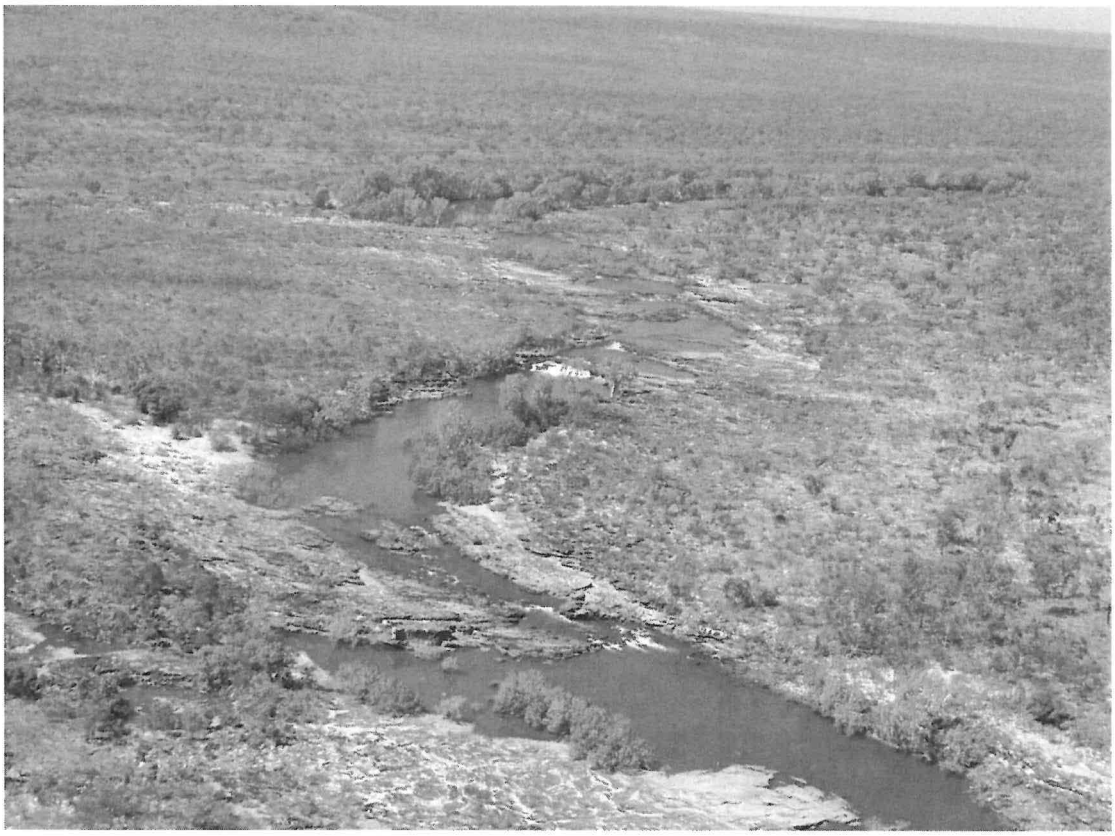
KIMBERLEY SCIENCE AND CONSERVATION STRATEGY

PERFORMANCE REPORTING PROGRAM FOR THE LANDSCAPE CONSERVATION INITIATIVE



E.SHEDLEY, I. RADFORD, K.CARNES

DEPARTMENT OF ENVIRONMENT AND CONSERVATION
KIMBERLEY REGION

NOVEMBER 2011

KIMBERLEY SCIENCE AND CONSERVATION STRATEGY: PERFORMANCE REPORTING PROGRAM FOR THE LANDSCAPE CONSERVATION INITIATIVE

1. INTRODUCTION

The Kimberley Science and Conservation Strategy (Kimberley Strategy) includes a commitment to the Landscape Conservation Initiative (LCI), which aims to conserve the world class and unique biodiversity values of the Kimberley for current and future generations (DEC, 2009; DEC, 2011).

The LCI recognises that the higher rainfall north-west Kimberley (Figure 1) in particular retains high conservation values, such as intact native fauna and flora assemblages, ecosystems and landscapes, and requires urgent management action in order to protect these values. While emergent threatening processes such as altered fire regimes and introduced plants and animals have had greater impacts on the flora, fauna and landscapes in the south-west, central and east Kimberley, the north-west area offers unique opportunities for landscape scale conservation recovery and is the focus of initiatives established under the Kimberley Strategy.

