent-wing Bat (*Miniopterus schreibersii*)
- Gould's Wattled Bat (*Chalinobus gouldii*)
- Hoary Wattled Bat (*Chalinobus nigrogriseus*)
- Mangrove Pipistrelle (*Pipistrellus westralis*)
- Little Broad-nosed Bat (*Nycticeius greyi*)
- Broad-nosed Bat (*Nycticeius balstoni*)

Kurrujartiny/Echidna (*Tachyglossus aculeatus*)

Once its tracks are found, echidnas are often located in either hollow logs or the base of termite mounds and dug out. They are hunted in **Parrkana** season (Yu, Expert Report, 2000, p.20).

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Kurriti/Dingo (*Canis lupus*)

It is believed that dingoes were brought to Australia by Aboriginal people, perhaps from southern India, where their closest relatives still live. Before the arrival of Europeans, they would have served as pets and been kept for hunting. Probably some still are.

According to Norman Munro, dingo scalps were often brought to the coast in **Parrkana** season by inland people going salmon fishing (Yu, Expert Report, 2000, p.20).

8.2 BUSH BIRDS

Johnstone (1983) reported that 214 species (143 non-passerine and 71 passerine) had been recorded from the Dampier Peninsula. The best summary of local birds can be found in Collins (1995). Hassell (2000) was able to record 68 bird species at Bidyadanga during an early morning survey (4.5 hours) in December 1999. He noted that the area “appears to have a rich and varied avifauna”. George Swann recorded 120 species of birds during surveys totalling 53 hours at Gourdon Bay in 2008 (Welsh and Broun, p.33 and 39).

The following readily identifiable species are sourced from the Karajarri Dictionary:

- **Jalarapalpal**/crested pigeon (*Ocyphaps lophotes*)
- **Jalpintari**/pictorella mannikin (*Heteromunia pectoralis*)
- **Jawari** or **Waakarangu**/Torresian crow (*Corvus orru*)
- **Jilkarangu**/Horsfield's or singing bush lark (*Mirafra javanica*)
- **Juli**/tawny frogmouth (*Podargus strigoides*)
- **Juni**/Nankeen kestrel (*Falco cenchroides*); however Yu (Expert Report, 2000, p.20) states that **Juni** is the black kite (*Milvus migrans*) and notes that Karajarri people compare its tail shape to **Panganu**/salmon.
- **Juwi** or **Rakin**/great bower-bird (*Chlamydera nuchalis*)
- **Kakartu**/little corella (*Cacatua sanguinea*)
- **Kalkaruru**/blue-winged kookaburra (*Dacelo leachii*)
- **Kurrngapurru** or **Putarapurru**/pied butcher-bird (*Cracticus nigrogularis*)

- **Kurturr**/brolga (*Grus rubicundus*)
- **Lirrkarrangu**/red-tailed black cockatoo (*Calyptorhynchus banksii*)
- **Nyinyinparri**/zebra finch (*Taeniopygia guttata*)
- **Parrkarra**/Australian bustard or bush turkey (*Ardeotis australis*); the spectacular male display is known as **Yurruly**
- **Pijarta**/emu (*Dromaius novaehollandiae*); an emu chick is called **Wirnirni**;
- **Pitara**/galah (*Eolophus roseicapillus*)
- **Puntaru**/brown quail (*Coturnix ypsilophora*)
- **Titi**/painted finch (*Emblema pictum*)
- **Turrkurr**/southern boobook (*Ninox novaehollandiae*)
- **Walakurru**/wedge-tailed eagle (*Aquila audax*)
- **Wijulu tulurl**/willie wagtail (*Rhipidura leucophrys*)
- **Wilirmin**/red-winged parrot (*Aprosmictus erythropterus*)
- **Wiraju**/pacific barn owl (*Tyto javanica*)
- **Wirunywiruny**/rainbow bee-eater (*Merops ornatus*)
- **Wiyurru**/cockatiel (*Nymphicus hollandicus*)
- **Yililinjirr**/budgerigar (*Melopsittacus undulatus*)

Cultural Use

Yu (2000, p.42) noted that Karajarri people regard the **Kitirr**/fork-tailed wift (*Apus pacificus*) and **Wiyurr**/barn swallow (*Hirundo rustica*) as indicators of the wet season. The birds are said to “pull in the rain” and are associated with different forms of lightning. **Kitirr** brings **Jitama** or “Strong Lightning” which strikes the ground and sometimes kills people, while **Wiyurr** brings **Kapalawurr** or sheet lightning, which does not touch the ground.

It would be well worthwhile for Karajarri Rangers to attempt to record more language names for local birds, using a field guide, in addition to cultural stories associated with different species.

8.3 WATARA/AMPHIBIANS

The vertebrate fauna survey conducted in the vicinity of Pangaragara/Gourdon Bay in 2008 (Welsh *et al.*) yielded no frog species.

However, the Green Tree Frog (*Litoria caerulea*) is called **Walak** in Karajarri. **Purtwarniny** is a “little brown frog”, which is good for eating (Bidyadanga Workshop). Small wet season frogs are called **Ngarrkarrangu**. Big frogs which appear after the rain [probably *Cyclorana australis*] are called **Purukarrangu**, (Karajarri Dictionary, p.60).

At the present time, there is clearly inadequate information available on Karajarri frogs.

8.4 JALKANA/REPTILES

The vertebrate fauna survey conducted in the vicinity of Pangaragara/Gourdon Bay in 2008 (Welsh and Broun. p.33) yielded **41 reptile species**:

Dragons 7	Gilbert’s, frill-necked, ring-tailed, military, central netted, pindan, and dwarf bearded;
Geckoes 11	3 <i>Gehyra</i> , 2 <i>Diplodactylus</i> , 3 <i>Strophurus</i> , 1 <i>Oedura</i> , 1 <i>Heteronotia</i> , 1 <i>Hemidactylus</i> (introduced);
Legless Lizard 1	Burton’s snake-lizard (<i>Lialis burtonis</i>);
Skinks 10	1 <i>Carlia</i> , 1 <i>Cryptoblepharus</i> , 1 <i>Ctenotus</i> , 1 <i>Eremiascinus</i> , 1 <i>Glaphromorphus</i> , 4 <i>Lerista</i> and 1 <i>Morethia</i> ;
Blue-tongues 2	<i>Tiliqua multifasciata</i> and <i>T. scincoides</i> ;
Goannas 3	<i>Varanus acanthurus</i> , <i>V. gouldii</i> and <i>V. tristis</i> ;
Pythons 2	Stimson’s and black-headed;
Snakes 5	Yellow-faced whipsnake, moon snake, king brown, desert banded and spotted.

Cultural use

Lizards

According to Yu (Expert Report, 2000, p.25) **Mankala** season is considered the best time to hunt blue-tongue and **Kulumana**/frill-neck lizards, as well as goannas – because all are fat at this season. Yu gives **Lunkuta**, **Pilirri** and **Ngalyak** as names for blue-tongue lizards. It is said that when **Kulumana** is fat, the fish **Pantirrpantirr**/spanish flag is skinny (p.16). The goannas considered good eating are **Yalki** (*Varanus tristis*), **Munkukaraji**/spinytail goanna (*V. acanthurus*) and **Jalangarti**/goulds’s monitor (*V. gouldii*), which grows to an impressive size around 1.6 m length (p.25).

Other dragons, geckoes, lizards and skinks in the Karajarri Dictionary include:

Japarra	bearded dragon (<i>Pogona minor</i>)
Jirntikurru	thorny devil (<i>Moloch horridus</i>)
Jirrkala	little red lizard
Liwirungu/Wurrkarn	skink
Pampirta	defenceless dragon
Pantily	gecko
Tintalpi	long-tailed tree lizard

Snakes

The feared desert death adder (*Acanthophis pyrrhus*) has many names – **Juntangu**, **Mayangarra**, **Ngurakarrangu** and **Yulu**.

The venomous **Wiril**/king brown or mulga snake (*Pseudechis australis*) is also called **Pangkatory** or **Patarrangalu**.

The docile Stimson’s python (*Antaresia stimsoni*) is called **Pinyunku**. The black-headed python (*Aspidites melanocephalus*) is called **Kalurrjawa** and considered good eating. The water python (*Liasis mackloti*) is called **Jikarta**

8 TERRESTRIAL FAUNA

and is also considered good eating (Bidyadanga Workshop).

The Karajarri Dictionary gives the following other snake names:

Jjikirrkirr	‘snake with red spots on head and black bands around body’
Julira	grass snake
Juna	‘small toothless snake’
Lawurr	red belly snake
Maralankarr	type of snake
Parlita	type of snake
Wangarl	whipsnake
Winkujartu	‘lice-eating snake’
Wirimangurru	yellow belly whipsnake
Wirtu	small brown snake

8.5 JURRU/INSECTS AND INVERTEBRATES

Collections of insects including Diptera, Lepidoptera and Orthopteroids were briefly summarised by D.H. Colless, I. F. B. Common and J. Balderson for the Dampier Peninsula in McKenzie (1983, p. 75-77).

The Karajarri Dictionary gives the following language terms for a variety of insects and other invertebrates:

Ants

Muwara	black ant
Panpalji	bull ant
Pingka	small ant
Winyputu	big ant
Yantu	ant eggs

According to Yu (Expert Report, 2000, p.18) **Malaja** are winged, edible ants, which emerge in **Wiralpuru** season and derive from anthills.