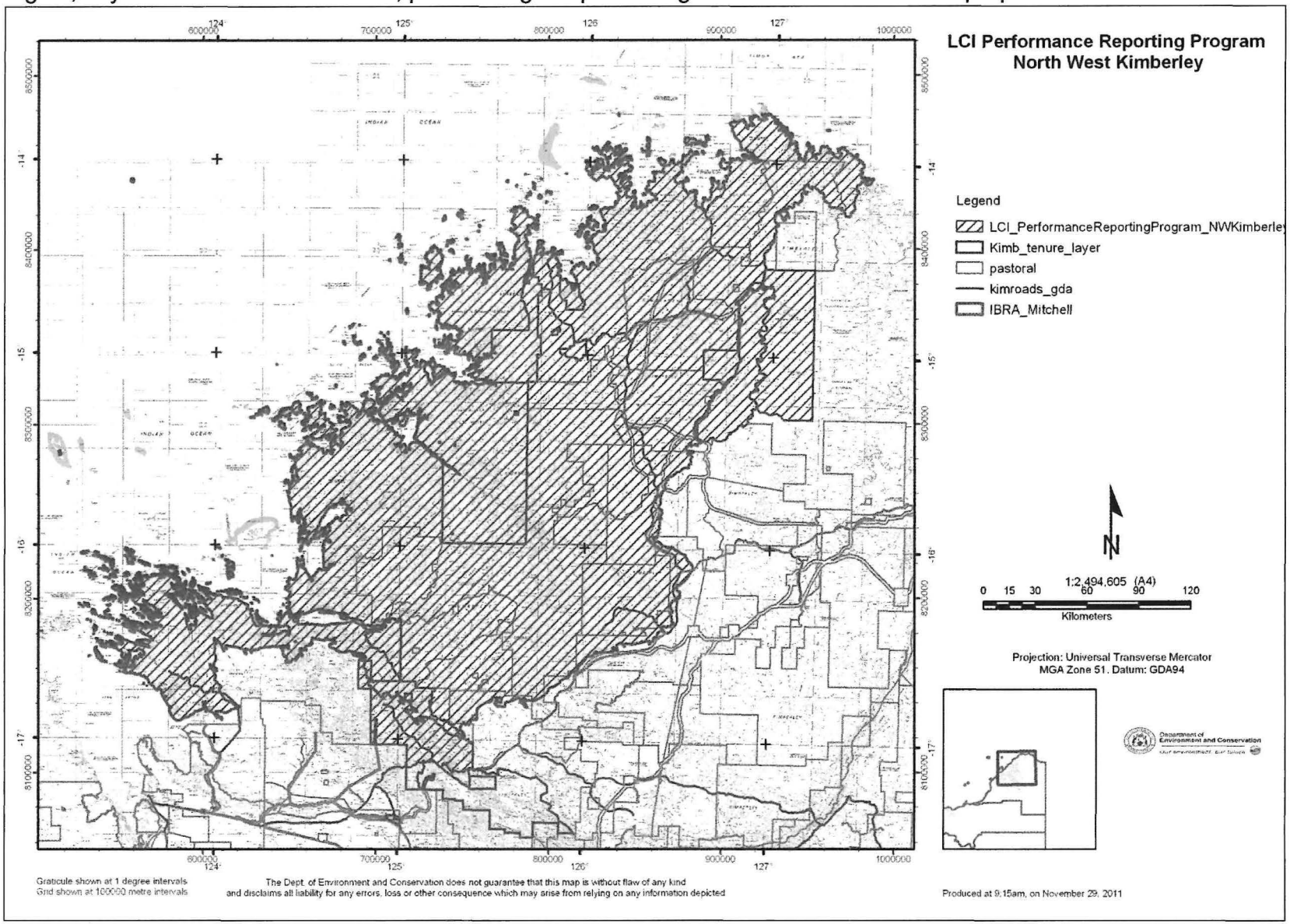
The State Government, through the Department of Environment and Conservation (DEC), is implementing the LCI of the Kimberley Strategy. The LCI provides DEC with significant resources to protect the biodiversity values by managing the threatening processes across different land tenures in the Kimberley. The LCI program will be seek partnerships with pastoralists, indigenous communities and ranger groups and non-government organisations to achieve its wider outcomes. The LCI management actions are additional to the ongoing DEC conservation management programs conducted by the Kimberley Region to meet its statutory obligations.

An important part of the LCI implementation is the performance reporting program. This will identify overall success in achieving the LCI objectives and in implementing the key management actions identified in the LCI component of the Kimberley Strategy. The performance reporting program will also provide vital feedback information that will be used to identify any need for changes in management activities in order to better target these to delivering the outcomes sought under the LCI. This performance reporting program does not set out to report on the full extent of the LCI management actions, rather it seeks to demonstrate the effectiveness of those actions in improving biodiversity outcomes.

It is expected that the LCI and performance reporting programs will continue in the foreseeable future which will allow some long term monitoring trends to be established. In addition, many of the selected monitoring sites have previous survey data so that trends can be extended backwards over 10–20 years. Remote sensing data being used to assess fire scars and changes in canopy cover can also provide trends over the last 20 or so years.

Other commitments under the Kimberley Strategy, such as establishing a Landscape Conservation Corridor in the north Kimberley, partnerships with the AWC and the conservation of Kimberley Islands will be included in the performance reporting program in the near future as these programs develop. This paper does not cover programs to assess

Figure 1. Indicative map of north-west Kimberley for LCI performance reporting based on North Kimberley IBRA Mitchell sub-region, Drysdale River National Park, part of King Leopold Range Conservation Park and proposed Conservation Corridor.



success in achieving Kimberley Strategy partnerships and social outcomes for Indigenous people, which will be assessed through training, employment and related assessment measures detailed elsewhere.

2. LCI REGIONAL OUTCOME STATEMENT

The principle outcome being sought under the Landscape Conservation Initiative is:

To have maintained, and where possible enhanced, the natural terrestrial biodiversity values of the Kimberley at a landscape scale.

3. BIODIVERSITY VALUES

The LCI program aims to protect significant terrestrial biodiversity values in the Kimberley at the landscape scale which are under greatest threat from inappropriate fire regimes, excessive grazing from introduced animals and competition from introduced plants. The biodiversity values are briefly described below, with a focus on the north-west Kimberley.

The highest priority ecosystems and threatened and priority fauna species (highlighted) will be targeted for monitoring under this performance reporting program. Other priority ecosystems and species are being monitored under existing regional conservation programs (e.g. monitoring of threatened flora, mound springs TECs, migratory shorebirds and turtle nesting), or will be monitored according to the level of threat and availability of resources in future years (e.g. Devonian Reef NP, Purnululu NP).

These biodiversity values have been based on various documents and the literature cited within them (DEC, 2002; DEC 2008; DEC 2009; DEC 2010a; DEC 2010b; DEC, 2011; Carwardine *et al.*, 2011). Priorities and monitoring protocols were discussed at a workshop held in November 2009 at Mornington Wildlife Sanctuary with pastoralists, the Australian Wildlife Conservancy, DEC and other land managers (DEC 2010b) which have been adapted for the current performance reporting program.

Ecosystems

1. High priority

- Tropical savanna woodlands characterized by specific tree and hummock or tussock grass communities, which vary in structure and floristics with geology and rainfall. Some of the rock formations include sandstones, volcanics, granites, limestones, mudstones and siltstones. The laterite savanna woodland on the Mitchell Plateau dominated by *Livistona eastonii* palms, and the boab (*Adansonia gregorii*) mixed open woodlands with tussock grasses, are unique in Western Australia.
- Dissected sandstone uplands with herbfields, triodia hummock grasslands and fire sensitive shrublands with high levels of species diversity and endemism. These rugged environments provide a level of protection from fire for obligate seeder plants, including cypress pine (*Callitris intratropica*) and many threatened and declining fauna species and their habitats.
- Rainforests with distinct flora and fauna species assemblages including many endemic and fruit eating species not found in the surrounding savanna (e.g. fruit pigeons, pittas and flying foxes), as well as many endemic camaenid land snails

and earthworms. Rainforests occur as isolated patches on scree slopes, gullies and gorges, along rivers and swamps, and in the near tidal flats, with greatest representation in the high rainfall region. Cape Bougainville rainforest on laterite and volcanic soil is the largest rainforest patch in the Kimberley. Some inland swamp rainforests (e.g. Roe River, Theda and Walcott Inlet) are gazetted threatened ecological communities.

- Monsoon vine thickets are semi-deciduous rainforest ecosystems which occur in coastal sand dunes, drier inland rocky springs and limestone outcrops and provide dry season refuges for a variety of animals, plants and many endemic invertebrates, and many are gazetted threatened ecological communities. Devonian reef limestone ridges and gorges have important cave systems for bats (e.g. Windjana and Geiki Gorges, Mimbi Caves, Tunnel Creek, Ningbing Range, Napier Range).
- Riparian and gorge ecosystems (e.g. Prince Regent, Mitchell, Roe, Charnley, King Edward, Moran, Berkley, Hunter Rivers, Ord, Pentacost, Durack, Fitzroy) with fringing vegetation comprising closed forests of melaleuca and pandanus, tall melaleuca and eucalypt gallery forests, and rainforest patches which are all important dry season refuges for birds and fauna and contain a high diversity of fish and aquatic invertebrates. A number of rivers are classed as Ramsar Wetlands and Wetlands of National Significance.
- Freshwater wetlands and swamps, including Airfield Swamp and Glauert's Lagoon on the Mitchell Plateau, Le Lievre Swamp near the Fitzroy River, Beverley Springs, Lake Gladstone, Munja Lagoon, Lake Gregory in the Tanami Desert and smaller sandplain seepages near sandstone ridges. Organic mound springs with sedgelands and melaleuca low forests including Mandora Marsh, Dragon Tree Soak, Bunda Bunda, Black Spring, some of which are gazetted threatened ecological communities.
- Near coastal uninhabited islands with no known feral animals and few introduced plants represent intact ecosystems that are less exposed to fire and provide important refugia for native fauna species that are in decline on the mainland. A variety of geological formations and vegetation structures are represented on the islands which reflect the adjoining mainland systems. They also provide important habitat for migratory birds, shorebirds and nesting turtles.