Termites

Karajarri people identify three different termite-mounds occurring on their country (KCMP, p. 14):

Kalipitany	tall, narrow termite-mound
Marla	large, rounded termite-mound
Mintipa	small, flat termite-mound

In 1699 William Dampier described the hinterland of Lagrange Bay. He first mistook the coastal termite mounds he saw there for huts and then decided that they must be rocks! He did not, it seems, get close enough to realise his mistake:

“Here are a great many Rocks in the large Savannah we were in, which are 5 or 6 Foot high, and round at the top like a Hay-cock, very remarkable; some red, and some white.”
[Quoted in George 1999, p.14-15 with photos p.37]

Other Invertebrates

Jinpalka	grasshopper
Jularn	caterpillar
Jungulanka	moth
Kanil	big beetle
Kanparr	centipede
Karrutu	cicada
Linjarr	louse eggs or nits – Palurl is lice
Marlpurn	marsh fly
Mirrpuulu	jumping beetle
Mungarnangarna	greenfly
Ngangki	cicada
Nikarrangu	mosquito
Nyirtiny	cicada
Pintinya	scorpion (identity changed from ‘centipede?’ at Bidyadanga Workshop)
Pinyjapinyja	butterfly
Pirna	edible grub
Piyarapin	bee
Pujiji	black beetle
Rawal	blowfly
Rurrururu	hornet
Tutu	cicada
Wangkarrangkarra	spider and spider-web
Wanminy	fly
Winka	lice
Winy	sandfly
Winywiny	maggot
Yankarayin	centipede

Cultural Use

Walaja or **Wanminy**/native stingless bees (*Trigona hockingsi*) are important culturally for their production of **Ngulu/sugarbag or honey** from tree hollows. Akerman (1985, p.7) noted that obtaining sugarbag was traditionally a job for women [as elsewhere in the Kimberley] and that they used stone hatchets to chop out the hives. From the hives honey, pollen and the grubs of developing bees were eaten, while the beeswax was kept, cleaned and used in making tools and ornaments. Akerman (1979) later studied in detail the importance of sugarbag for Aboriginal people in the NW Kimberley: usage, which appears to closely resemble that of the Karajarri. To locate their holes, trunks of favoured trees (*Bauhinia*, *Melaleuca* and *Corymbia* spp.) are scoured, until the small wax tube, which serves as a nest entrance is located. By placing an ear close to the tube, an active nest can be heard by its low hum. Merrilee Lands (1987, p.28-29) noted that pollen “cake” is yellow and called **Jimpu**, meaning “egg” in Karajarri. The wax can be applied warm or hot to treat sores. Mixed with finely chopped spinifex and melted, it sets very hard. As such, it is particularly useful for cementing bone or glass spear-tips to spear-shafts and can even plug small leaks in dinghies! Lands’ book includes useful magnified drawings of these bees and their wax nest entrance.

Yu (Expert Report, 2000, p.6) notes that the Karajarri traditionally used a **Minyaruru**/stone axe for getting **Walaja**/sugarbag. These days it has been replaced by a **Kaju**/steel axe.

There is a rock at Lagrange Bay sacred to the spirit of bees, where increase ceremonies were held according to the anthropologist Ralph Piddington (1935). This rock is illustrated by Elkin (1933, plate 2). He noted (p. 281-2) that native bees are one of the totems of **Injitan** country, where there is another increase site. **Kirpaju** is another name he gives for sugar-bag, i.e. honey and he describes the **Talu**/increase ceremony for a site at **Kuranan** (p. 291).

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9.1 SPECIES OF CONSERVATION SIGNIFICANCE

PLANTS

The Pangarangara/Gourdon Bay survey (McIntyre and McCann, 2008, p.15-16 and Appendix F3) identified two significant species:

Aphyllodium parvifolium (Priority 1) found in pindan at three sites;

Pterocaulon sp. A Kimberley Flora (Priority 2) found at two sites on grassy plains, dominated by buffel grass and at one site on a limestone outcrop;

Extensions of known range were found for 8 species: *Acacia hilliana*, *Acacia stellaticeps*, *Corchorus walcotti*, *Evolvulus alsinoides* var. *villosicalyx*, *Panicum effusum*, *Scaevola spinescens*, *Spermacoce auriculata* and *Triodia bitextura*. Specimens of a hybrid *Acacia monticola* x *stellaticeps* were also collected.

KUWI/MAMMALS

Welsh and Broun (2008, p.26-32) recorded the following 7 species of conservation significance at Gourdon Bay:

Lakeland Downs Mouse (*Leggadina lakedownensis*) (Priority 4) - a poorly-known species;

Bilby (*Macrotis lagotis*) (Vulnerable: EPBC; Schedule 1: WA)

Spectacled Hare-wallaby (*Lagorchestes conspicillatus*) (Vulnerable)

Northern Nailtail Wallaby (*Onychogalea unguifera*)

Northern Brushtail Possum (*Trichosaurus arnhemensis*) (Priority 3)

Little Northwestern Mastiff Bat (*Mormopterus loriae cobourgiana*) (Priority 1)

Northern Freetail Bat (*Chaerephon jobensis*)

Another mammal which elders stated at the Bidyadanga Workshop as being present along the Karajarri coast in mangroves:

Water Rat (*Hydromys chrysogaster*) (Priority 2)

BIRDS

Welsh and Broun (2008, p.26-30) recorded four bird species of conservation significance at Pangarangara/Gourdon Bay:

Peregrine Falcon (*Falco peregrinus*) (DEC Schedule 4)

- Possibly nests on coastal cliffs in Karajarri country. Also known from the Edgar Ranges.

Parrkarra/Bush Turkey, Australian Bustard (*Otis australis*) (DEC Priority 4)

- Regarded by Johnstone as “moderately common” throughout the Dampier Peninsula.
- This species may be declining, as it is much hunted for food and has a low reproductive rate (one young per year).
- Especially vulnerable to late dry season fires, as this is when they breed (Ziembicki, 2010).
- Yu (Expert Report, 2000, p.36) notes that young Karajarri men generally burn off a patch of country in the evening. The young hunters then return at first light in the hope of shooting turkeys, which have come in overnight looking for insects in the Jalalu or burnt ground.

Wiluru/Bush Stone Curlew (*Burhinus grallarius*) (DEC Priority 4)

- Regarded by Johnstone as “moderately common” on the Dampier Peninsula.
- Known for its spooky, wailing call at night.

Pictorella Mannikin (*Heteromunia pectoralis*) (DEC Priority 4)

- Known to be nomadic;
- Known to be a ground feeder, eating especially grass seeds.
- In addition, the following shorebird species are of conservation significance:

Eastern Curlew (*Numenius madagascariensis*) (DEC Priority 4)

- Known to occur at coastal estuaries in small numbers;
- Counts of up to 700 known from Malampurr/Eighty-Mile Beach;
- Populations of this species are in a steady decline.

Asian Dowitcher (*Limnodromus semipalmatus*) (DEC Priority 3)

- Known to occur in very small numbers at Malampurr/Eighty-Mile Beach;
- Their non-breeding stronghold is coastal Sumatra.

The following Asian birds probably pass through Karajarri country on migration and are protected under the JAMBA/CAMBA Treaties, signed by Australia:

Fork-tailed Swift (*Apus pacificus*) (DEC Priority 1)

- These birds tend to circle high in flocks, feeding on insects during the wet season, often just ahead of storms. Important species in Karajarri culture.

Yellow Wagtail (*Motacilla flava*)

- These rare birds are usually seen around grassy ovals and airfields in the dry season.

Oriental Cuckoo (*Cucullus saturatus*)

- These uncommon birds visit northern Australia during the dry season.

JALKANA/REPTILES

One skink species collected during the vertebrate fauna survey conducted in the vicinity of Pangarangara/Gourdon Bay during 2008 (Welsh and Broun) was regarded as of conservation significance:

Lerista separanda (DEC Priority 2)

This species has a horizontal black body stripe and a distinct reddish-pink tail. It has been recorded from Nita Downs north to the Dampier Peninsula in sandy habitats.

9.2 TERRESTRIAL THREATS

FIRE

Fire in a Traditional Context

An especially informative account of the use of fire in a hunting and gathering context in the Great Sandy Desert is provided by Pike (2008). The late artist and author was a Walmatjarri man, who spent much of his youth in the desert. He describes how there are fires for hunting, fires for clearing ground, fires for cooking and ceremonies. Desert people have numerous words to describe how wind affects fires and also the suitability of different woods for making “bush matches”.

Skyring (2000a, p.31) records that Panton noted Karajarri signal fires at Cape Frazier in 1885. In 1902, pastoralists at Anna Plains complained bitterly about Karajarri people burning the Stock Route. Then in October 1907, there is clear evidence that Karajarri people used burning as a strategy to thwart the police from conducting horseback patrols (Skyring, 2000a, p.61).

Michael Terry camped at Eil Eil Spring in Walyarta country in 1928, related:

“Towards midday a black suddenly appeared over the sandhill to the north. Carrying a flaming piece of brush, he raced down the hillside, dabbing at the resinous tufts of spinifex. A train of flares sprang up. A face of flaming grass, belching forth great puffs of jet-black smoke rent by shoots of livid flame, was soon sweeping down the hillside”
(Terry, 1931, p.42-43).

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Terry soon understood that the man was using fire to flush out game for hunting. Later, after travelling into the western edge of the Great Sandy Desert, he wrote:

“Always about the traveller are the tall smoke signals of the invisible black. They light the spinifex and by some ill-understood means produce tall thin columns of smoke, squat thick-set ones, columns which ascend alternatively wide and narrow, and finally a famous curly smoke which no white can understand. Each type conveys its special message. The amount of news which filters through the Bush seems so beyond the power of smoke signalling that some of us are inclined to believe smokes are but to establish contact between sender and receiver; thereafter by some occult thought-transference word may be flung through space.”