2. Medium priority

- Extensive coastal mangroves (mangal) in estuaries have high flora species richness and endemic fauna and are important habitats for fisheries and saltwater crocodiles. These are some of the largest patches of mangroves in Australia and are among the most pristine in the world.
- Sandy coastal beaches are important for shorebird and turtle nesting, including Cape Dommett for Flatback Turtle (*Natator depressus*). Tidal mudflats, coastal swamps and grasslands are feeding grounds for thousands of migratory shorebirds (e.g. Eighty Mile Beach, Roebuck Bay and Roebuck Plains).
- Large alluvial floodplains and natural productive grasslands (e.g. Camballin, Parry Lagoons, Lower Ord and Lake Argyle) are nationally and internationally important wetlands for waterbirds and shorebirds feeding and breeding sites as well as crocodile nesting.
- Purnululu World Heritage Area with the imposing Bungle Bungle Range with the orange and black banded sandstone domes, steep gorges and creeklines

supporting several endemic and threatened species, and the Osmond Range to the north with remnant rainforest patches.

- Semi-arid red sandplains with shrubland of acacia, hakea and grevillea species and grasses in the Tanami Desert and Dampier Peninsular, known habitat of the threatened Bilby (*Macrotis lagotis*).
- Vast natural tussock grasslands and herbfields on volcanic cracking black clay plains along the Ord River floodplain and throughout the Kimberley. Also extensive plains on dry calcareous soils with shorter tussock grasses.

Species

Mammals

- **Endemic terrestrial mammals in the north-west Kimberley include Scaly-tailed Possum (*Wyulda squamicaudata*), Monjon (*Petrogale burbidgei*), Kimberley Rock-rat (*Zyzomys woodwardii*)** and Yellow-lipped Cave Bat (*Vespadelus douglasorum*), while Narbarlek (*Peradorcas concinna* subsp. *monastria*) have limited distribution.
- **Threatened mammals in the north-west Kimberley include Golden Bandicoot (*Isoodon auratus*), Northern Quoll (*Dasyurus hallucatus*) and Butler's Dunnart (*Sminthopsis butleri*).** Other threatened mammals in the Kimberley include the Bilby (*Macrotis lagotis*), Crest-tailed Mulgara (*Dasycercus cristicauda*), West Kimberley Rock Wallaby (*Petrogale lateralis* subsp. WAM M151135), Northern Marsupial Mole (*Notoryctes typhlops*) and Orange Leaf-nosed Bat (*Rhinonicteris aurantius*).
- **Priority mammals in the north-west Kimberley include Golden-backed Tree-rat (*Mesembriomys macrurus*), Black-footed Tree-rat (*Mesembriomys gouldii*), Scaly-tailed Possum (*Wyulda squamicaudata*), Monjon (*Petrogale burbidgei*), Rock Ringtail Possum (*Petropseudes dahli*),** Northern Leafnosed-bat (*Hipposideros stenotis*), Yellow-lipped Cave Bat (*Vespadelus douglasorum*) and Ghost Bat (*Macroderma gigas*). Other Kimberley priority species include the Spectacled Hare-wallaby (*Lagorchestes conspicillatus* subsp. *leichardti*), Little North-western Mastiff Bat (*Mormopterus loriae* subsp. *cobourgiana*), Water-rat (*Hydromys chrysogaster*) and Lakeland Downs Mouse (*Leggadina lakedownensis*).
- **Critical Weight Range (CWR) mammals (35g to 5.5kg) other than above including Brush-tailed Tree-rat (*Conilurus penicillatus*), Black-footed Tree-rat (*mesembriomys gouldii*), Northern Brown Bandicoot (*Isoodon macrourus*), Northern Brushtail Possum (*Trichosurus vulpecular* subsp. *arnhemensis*), Narbelek (*Petrogale concinna*), Short-eared Rock Wallaby (*Petrogale brachyotis*), Brush-tailed Phascogale (*Phascogale tapoatafa*) and Sugar Glider (*Petaurus breviceps*).**
- **Smaller rodents and dasyurids (<35g) at risk including Grassland Melomys (*Melomys burtoni*), Common Planigale (*Planigale maculata*), Delicate Mouse (*Pseudomys delicatulus*), Western Chestnut mouse (*Pseudomys nanus*), Pale Field Rat (*Rattus tunneyi*), Red-cheeked Dunnart (*Sminthopsis virginiae*) and Common Rock-rat (*Zyzomys argurus*).**