(Terry, 1931, p. 50).

Yu (Expert Report, 2000, p.19-20) noted that **Parrkana** season is considered a good time to **Jungku Minjanakuwiku** or burn the country, especially for tracking and finding the holes where lizards and snakes are. **Jalalu** is the name applied to burnt ground, while **Wiyapuka** are the green shoots of grass poking up soon after a fire. Fire is also used to ‘clean up’ around springs to allow access and visibility for tracking snakes, lizards and echidnas and encourage kangaroo and wallaby in when regrowth of grasses and shrubs commences. The use of fire by Karajarri has been somewhat constrained by certain pastoralists. However, burning is not an arbitrary process in Karajarri culture, as it requires a personal attachment to the landscape. Elders are careful only to burn their country and regard late season fires as ‘wrong time’ (Yu, Expert Report, 2000, p.36-37).

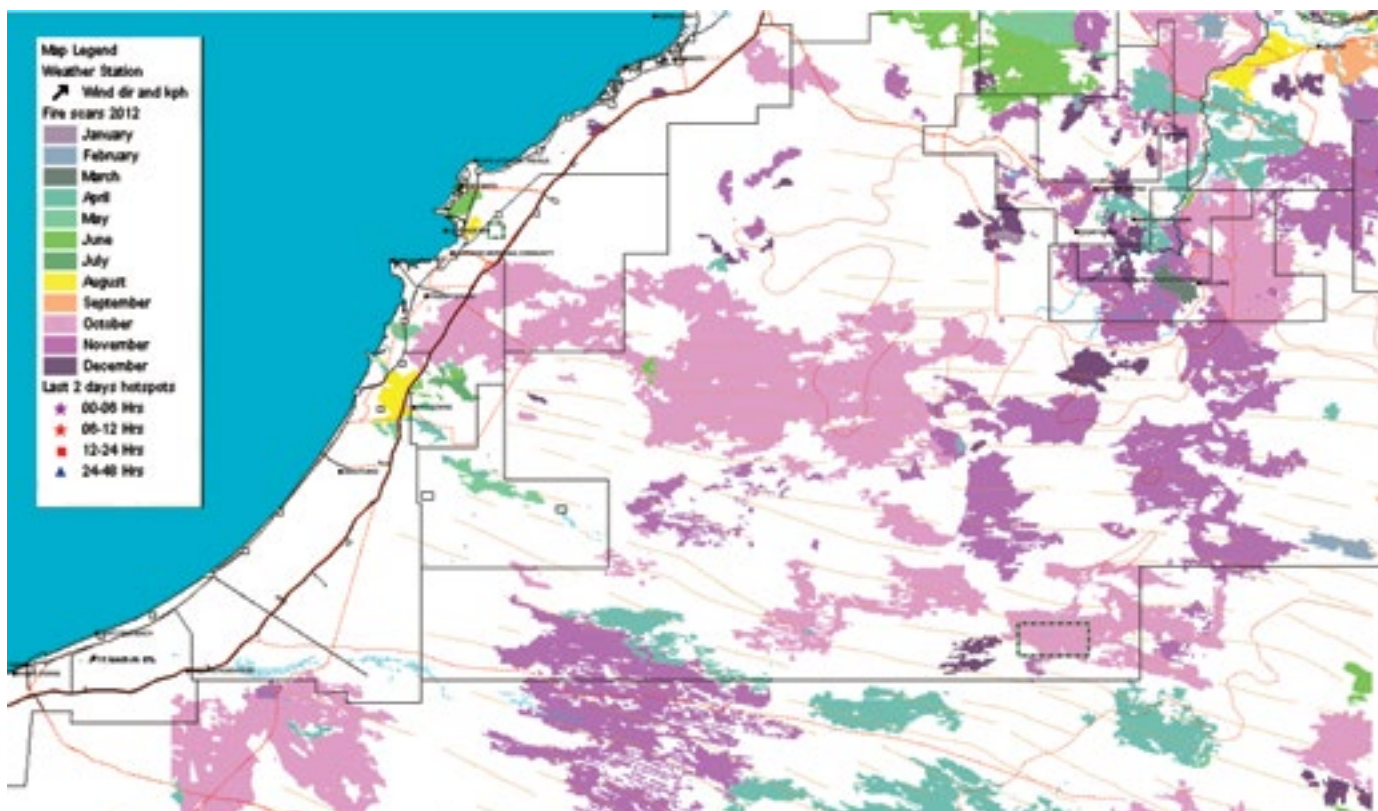
The Karajarri Dictionary lists many fire-related words:

Ngunjirr, Ngurran, Ngurrun, Jiwiny	smoke
Layilayi	continuous smoke
Parnti	distant smoke
Tuyi	little smoke
Putijputij	rising smoke
Minjanpa, Tili Janpa	to light a fire
Tili	light or flame
Tily	sparks
Yura	bushfire
Kampana	is burning
Pulkaru	ashes
Wijinti	ashes used for circumcision wounds and healing
Karita	big fire
Parrpanpa	passing over fire
Jungku, Ngurimparri	firewood
Munja Jungku, Panijungku	firestick
Yanurtany	fire-saw
Wungkalka	fire drill

Current Fire Issues

Fire regimes have changed from traditional practise, where mild (“cool”), patchy, small-scale fires were lit at the start of the dry season for hunting, regenerating food and medicinal plants or “cleaning up country” to one where intense large, uncontrolled fires in the late dry season are now common. Fire frequency has also greatly changed, so that few areas of the pindan community now go unburnt from one year to another, where in the past many areas went unburnt for periods of years (Russell-Smith *et al.* 2002, Radford & Anderson, 2006).

The current regime of too frequent, intense late dry season fires has destroyed many mature trees (especially eucalypts), with hollows used by wildlife. In so doing, it has reduced the complexity and age structure of plant communities, diminished leaf litter and fallen logs, increased erosion and accelerated the spread of weeds.



Map 8 Fire scars on Karajarri country since 2012 (NAFI website)

Better on-ground fire management is urgently needed right across Kimberley landscapes to reduce erosion, simplification of vegetation communities and arrest the decline of indigenous wildlife (Legge *et al.* 2008). Ideally, an early dry season mosaic fire regime needs to become standard with late dry season fires actively suppressed wherever possible.

Latz (2007) detailed his extensive, lifetime experience in central Australia, observing the impacts of different intensity fires on spinifex communities and other vegetation types.

Bush fires produce substantial emissions of greenhouse gases – including carbon dioxide, carbon monoxide, methane and various oxides of nitrogen. Nationally, savanna burning has been estimated to contribute 3% of Australia's greenhouse gas emissions. Recent data from the Northern Territory suggests that woollybutt (*Eucalyptus miniata*) country sequesters more carbon than it loses into the atmosphere. This amount increases when fires are less frequent, intense or extensive. The potential abatement of greenhouse gases that could be achieved in the Kimberley amounts to millions of tons per year (Williams, in Woinarski *et al.* 2007, p.91). The concept of “cultural burning for carbon abatement” has led to a recent KLC-led project in the North Kimberley, which can hopefully be extended in time to Karajarri country. Such carbon abatement scenarios present real economic opportunities for Indigenous people, as both landowners and on-ground fire managers.

WEEDS

Weeds represent a major threat to the integrity of ecosystems in Karajarri country, especially in coastal country. Weeds can alter vegetation structure (e.g. rampant, fast-growing climbers can smother slower-growing plants), displace fauna, reduce access, sometimes increase fire impacts and make bush tucker harder to locate.

At the present time, 236 species of weed are listed on the online Kimberley weed database, maintained on Florabase by the Dept. of Environment and Conservation. Agricultural areas around Kununurra (Ord Valley) have the greatest number of weeds in the region. Agricultural and lawn grass seed, often imported from Queensland in the past, have sometimes included weed species as a minor contaminant. Unfortunately, the ecological consequences have been significant. Over the past half century, there has been a steady flow of weed species west from N. Queensland, into the Northern Territory and later, the Kimberley. This has occurred despite border control points, staffed by Quarantine officers, undertaking thorough inspections and conducting truck washdowns.

9 TERRESTRIAL CONSERVATION

Kenneally *et al.* (1996) recognised 68 weed species as present on the Dampier Peninsula and a lesser number of these are now established in Karajarri country. Thomas King (pers.comm.) advised that at Bidyadanga significant weeds include:

- Darwin pea (*Clitoria ternatea*);
- coffee bush or sneaky tree (*Leucaena leucocephala*);
- black pea or siratro (*Macroptilium atropurpureum*);
- divided-leaf morning glory (*Merremia dissecta*);
- castor oil bush (*Ricinus communis*).

In the past remoteness helped to protect Karajarri country from weed impacts, but now increasing numbers of 4WD tourists, many travelling long distances in hire vehicles across northern Australia, can easily carry burrs or seeds without being aware. Car tyres, swags, rubber thongs and socks are all well-known agents for weed dispersal.

The 2008 **Pangaragara**/Gourdon Bay survey (McIntyre and McCann, Appendix H3) found only 3 weed species present in their quadrats – all of them what might be termed “pastoral weeds”:

buffel grass (*Cenchrus ciliaris*) at 14 sites (5 sites had in excess of 50% cover);

kapok bush (*Aerva javanica*) at 4 sites with 2% cover;

Townsville stylo (*Stylosanthes hamata*) at 1 site with 1% cover.