Birds

- **Endemic birds in the north-west Kimberley include Black Grasswren (*Amytornis housei*), Western Partridge pigeon (*Goephaps smithii* subsp. *blaauwi*) and Kimberley Rainbow Pitta (*Pitta iris* subsp. *johnstoneiana*)**

- **Threatened birds in the north-west Kimberley includes the Western Partridge Pigeon (*Goephaps smithii* subsp. *blaauwi*), while other threatened Kimberley species include Gouldian Finch (*Erythrura gouldiae*), Northern Crested Shrike-tit (*Falcunculus frontatus* subsp. *whitei*), Red Goshawk (*Erythrotriorchis radiatus*), and Australian Painted Snipe (*Rostratula benghalensis* subsp. *australis*).**
- **Priority birds in the north-west Kimberley include Northern Masked Owl (*Tyto novaehollandiae* subsp. *kimberli*) and Chestnut-backed Button-quail (*Turnix castanota*). Other Kimberley priority species include Western Purple-crowned Fair-wren (*Malurus coronatus* subsp. *coronatus*), Grey Falcon (*Falco hypoleucos*), Australian Bustard (*Ardeotis australis*), Star Finch (*Neochima ruficauda* subsp. *subclarescens*), Pictorella Mannikin (*Heteromunia pectoralis*), Bush Stone-curlew (*Burhinus grallarius*),** Eastern Curlew (*Numenius madagascariensis*), Flock bronzewing (*Phaps histrionica*) and Princess Parrot (*Polytelis alexandrae*).

Reptiles

- Endemic reptiles in the north-west Kimberley include Rough-scaled Python (*Morelia carinata*) and Kimberley deep-soil Blind Snake (*Ramphotyphlops howi*). Another three blind snake, four dragon lizard, seven gecko and ten skink species are endemic to the Kimberley which is recognised as a centre for reptile endemism.
- Threatened reptiles include the Flat-backed Turtle (*Natator depressus*) which nests along the north Kimberley coast and another five turtle species that may use the Kimberley coastline or islands for nesting.
- Priority reptiles include Rough-scaled Python (*Morelia carinata*), Dampierland Burrowing Snake (*Simoselaps minimus*), four blind snake and six skink species.
- Specially protected reptiles include Saltwater Crocodile (*Crododylus porosus*), Freshwater Crocodile (*Crocodylus johnstoni*) and Woma Python (*Aspidites ramsayi*).

Amphibians

- There are six endemic frog species in the Kimberley including two that are priority species, Marbled Toadlet (*Uperoleia marmorata*) and Small Toadlet (*Uperoleia minima*).

Fish

- There are two threatened fish species, Grey Nurse Shark (*Carcharias taurus*) and Green Sawfish (*Carcharodon carcharias*) and twelve priority inland freshwater fish species.

Invertebrates

- Endemic invertebrates include numerous species of camaenid land snails and earthworms associated with different rainforest and vine thicket patches.
- Threatened invertebrates include 32 species of molluscs
- Priority invertebrates include another 19 species of molluscs.

Plants

- Threatened flora species in the Kimberley include five threatened species: *Eucalypus mooreana, Eucalyptus ceracea, Keraudrenia exastia, Pandanus spiralis* var. *flammeus* and *Typhonium* sp. Kununurra.
- Nearly 500 priority flora species are listed although many are poorly known and in urgent need of further survey effort which could change their conservation status. These include 261 Priority one, 106 Priority two, 120 Priority three and 8 Priority four species.

4. THREATS

The major threats to the biodiversity and landscape values of the Kimberley to be addressed under the LCI are interconnected:

- **Inappropriate fire regimes**, principally extensive hot fires that occur late in the mid-dry season and occur too frequently. In recent years nearly half the Kimberley has been burnt each year which is seriously threatening many biodiversity values by altering and simplifying the natural vegetation composition and structure required for fauna habitats. The large area burnt each year increases the opportunity for introduced and native predators to locate prey and for weeds to establish and compete with native species.

- **Introduced animals**, particularly feral cattle, donkeys, horses, pigs and cats, and the introduced cane toad. Impacts from introduced grazing animals include altered vegetation composition, accelerated weed invasion, denuded soils, increased run-off, soil erosion, loss of nutrients and sedimentation of creeks and river systems. They also cause significant degradation of sensitive rainforest patches, wetlands and riparian ecosystems by trampling vegetation degrading soil and spreading weed seeds into these disturbed and productive sites. Cattle strongly favour recently burnt areas to graze on regrowth which exacerbates the damage to soils. Cane toads and feral cats prey on a wide range of native species and compete with them for food and habitat resources. The spread of cane toads is facilitated in heavily grazed areas and by cattle pads, while feral cats are known to hone in on recently burnt areas.