Buffel grass (*Cenchrus ciliaris*) and **birdwood grass** (*Cenchrus setiger*) are both perennial grasses which have been actively spread in the past by pastoralists, often by spreading seed into areas of burnt spinifex. Both species have a high pastoral value. As both these species respond rapidly to winter rain – unlike many native grasses – and secrete allelopathic chemicals from their roots, they can with time form almost monocultural stands. Cotching (2005, p. 61) notes that this process is particularly marked around bores on sandplain, where fertility has been increased by cattle dung and urine. Unfortunately, these species are also actively invading coastal dune systems throughout Karajarri country. Cotching estimated that 217 square kms of Karajarri country are now covered with this pasture type.

The weeds of northern Australia have been well described and illustrated by Smith (2011) with detailed control methods.

In 2010, Karajarri Rangers in collaboration with Environs Kimberley undertook a *Parkinsonia aculeata* control project at Glunjardiny, on Anna Plains Station. The infestation centred on Calengeti Well, where this spiny tree had become well established in dense thickets. Rangers successfully poisoned, chain-sawed and pulled out the **Jerusalem thorns** over about 26 working days (Environs Kimberley & Karajarri Rangers, 2010).

FERAL FAUNA

Black Rat (*Rattus rattus*)

In Broome, they are invariably resident anywhere where old mango trees (*Mangifera indica*) are established, as they thrive on a diet of this fruit; likely to be present at Bidyadanga.

Liliwarri/House Mouse (*Mus musculus*)

This species is known to be widespread throughout Karajarri country and settlements. The name was supplied by Mervyn Mulardy to Tom Vigilante.

Camel (*Camelus dromedarius*)

This species is known to be abundant in the Great Sandy Desert, where it has been regarded as a particular threat for Dragon Tree Soak. In the past, the Dept of Environment and Conservation has advocated fencing them out at this location. A better strategy may be to undertake an aerial cull of the camels instead. However, locating the scattered herds may prove problematic, as they can easily travel 50 km in a day. The females tend to live together in a group and are temporarily herded by a male. They generally mate in the dry season, while pregnancy takes 12-13 months.

Pulimanu/cattle (*Bos taurus and Bos indicus*)

Cattle numbers on **Kuwiyimpirna**/Frazier Downs have declined since the 1980s. Stock numbers have been halved from 4,000 to 2,000. At that time, open range pastoral operations for cattle with watering points (bores), yards and

tracks were widespread. Now, most of the older generation of trained stockmen have passed away or retired and the surviving cattle are fewer, providing a food source as occasional “killers”.

Cattle have the most visible negative ecological impact on springs, claypans (hoof impacts) and tend to seek shade in [Jurnkurl](#)/saltwater paperbark thickets, often introducing weeds into the latter community. Feral cattle are abundant in the eastern springs area of [Walyarta](#).

Ngatin/red fox (*Vulpes vulpes*)

Foxes breed from 10 months of age and usually mate once in cooler months. Vixens are pregnant for 51-53 days and can produce litters of up to 10 cubs. The cubs are weaned after a month and then begin to eat prey. Juvenile fox mortality is relatively high. The average lifespan of a fox is 4 years (Invasive Animals CRC).

Foxes appear to prefer near-coastal environments in Karajarri country, as well as remote desert areas and are spreading north from Broome (Kingsley Miller, former wildlife officer at DEC West Kimberley, pers. comm.). The spread of foxes is thought to be closely linked to the decline of the bilby.

Minyawu/cat (*Felis catus*); **old name Pirni**

Feral cats are widespread throughout Karajarri country and they were also seen on the 2008 vertebrate fauna survey at [Pangarangara](#)/Gourdon Bay. This species is known to have a major impact on native wildlife and is regularly trapped by Karajarri Rangers. Cats are an important food for many desert people and the object of many hunts.

Cane toad (*Bufo marinus*)

This species has recently become established around Kununurra (2010), having spread westward from the Northern Territory. Because of its toxicity, this species represents a major future threat to biodiversity (especially for goannas), when it colonizes the area, most probably within the next five years.

Asian house gecko (*Hemidactylus frenatus*)

This species, a native of South-East Asia, has been present in Broome and outlying settlements for many years, having probably arrived in cargo or boxes imported from Singapore. It is closely associated with human dwellings, thriving where electric lighting attracts insects on flyscreens, windows, doorways and even ceilings. Its loud call: “chuck chuck chuck” is familiar to many locals from infancy, the majority of whom remain unaware that it is not indigenous. Indeed many value the reptile for eating mosquitoes, spiders and cockroaches. Unfortunately recent research in Darwin suggests that by being territorial, it aggressively displaces native gecko species and invades native bush (Csurhes and Markula 2009).

European bees (*Apis mellifera*)

Originally imported from Italy and highly valued for pollinating crops and honey production. These were bred for many years at La Grange Mission, from where some appear to have gone feral. Melon farms in Karajarri country also utilize this species to improve crop pollination. They are believed to compete adversely with the much smaller [Walaja](#)/stingless native bee (*Trigona hockingsi*) for nectar and pollen, but their ecological impact has not been studied locally.

Singapore ants (*Monomorium destructor*)

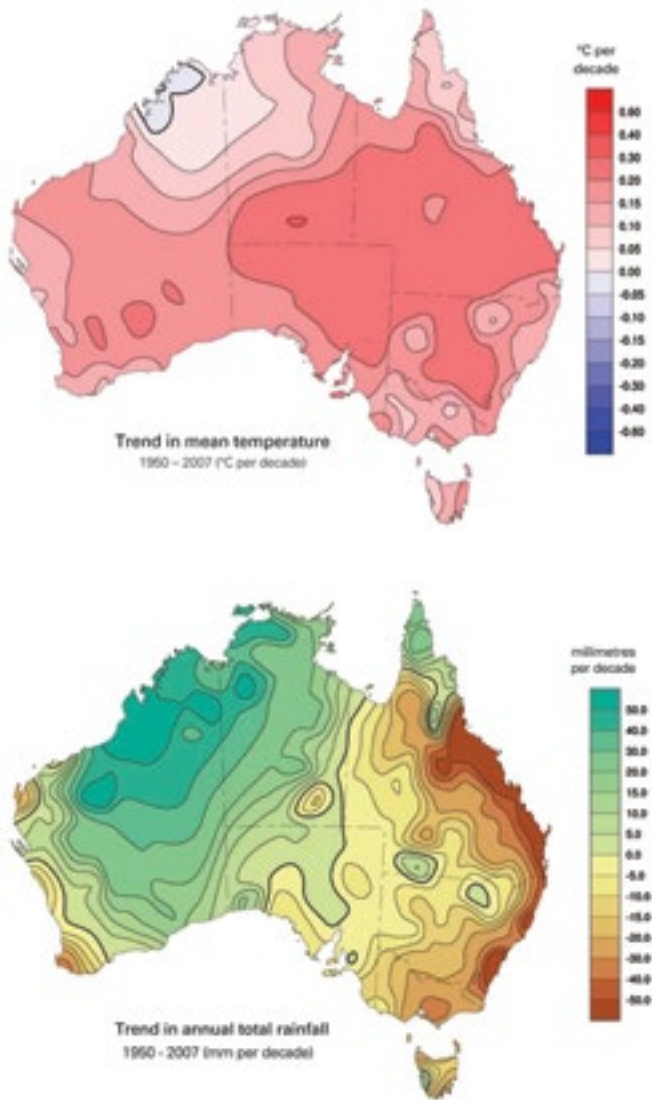
These small ants are a serious pest of houses, stores and gardens, being attracted to plastics used in electrics and reticulation as well as biting people, especially small children. They are often spread inadvertently when pot plants are shifted to new locations.

CLIMATE CHANGE

Major changes in Kimberley rainfall patterns have occurred in the last century, especially if the period 1910-1950 is compared to 1950-2010. Since 1950, annual rainfall and extreme daily rainfall intensity and frequency have increased, particularly over the wet season period (Steffen *et al.* 2009). For the entire Broome Shire, annual rainfall has increased by 50%.

9 TERRESTRIAL CONSERVATION

MAPS 9 and 10 Temperature and Rainfall Trends: 1950-2007 (BOM)



However, there has been virtually no change in daily temperatures picked up for the period 1910-2010. Sadly, predicted rates of temperature increase for the rest of this century far exceed that experienced over the last million years. How much biodiversity is affected is dependent on the size and speed of this change. This in turn will depend greatly on how nations act to reduce carbon dioxide and other greenhouse gas emissions during the next decade.

Even with a decisive and rapid global response by nations, at least a 1.4 degree C increase is likely. However, few climate scientists are optimistic that the rise will be less than 2 degrees C by 2100.

Some of the likely impacts to be expected in Karajarri country include:

- Increase in frequency of cyclones coming out of Timor Sea;
- Increase in intensity of cyclones (i.e more Category 5 events);
- Longer wet seasons;
- Major changes to distribution of plants and wildlife;
- More intense bushfires, damaging more trees with increased lightning strikes.



PHOTO 1 *Kurriji Pa Yajula/Dragon Tree Soak from the air, looking south*

9.3 EXISTING PROTECTED AREAS:

KURRIJI PA YAJULA/DRAGON TREE SOAK NATURE RESERVE

At the present time, the only Nature Reserve within Karajarri country is remote **Kurriji Pa Yajula/Dragon Tree Soak Nature Reserve**, first gazetted in March 1979 as Government Reserve 35918 for the Conservation of Flora and Fauna. Its original size was 14,182 ha. After it was discovered that the principal soak was very close to the northern boundary of the Reserve, in December 1994 an additional 3,547 ha was added on the northern side. For Karajarri reaction to this when it was first proposed see Arthur (1985). The present size of the Class “A” Crown Reserve is thus 17,729 ha, vested in the Conservation Commission of WA. However, Karajarri native title rights have since been granted for the northern area in Determination “B” of 2004. Native title rights for the southern portion of the Reserve have been determined to be extinguished under the act.