- **Introduced plants**, particularly declared species and weeds of national significance with high invasiveness potential and ability to smother and replace native species in a manner that alters and simplifies the vegetation structure and range of available habitats, including Rubbervine (*Crytostegia grandiflora*), Gamba grass (*Andropogon gayanus*), Parkinsonia (*Parkinsonia aculeata*), Grader Grass (*Themeda quadrivalvis*), Stinking Passionfruit (*Passiflora foetida*), Rubberbush (*Calotrpis procera*) and Horehound (*Hyptis suaveolens*). Non-native plants are mainly introduced by humans but are spread by a variety of vectors including vehicles and machinery, introduced and native animals and birds, water flows and wind. Introduced plants establish more successfully where the soil and native vegetation have been disturbed by fire and heavy grazing pressures.

5. MANAGEMENT GOALS

Given the current status of the Kimberley landscape and biodiversity, the LCI management goals have been separated sub-regionally.

For the north-west Kimberley (Figure 1), the management goal is:

To retain and enhance current natural biodiversity and landscape values by mitigating impacts from inappropriate fire regimes, introduced animals and plants, and other identified threats.

This will be achieved by undertaking the following management actions:

- Changing fire regimes in the north-west Kimberley to protect fire sensitive ecosystems (particularly rainforest patches and wetlands) and to prevent loss of habitat diversity at appropriate scales from impacts of intense and extensive mid-late dry season bushfires. This will necessitate using prescribed burning early in the dry season (Jan-Jun) to create a patchy mosaic of burnt and unburnt land that will reduce the spread of large bushfires later in the dry season. Prescribed burning aims to decrease the overall area burnt each year, decrease the proportion of area burnt in the mid-late dry season (Jul-Dec), decrease the size of burnt patches and increase the proportion of vegetation in older age classes. Prescribed burning regimes (timing, frequency, intensity, patch size) will be sensitive to the vegetation type and rainfall region to ensure successful regeneration of native vegetation and fauna habitats.
- Eradicating wherever possible, and in other areas mitigating the impacts of, feral cattle and other introduced animals from the north-west Kimberley. This will involve mustering cattle as well as aerial and ground culling and trapping of feral animals in and around the conservation reserves and other high value ecosystems. A strategic approach will be used to concentrate on clearing areas of high feral animal density and creating buffers of low feral animal densities around the high value conservation areas. Some strategic fencing may be considered to prevent re-invasion of treated areas. Pigs will be trapped and eradicated where they are detected. Surveillance for cane toads at entry points and along pathways will increase to protect high conservation areas, as will the public awareness campaign. Research into feral cat ecology and culling methods will continue to be supported.
- Prevent the introduction, establishment and spread of high priority environmental weeds that have been ranked for their invasiveness and impacts in the Kimberley and elsewhere but are not present in the north-west Kimberley. Eradicate small new populations of high priority environmental weeds in the north-west, and reduce the impacts of those weeds with limited populations already in this area. Appropriate methods for eradication and control will be used where logistically feasible and with due consideration to sensitive wetland ecosystems. Known weed species have been prioritised for management in the Kimberley region (Appendix 1), and will be prioritised specifically for the north-west Kimberley. Mapping of new and priority areas for eradication and management in the north-west Kimberley will be based on protection of high biodiversity values and will follow DEC Standard Operating Procedures (SOP No. 22.1). Increased surveillance and quarantine measures will be part of the weed management plan, including boat landing areas, camping areas and roadsides.

For the south-west, central and east Kimberley region the management goal is:

To enhance biodiversity values at a landscape scale in the south-west, central and east Kimberley by reducing the detrimental impacts of inappropriate fire regimes, introduced animals and plants, and other threats on selected high value biodiversity ecosystems, including pathways for these identified threats that may impact on the north-west Kimberley.

This will be achieved by undertaking the following management actions:

- Implementing appropriate prescribed burning regimes (timing, frequency, intensity and patch size) to promote recovery of habitat diversity and reducing the spread and impacts of intense and extensive, mid-late dry season bushfires on priority ecosystems and conservation reserves. Additional prescribed burning will be undertaken in partnership with pastoral and indigenous land managers to optimise the management of pastoral and conservation objectives.
- Reducing the impacts of feral cattle and other introduced animals in priority ecosystems and conservation reserves, and reducing the potential for re-invasion of introduced animals into the north-west Kimberley. Some culling of feral cattle and introduced animals will be undertaken in partnership with pastoral and indigenous land managers as required to create low density buffers.
- Eradicating declared weeds and controlling damaging environmental weeds in high priority ecosystems and conservation reserves, where such control is identified as feasible and providing the potential for significant recovery of natural habitat and native species over the long term. Management of predisposing factors and vectors (e.g. horses and cattle) will be required in some areas to lessen the impacts from past and present pastoral activities. Weed control will be undertaken in partnership with pastoral and indigenous land managers as required to protect high priority ecosystems and to reduce the potential for spread of weeds into the north-west Kimberley. Known weed species in the Kimberley region have been prioritised for on-going management and mapping (Appendix 1). Increased surveillance will be part of the weed management plan to prevent new and damaging weeds becoming established in the region.