Description

The **Kurriji/Dragon Tree** soak site (19. 40' 14”S; 123.21'43”E) and **Yajula/Elizabeth** soak site (19.41'02”S; 123.22'07”E) are both oasis swamps with very similar flora. They lie about 2.5 kms apart, approximately 20 km distant from the McLarty Hills.

Flora

The central sedgeland is dominated by *Baumea articulata* with sparse **Ngalingmarra/dragon trees** (*Sesbania formosa*) to 10 m and beds of bullrushes (*Typha domingensis*). At the northern and southern ends of the soak are groves of **Ngalingmarra/dragon tree** with some bullrushes beneath. The fringing grassland is *Paspalum* sp. with some *Fimbristylis ferruginea*. Surrounding flats support **Kupan/saltwater couch** (*Sporobolus virginicus*), **Munturu/salt wattle** (*Acacia ampliceps*) and a paperbark (*Melaleuca glomerata*).

9 TERRESTRIAL CONSERVATION

Nearby claypans are characterised by salt-loving succulents, e.g. *Tecticornia indica* and *Trianthema turgidifolia*. Also present are **Yarrinyarri**/bush onion (*Cyperus bulbosus*) and a grass *Eragrostis pergracilis*. Some groves of **Parntal**/desert walnut (*Owenia reticulata*) occur nearby.

Fauna

Two waterbird species recorded in the wetland are Australian crane (*Porzana fluminea*) and clamorous reed-warbler (*Acrocephalus stentoreus*). Both species may breed in the dense vegetation.

Access

In the past, **Kurriji Pa Yajula** was regarded as being an 8-9 day walk in from the coast (Tindale, quoted in Bagshaw, 1997, p.12). As the 'crow flies', it is approximately 340 km SE from Broome. A number of access routes are available. One is to use the McLarty Track, which goes east from the Great Northern Highway at a point 201 km south of the Roebuck Roadhouse (roughly east of Cape Jaubert). At a point 19 degrees 23.05'S, 123 degrees 21.96'E a cutline runs south and can be followed, crossing sand dunes, until it terminates. However the final 20 km has to be negotiated off-road, proceeding SE towards **Kurriji Pa Yajula**/Dragon Tree Soak, crossing a number of linear sand dunes.

Management Issues

The impact of camels at **Kurriji Pa Yajula**/Dragon Tree Soak has long been of concern to DEC. The camels foul the waterhole, trample the sedgeland and by browsing the **Ngalingmarra**/dragon trees, inhibit their regeneration and shedding of seed. In May 2003, a DEC representative met with KTLA and KLC representatives to discuss the fencing. At that time DEC had \$20,000 allocated for fencing materials, obtained from its Wetland Conservation Program. DEC District Manager, Alan Grosse had advocated fencing **Kurriji Pa Yajula**/Dragon Tree Soak with an 8-strand Iowa barb fence, supported on 50 bore casing steel pipe uprights; total length of fencing nearly 2 km. Only one small wedge-shaped water access was to be left open for the camels and was to be reinforced with yard panels. DEC subsequently abandoned the proposed fencing in the face of opposition from the Traditional Owners.

For further discussion of feral camels see Section 9.2 under Ferals.

Yajula/Elizabeth Soak is reportedly less impacted by camels on account of its dense, surrounding belt of **Munturru** (*Acacia ampliceps*).

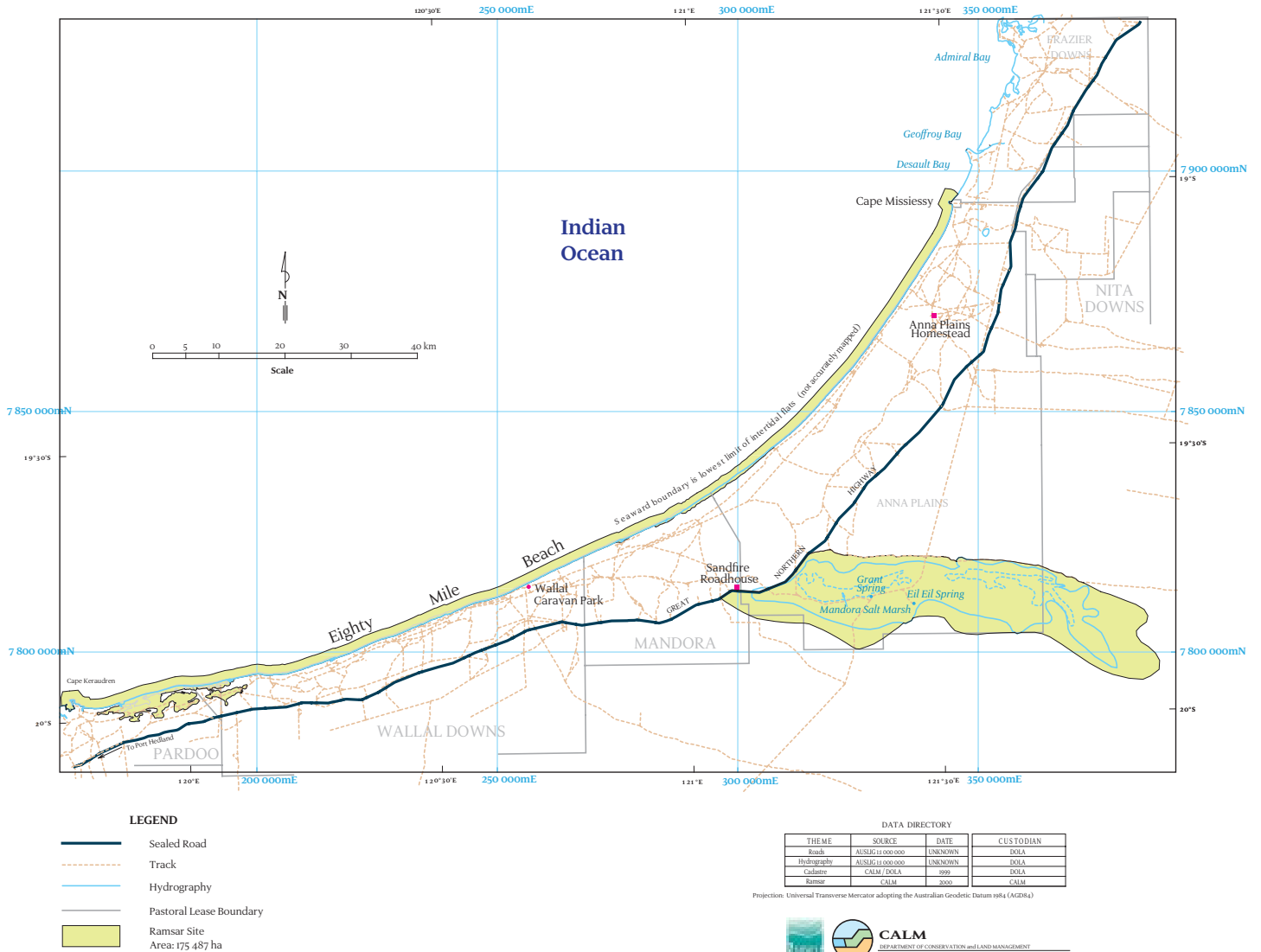
Heritage Values

There are thought to be significant camping areas associated with the soaks. The peat beds have been cored by scientists (Wyrwoll *et al.* 1986 and 1992) and are a highly significant source of pollen data to establish past climate patterns in the Great Sandy Desert.

Yu (Expert Report, 2000, p.43-44) noted that **Kurriji Pa Yajula** was an important exchange place for Karajarri people, as it lay close to Martu country. **Yinyili** or trading parcels would be exchanged here to establish friendships and alliances, which sometimes led to marriages. Traditional trade objects included **Yilpiriny** and **Yirrkili**/boomerangs, axes, **Miliny** and **Karu**/spears, **Karrpina**/shields, **Purrurru**/hairbelts, **Talki**/hunting sticks, **Riji**/pearl shell and ochre.

Eighty Mile Beach Ramsar Site

Boundary as nominated by the Government of Western Australia in February 1990



MAP 11 Malampurr/Eighty-Mile Beach Ramsar Wetland

MALAMPURR/EIGHTY-MILE BEACH RAMSAR WETLAND

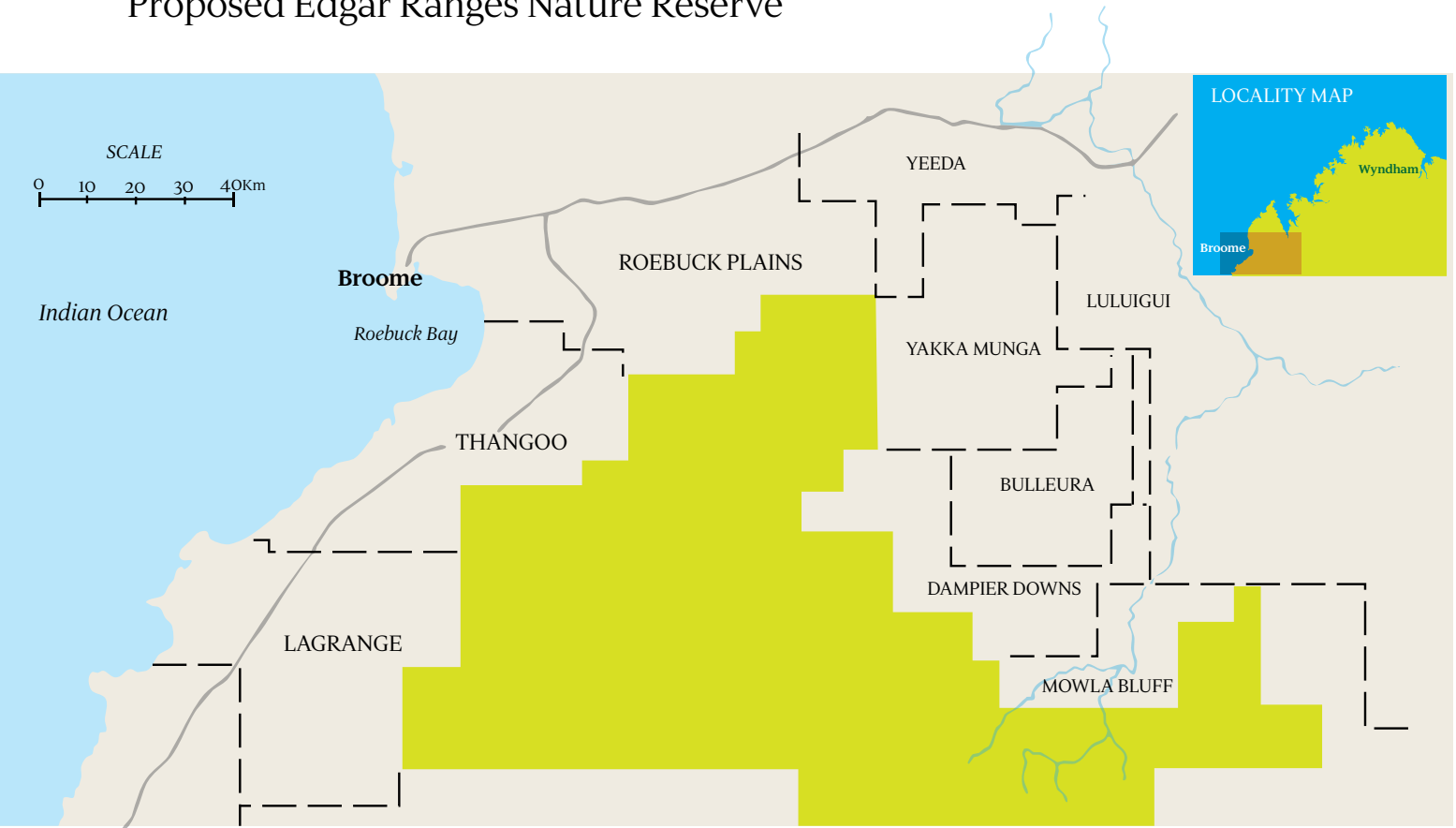
In 1990, the Federal Government nominated Malampurr/ Eighty Mile Beach as a designated Wetland of International Importance under the Ramsar Convention, named after the city in Iran where delegates met. A persistent complaint from DEC in the past has been that they received no Federal funding to manage the area, despite this international status. The principal reason for the nomination was to protect the habitat of migratory shorebird populations. Note that the Ramsar site includes Walyarta/Mandora Marsh, whose values are different and are dealt with in detail in the next Section, 9.4.

9.4 PROPOSED TERRESTRIAL PROTECTED AREAS:

There are essentially two categories: **nature reserves proposed** by the WA Government in 1991 (Burbidge *et al.*) and the so-called “**2015 conservation exclusions**”, which were negotiated with pastoral leases. After 30 June 2015, when pastoral leases are renewed, these areas automatically become conservation areas. However, the exact tenure arrangements with Karajarri still require further discussion and negotiation.

In Karajarri country, two nature reserves are proposed, while two 2015 conservation exclusions – together amounting to 90,541 ha - have already been negotiated (July 2004) between the State Government/DEC and the pastoral lessee of Anna Plains Station, John Stoaite.

Proposed Edgar Ranges Nature Reserve



Proposed Nature Reserve

Map 12 - Proposed Edgar Ranges Nature Reserve

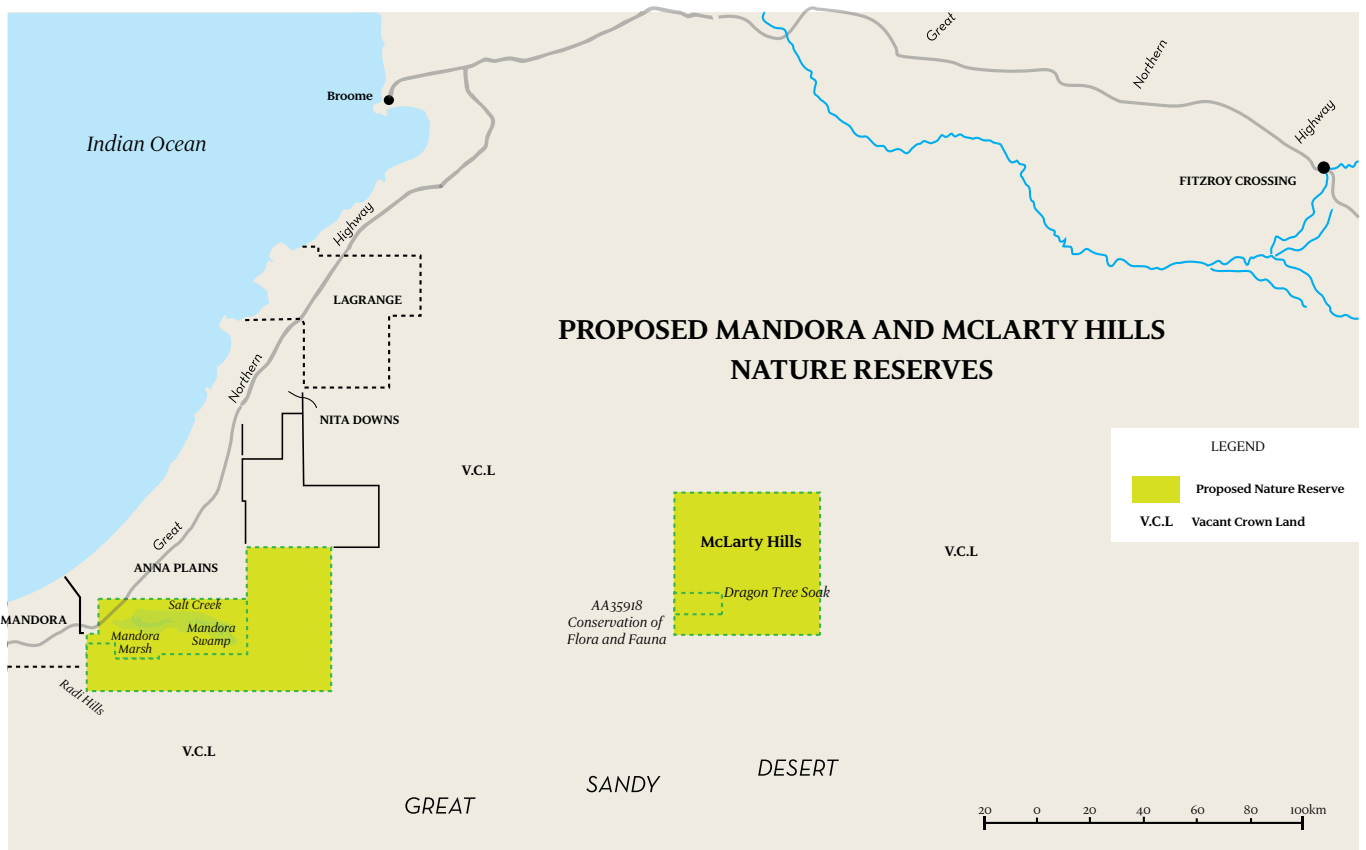
PROPOSED WALANKARRJARRI/EDGAR RANGE NATURE RESERVE

This proposed area covers 807,000 ha. It includes parts of the escarpment area of the Edgar Ranges to the south of Dampier Downs Station, as well as the headwaters of Geegully Creek, south of Mowla Bluff Station. The western area includes a vast area of currently unutilised pindan sandplain country, either side of the Broome-Dampier Downs access track. Much of the the proposed reserve area overlaps Determination “A” country, while an area in the far north is the subject of Karajarri’s latest native title claim (Joseph Edgar, pers. comm.). Scientists surveyed this area in 1981 and 1983.

The Edgar Ranges are known to support over 213 plant species, including two endemic plants: a mulla-mulla (*Ptilotus kenneallyanus*) and the Logues Spring pandanus (*Pandanus spiralis* var. *flammeus*). The fauna includes 24 mammal species, among them the taxonomically distinct black-flanked rock-wallaby (*Petrogale lateralis*). Also

recorded are populations of bilby, sandy inland mouse, Forrest’s mouse and lesser hairy-footed dunnart. The Edgar Ranges are the “type locality” for the latter species. 120 species of birds are known from the area including the rare princess parrot (*Polytelis alexandrae*), peregrine falcon (*Falco peregrinus*) and Major Mitchell’s cockatoo (*Lophocroa leadbeateri*).

Burbidge, McKenzie and Kenneally (1991, p.13 and 15-17) recommended that the area should become a Class “A” Nature Reserve, vested in the NPNCA (now the Conservation Commission of WA).