6. PERFORMANCE REPORTING INDICATORS

Performance reporting needs to provide high quality, robust and readily assessed information on both progress toward the overall LCI program outcome and management performance.

The performance reporting program needs to be resilient to personnel changes and to be managed so that the information is collected, analysed and reported in a consistent manner and within specifications for timeliness and practice over the long term. The best long-term monitoring programs are those that are streamlined, implementable with available capacity and kept to a standard set of simple but meaningful activities. Given the need to assess overall performance of the LCI towards the desired long term outcome and management goals, as well as performance in implementing management actions, the performance reporting program will have two components: landscape health indicators (outcomes); and, management action indicators (inputs).

While this performance reporting program and indicators have been designed for the LCI, they can be extended to include the Conservation Corridor and Kimberley Islands components of the Kimberley Strategy. The program also has application for overall performance monitoring of DEC's Nature Conservation Service in the Kimberley Region.

6.1 Landscape Health Indicators

The LCI outcome statement, as applied to the north-west Kimberley can be interpreted as seeking to retain the 'naturalness' or landscape health of the sub-region. While landscape or ecosystem health can be defined and measured many ways, including detailed, complex and expensive biotic and abiotic measures, this reporting program identifies broad indicators of landscape condition. By definition, these indicators are surrogates for the overall condition of the biodiversity values at the landscape scale and are relatively straight forward to measure.

The following key indicators for the landscape conservation initiative outcome have been selected:

- **Rainforest patch extent and quality**

The key habitats across the north-west Kimberley that are most indicative of landscape health are the rainforest patches. These are thought to be remnants of the natural environment dating back millions of years and are known to be under threat from a combination of inappropriate fire, feral animals and weed invasion. These threatening processes are resulting in reductions in the areal extent of rainforest patch sizes and if unmanaged, will probably result in the loss of entire patches. Retaining the extent and quality (species diversity and vegetation structure) of rainforest patches by landscape-scale management of threatening process is fundamental to the desired LCI outcome and is indicative of healthy landscapes more broadly.

- **Small native mammal abundance and diversity**

The second key indicator of the success of the LCI in retaining the landscape health is the extent to which the various native mammal species are retained, as the smaller mammal fauna (<5kg) are considered to be highly susceptible to local extinction through habitat degradation by inappropriate fire and introduced herbivores, and predation by introduced predators, as demonstrated elsewhere across northern Australia. Retaining this intact assemblage of smaller native mammals in the north-west Kimberley will be a key indicator of the success of this program.

- **Native vegetation canopy cover**

The third indicator of landscape health is a measure of long term changes in overstorey canopy cover across selected landscape scale vegetation community units. Changes in overstorey canopy cover are considered to be indicative of changes in overstorey species dominance, as well as vegetation structure and floristic diversity and to therefore reflect changes in habitat condition. This measure is considered to be responsive to gross landscape vegetation changes through impacts of fire, feral animals and weeds, as well as rainfall trends, and will be monitored across the Kimberley, but with an initial focus on the north-west Kimberley.

- **Rainfall**

The pattern, frequency and quantity of rainfall are extremely important for natural environment and biodiversity outcomes across the Kimberley. In order to separate habitat condition and outcome trends from the effects of abnormal or extraordinary rainfall impacts it will also be necessary to monitor rainfall patterns across the region. Mean annual rainfall in representative locations in the north-west, south-west, central and east Kimberley will therefore be a trend verification indicator.

Table 1 provides a framework for the LCI outcome performance reporting program for the Kimberley region, outlining the landscape health indicators, condition targets, monitoring

targets, methodology, reporting frequency and responsibility. These landscape health indicators are largely targeted at the north-west Kimberley even though many of the management actions will be applied across the broader Kimberley region.

6.2 Management Action Performance Reporting

The management actions will be applied strategically over different spatial scales. Prescribed burning will be applied across the Kimberley by DEC on conservation reserves and unallocated crown land (UCL), and in partnership with managers of other land tenures. Feral animal and weed control will be more targeted to where these are threatening areas of high conservation value. Some threats such as feral pigs and new and declared weed populations will be targeted for eradication at a very local scale.