Map 13 - Proposed Mandora and McLarty Hills Nature Reserve

PROPOSED McLARTY HILLS NATURE RESERVE

This proposed area covers 290,000 ha. It comprises desert sand dune country, as well as part of the Mandora Paleoriver with small salt lakes and the low sandstone plateaux and mesas of the McLarty Hills. The proposal is essentially a mega-expansion of the Kurriji Pa Yajula /Dragon Tree Soak Nature Reserve.

Only the western half appears to be on Karajarri native title- determined land, as the eastern side is Martu country. A biological survey was carried out in 1977-1980 and results reported in Burbidge and McKenzie (1983). Burbidge, McKenzie and Kenneally (1991, p. 94-96) recommended that the area become a Class "A" nature reserve, vested in the NPNCA (now called the Conservation Commission of WA).

MALAMPURR/EIGHTY-MILE BEACH DUNE CORRIDOR (2015)

This excision was signed off by the lessee of Anna Plains Station in July 2004. It comprises a very narrow strip of land lying between the gazetted Stock Route and Malampurr/ Eighty-Mile Beach itself. Nearly all of it is low coastal sand dune, vegetated with beach spinifex (*Spinifex longifolius*) and the endemic *Triodia epactia*. It effectively reinforces and protects both the values of the Ramsar Wetland and the new Eighty-Mile Beach Marine Park. The dune corridor has been fenced off over recent years using NRM funding.

9 TERRESTRIAL CONSERVATION

WALYARTA/MANDORA MARSH (2015)

This is a much larger conservation excision, taken out of Anna Plains Station, and also signed off by Anna Plains in July 2004. It is understood that fencing along the northern boundary with Anna Plains is already in place. The excision covers periodically flooded **Walyarta Lake** (8,000 ha), Salt Creek and an area of gypsum lakes further east, representing part of the Mandora Palaeoriver. Semeniuk (2000, p. 39-40) refers to this area in geomorphological terms as the “Salt Creek playa chain”.

This whole area is regarded as part of the **Malampurr/ Eighty-Mile Beach Ramsar Wetland**, even though it is geographically separate and ecologically quite distinct. High-resolution aerial photography of the **Walyarta** area was commissioned by DEC in 2001 at 1: 40,000 scale and is available on CD-ROMs.

When flooded, **Walyarta Lake**, is up to 5 km wide, but never exceeds 2 m in depth. When **Walyarta Lake** flooded in 1999 and 2000, it was found to be supporting around 480,000 and 490,000 **waterbirds** respectively (Halse *et al.*, 2005). This included an amazing 70%+ of the known Australian population of black-winged stilts (*Himantopus himantopus*), as well as about 100,000 hardhead (*Aythya australis*), a species of duck. Significant breeding terns included gull-billed tern (*Sterna nilotica*) and whiskered tern (*Chlidonias hybrida*). In June 2000, about 7,530 Australian pelican (*Pelecanus conspicillatus*) were at the Lake, where they nested on the central island. The nationally threatened Australian painted snipe (*Rostratula australis*) has also been recorded breeding in samphire near the Lake. Other significant visiting birds include grey teal, hoary-headed grebe, Eurasian coot, straw-necked and glossy ibis.

On the southern side of **Walyarta Lake** and eastern gypsum lakes are found a complex swarm of **mound springs**, associated with calcrete outcrops. The mound springs contain good examples of raised peat bogs, surrounded by freshwater ‘moats’: highly unusual in such an arid setting. Many of the springs support peculiar vegetation assemblages including disjunct populations of the paperbark *Melaleuca leucadendra*, *Timonius timon* and mangrove fern (*Acrostichum speciosum*) or **Ngalinmarr/ dragon tree** (*Sesbania formosa*), surrounded by belts of **Munturu/salt wattle** (*Acacia ampliceps*). The best-studied

of the mound springs appears to be Saunders Spring: its aquatic fauna and water chemistry were investigated by Daniel *et al.* (2009), as well as by Storey *et al.* (2011).

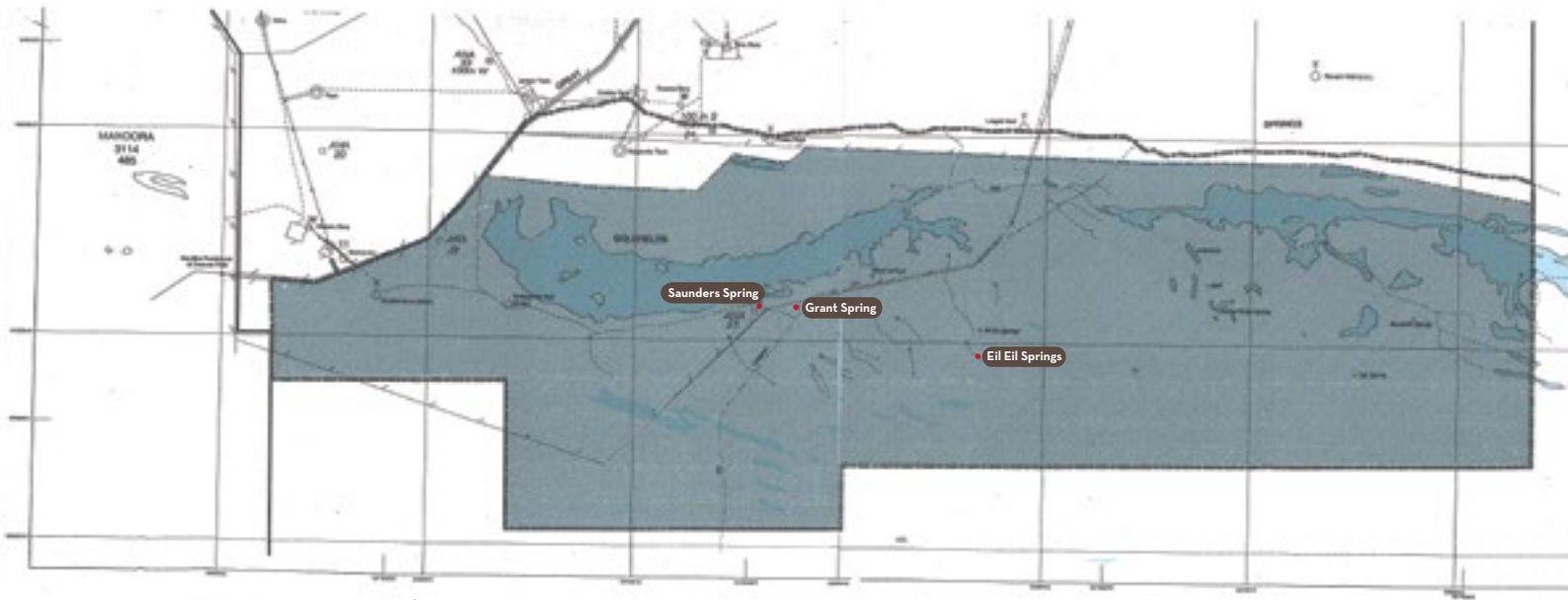
The margins of the area are mostly **red sand dune country** with a **few claypans**, supporting the most northerly known stands of *Eucalyptus victrix*.

However, there are also significant rocky exposures of **calcrete** (a special type of limestone), where a new endemic species of prickly bush tomato (*Solanum oligandrum*) was discovered in 1999 (Symon, 2001). Given the strong link between calcrete and **stygo fauna** (underground-dwelling creatures) already known from the Pilbara (Eberhard *et al.*, 2005), the Mandora Palaeoriver is quite likely to have its own – as yet unknown – species of endemic stygo fauna.

The remarkable, unique community of **inland mangroves** (*Avicennia marina* only) which occurs on Salt Creek, northeast from Sandfire Roadhouse, was first described by Beard (1967).

Further work undertaken by DEC in 1999 revealed that the mangrove stands commence at an island in **Walyarta Lake** (about 30 km from the sea), and continue the entire length of Salt Creek (Graham, 1999). Subsequently in 2001, Willing, Black and Dureau (unpublished) located a more inland stand of *Avicennia* mangroves at a point 52 km inland of **Malampurr/ Eighty-Mile Beach**. This is the most inland stand of mangroves in Australia at 19 degrees 44.63’ S; 121 degrees 37.08’ E. The trees were in good health to 5 m height with normal pneumatophores (breathing roots). In Pleistocene times, these mangroves probably grew in a shallow delta where the Mandora Palaeoriver emerged from inland. The continued survival of this healthy relict community, far from tidal influence, is thought to depend on springs in the area producing water of similar salinity to seawater.

However, downstream from saline springs, where hypersaline conditions prevail, a **small endemic fish** has adapted and thrives. This fish, a type of goby, has been characterised as “very weird”, is an undescribed species and even belongs to a new undescribed genus! (E-mail advice from Dr Helen Larson, NT Museum, dated 9 February 2013). At the present time, the fish is best called “*Acentrogobius* sp. Salt Creek”.



MAP 14: Walyarta 2015 excision from Anna Plains Station

Cultural Values

When flooded, Walyarta Lake supports large numbers of Paralpi/spangled perch (*Leiopotherapon unicolor*), which are highly valued by Karajarri people as a food. They are also likely to be a major food-source for waterbirds such as pelicans using the Lake.

Paralpi are remarkable for their rapid growth and ability to tolerate extreme water temperatures (44 degrees C) and high salinities (to seawater levels).

Many of the area's springs have Karajarri names, which were recorded by Yu (2000).

10 CULTURAL AND SOCIO-ECONOMIC CHANGE

Karajarri people, through their recent history, have already witnessed massive changes, moving from an era of paternal domination by the missions to land ownership through native title. In the modern era, rapid change has become the only constant. Such change can be perceived both as a threat and as an opportunity. The major challenge for Karajarri people, each generation, is to create meaningful fulfilled lives, embracing technological change while at the same time retaining/adapting their language, Law, traditional knowledge and cultural practices.

10.1 DEMOGRAPHIC CHALLENGE

In the 2006 census, 37% of the Bidyadanga population was under 14. Only 4.6% of the population was over 65 years. Accordingly, there is a major demographic challenge in finding sufficient Elders to act as mentors/role models and pass on their knowledge, skills, values, wisdom, tradition and Law. Elders fear that younger hunters may adopt wasteful hunting methods and abandon traditional sharing and distribution protocols (Buchanan *et al.* 2009, p.48 and 58).

10.2 ECONOMIC AND SOCIAL CHALLENGES

Most adults at Bidyadanga receive welfare payments or pensions from Centrelink. Previously, prior to the abolition of ATSIIC in 2005, CDEP funding supported as many as 230 positions at Bidyadanga, equating to a community income of about \$4.5 million. A few young men with family ties to the Pilbara have since found employment away from the area with mining companies (Edgar, 2011, p.58). However, there is little question that developing meaningful employment opportunities is badly needed.

Data from the 2006 Census shows that only 17% of the Bidyadanga population had completed high school. There were only 12 people in the age group 15-19 in full-time education. In contrast, the La Grange Remote Community School, which teaches from kindy to Year 12 had 180 students and 24 school employees. Median individual weekly income was very low at \$189 – this compares with \$466 nationally. Average household size was 5.2 people per dwelling, indicating significant overcrowding. In 2007, there were reported to be 116 occupied dwellings. In common with

many Indigenous communities, there is a high prevalence of diabetes, heart and renal problems in Bidyadanga's health profile.

10.3 ECO AND MARINE TOURISM

The Kimberley tourism industry generates \$637 million per year, or 36% of the Kimberley economy. Around \$411 million of this is generated in Broome (Griffiths and Kinane 2011, p.78).

In contrast, at the present time, the major tourism facility on Karajarri land is the [Punturrpunturr](#)/Port Smith Caravan Park, over which KTLA has neither ownership nor much influence. Indeed Karajarri Rangers have many issues over the way the Caravan Park advises its patrons to access Karajarri coastal country in inappropriate or disrespectful ways.

Ideally, KTLA would acquire this asset so that it had much greater control over the way tourism was conducted on its accessible coast.

In the longer-term, some consideration needs to be given to whether or not Karajarri wish to pursue higher value tourism, e.g. the Kooljaman or Eco Beach model along their coastline and if so, where such a facility could be constructed without adversely impacting on Karajarri cultural values.

There is undoubtedly further potential for whale watching and other marine-based eco-tourism businesses run by Karajarri people with appropriate mentoring and business support.

10.4 AGRICULTURE AND HORTICULTURE

Karajarri people's past experience with WAI and the push for broad-scale irrigated cotton on their lands has made them understandably wary about the State Government's apparent renewed interest in irrigated agriculture.

In the past, Bidadanga Market Garden producing melons, vegetables and other crops flourished for some years and there is no reason why this facility could not be re-vamped to both support Bidadanga community and sell surplus produce to Broome.

At the same time, there is undoubtedly a place for small-scale cultivation of culturally significant species such as *Nyaminyarri*/gubinge/ (*Terminalia ferdinandiana*) and *Kumpaja*/pindan walnut/ (*Terminalia cunninghamii*), especially if niche markets could be developed for their products (Cunningham *et al.*, 2009).

Other Karajarri plant resources such as *Mungkarliny*/bush potato (*Ipomoea costata*) and the nut *Stylobasium spathulatum* have potential for further economic investigation.

It would also be desirable if more Karajarri native plants could be used for landscaping communal areas and private gardens, instead of Broome-sourced non-indigenous exotics. There is also further scope for cultivating fast-growing species for rehabilitation purposes, especially in conjunction with weed control programs. There is potential for Karajarri Rangers to develop a small nursery at Bidadanga with such objectives in mind.

10.5 SUSTAINABLE PASTORAL LAND MANAGEMENT

A key objective of the KTLA is to run a reduced, productive area of *Kuwiyimpirna*/Frazier Downs, identified as two separate nodes, as a viable pastoral operation for cattle, while at the same time running the larger area as a conservation zone within the proposed IPA area.

Historic overgrazing and land degradation have characterised much pastoral management in WA, where lessees had little or no incentive to improve practices (Brandis, 2008). Currently, the cattle industry in the

Kimberley is also faced with major uncertainties in Indonesia: a previously significant export market. At the same time, there is hope that a new local abattoir can be established near Derby. Simultaneously, the Federal Government is advocating a new carbon economy.

These are challenging times for Indigenous pastoral managers, hopeful of restoring ecosystem health e.g. by rehabilitating degraded paddocks, while at the same time reducing carbon emissions. The analysis of Roebuck Plains' cattle operations by Alchin *et al.* (2010) in respect of carbon provides some useful general principles.

10.6 FISHING AND AQUACULTURE

The Kimberley Aquaculture Development Plan (1996, p.67-69) identified the West Kimberley as having potential for aquaculture of trochus, clams, marine finfish and eels, prawns, mud crabs and trepang (sea cucumbers). More recently, aquaculture opportunities for crocodiles, cherabin, aquarium fish, redclaw, giant clam, mud crab, tropical abalone, oysters, barramundi, coral trout and other fin fish have been advocated (Griffiths 2005, p.10). However, the reality is that to be viable many such projects require major capital investment.

10.7 MINING

Past interest in sand mining the coast between Gourdon Bay and Barn Hill by Terrex Resources in the early 1990s was resisted by Karajarri people.

In 1981, Meridian Oil NL accidentally found the so-called "Admiral Bay mineral prospect", in desert country east from Nita Downs. Meridian sold its interest to CRA, which undertook initial exploration from 1986 to 1992.

In early 2004, CRA Exploration sold its Admiral Bay Project to Kagara Mining, which commenced drilling in April 2007. The objective was to delineate a major lead-zinc-silver prospect. Some \$35 million was spent and, in August 2008, Kagara unveiled a maiden inferred resource of 72 million tonnes, grading at 3.1% zinc, 2.9% lead, 18g/t silver and 11.6% barite. A continuous mineralised zone of 2.1 km was confirmed, but was considered "likely to extend over at least 18 km".

In July 2010, Kagara was reported to be seeking investment of \$185 million to sink a 6.7m diameter shaft to 1,428 m depth and looking for a Chinese joint venture partner. However, with base metal prices low worldwide and the Australian \$ unusually high, Kagara went into voluntary liquidation in April 2012.

Rothschild has been appointed by the administrators to sell the asset, which it describes as “one of the world’s most significant undeveloped base metal projects”.

If this project is to be revived, KTLA need to think very carefully about related issues including:

- The siting of any proposed export port (China being the likely major consumer);
- Lead and zinc are heavy metals with known toxic effects on shellfish, other marine life, people (especially children), birds and animals;
- How lead and zinc concentrate could best be safely conveyed to port and loaded into ships without spillage (the recent experience of Magellan Metals at Esperance is salutary);
- What benefits (e.g. jobs/royalties) would flow to Karajarri people to offset the likely risks?

There are a number of other mothballed mining ventures in Karajarri country. Some sites still require rehabilitation to be properly carried out (Thomas King, pers. comm.) and remain a concern to Karajarri people.

Virtually the whole of Karajarri country is taken up with exploration permits for oil and gas, although few appear to be active at present. The most active operator is Buru Energy, which is pursuing efforts to develop oil and gas resources in the northern sector of Karajarri country, as well as in adjacent Yawuru areas. The company has courted considerable press controversy in recent months for advocating ‘fracking’ of underground strata, which may have unforeseen consequences for groundwater. The company has also stated its intention to build a LNG pipeline across Karajarri country to the Pilbara.

The possible location of a \$16 billion Liquid Natural Gas (LNG) processing hub at James Price Point, north from Broome, currently looms like an elephant over any

discussions relating to the future of the Broome area. A final investment decision by Woodside is expected in mid-2013. At the present time, the community in Broome and elsewhere is deeply divided over whether or not the possible advantages of this project (employment, business opportunities, royalties) outweigh the disadvantages (air pollution, damage to vine thickets and coastline, dredging, massive fly in-fly out workforce). If the project receives approval and proceeds, it is certain that Broome will undergo rapid expansion.

Karajarri country will inevitably be impacted by increased visitation and growing pressures on its coastline and cultural identity. In these circumstances, sound planning is needed to address such challenges.

10.8 ENVIRONMENTAL PLANNING AND EDUCATION

Griffiths advocated implementation of an *Environmental Planning and Management Strategy* (EPMS), to guide sustainable development on the Dampier Peninsula (2005, Appendix 7: p.48-53). Some of the principles she advocated included:

- Protection of areas of high conservation value;
- Protection of areas of cultural heritage;
- High quality site planning and design;
- Improved environmental management and monitoring – including waste management, recycling, training and education, energy and water conservation measures;
- Detailed guidelines for outstations – including heritage and biodiversity surveys, road design, drainage design, architectural design, use of building materials and landscaping with indigenous species, fire management and rehabilitation;

As an interim measure, KTLA might consider appointing an Environmental Officer at Bidadanga to assist implementing these objectives, working in conjunction with Karajarri Rangers, under the supervision of the Ranger Coordinator. The Dept of Indigenous Affairs (DIA) and Shire of Broome might be approached for support and further discussion about joint funding.

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EUROPEANS IN KARAJARRI COUNTRY

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Online index to files at aeon.sro.wa.gov.au indicates about 18 pages of file records exist under this heading.