Similarly, monitoring of management actions will be at different scales appropriate to the actions and targets being monitored. Tables 2 and 3 provide a framework for the management action reporting plan for the LCI. They outline the threats, management actions, management action indicators, indicator targets, monitoring methodology, reporting frequency and responsibility. Full reporting of management actions completed (e.g. number of feral cattle culled, area of *Passiflora foetida* controlled) is the subject of a separate LCI reporting process.

TABLE 1: KIMBERLEY LCI LANDSCAPE HEALTH OUTCOME PERFORMANCE REPORTING

REGIONAL OUTCOME GOAL: To have maintained, and where possible enhanced, the natural terrestrial biodiversity conservation values of the Kimberley at a landscape scale.

Landscape Health Indicator (Asset)	Condition Indicator	Monitoring Target	Methodology	Frequency	Responsibility
1. Rainforest patch extent	Rainforest patches retained or improved in both extent and condition.	Stable or increasing trend in area of rainforest patches (LHT1).	Aerial photography of at least 20 discrete and representative rainforest patches with analysis of changes in areal extent compared with early photography (1980s and pre-1960).	Five yearly	DEC regional monitoring team and GIS staff.
			Transects across rainforest patch boundaries in 50mx50m quadrats to measure changes in boundary position.	Annually	DEC regional monitoring team and GIS staff.
		Stable or increasing trend in rainforest vegetation cover with no evidence of clearing by grazing or burning, or invasion of annual plant species (LHT2).	50mx50m quadrats in a subset of patches above assessed for changes in vegetation structure and canopy cover quality based on vegetation structure and density, litter depth and presence of feral animal or weed impacts.	Annually	DEC regional monitoring team and GIS staff.
2. Small native mammal abundance and diversity	Small mammal species (<5kg) abundance and diversity retained or increased.	Stable or increasing trend in relative abundance (trap success) of small mammal species detected (LHT3).	Compare trap success for over time for each site and on average per vegetation type and impact level, with initial data points (2003/04).	Annually	DEC regional monitoring team

		Increasing number of sites with new species as they recover or recolonise to detectable levels (LHT4).	Identify number of sites with new species that indicates recolonisation during above standard surveys.	Annually	DEC regional monitoring team
		No decline in detected species diversity in the north-west Kimberley over time (LHT5).	Determine approximate species diversity from monitoring sites and compare with initial data points (2003/04).	Annually	DEC regional monitoring team
3. Native vegetation canopy cover, structure and species diversity	Vegetation structure and overstorey canopy cover are retained or re-established for six major vegetation types.	Vegetation structural integrity maintained or improved in six major vegetation types (LHT6).	50mx50m quadrats in replicated sites in six major vegetation types, including rainforest. Measure and compare changes in canopy cover of each vegetation strata in quadrats and in detail along a 50m transect per site with initial data points (2003/04). Assess changes in litter depth and soil erosion in quadrats. Include at least six reference sites on selected NW Kimberley Islands.	Annually	DEC regional monitoring team
		Vegetation overstorey canopy cover maintained or increased over the long term (LHT7).	Using VegMachine remote sensing analysis to assess long term changes in overstorey canopy cover since 1990 in 100mx100m (4 pixels) sites around quadrats and in at least 20 other sites per vegetation unit.	Annually	DEC regional monitoring team and GIS staff.
	Vegetation species diversity is maintained or	Vegetation species diversity maintained or increased (LHT8).	Using quadrats above, measure changes in dominant species	Annually	DEC regional monitoring team

	increased.		diversity for all strata.		
4. Annual rainfall and rainfall patterns	Annual rainfall trends and variances detected.	Rainfall data is compared with historic trends (LHT9).	Monthly rainfall data is obtained for representative sites from Bureau of Meteorology weather stations in the Kimberley and used in analysis of trends.	Annually	DEC LCI monitoring coordinator

TABLE 2: KIMBERLEY LCI MANAGEMENT ACTION PERFORMANCE REPORTING

NORTH-WEST KIMBERLEY

SUB-REGIONAL MANAGEMENT ACTION GOAL: To retain and enhance current natural biodiversity and landscape values by mitigating impacts from inappropriate fire regimes, introduced animals and plants, and other identified threats.

Threat	Threat Indicator	Monitoring Target	Methodology	Frequency	Responsibility
1. Inappropriate fire regimes	Proportion of landscape burnt in early dry season	An increasing trend in the proportion of landscape burnt each year by early dry season (Jan-Jun) fires (MAT1)	Analysis of remotely sensed (Modis) fire scar imagery to compare total area burnt by end of June and December each year. Ground truth transects to check sensitivity of analysis. Use scoring of fire impacts and intensity collated during vegetation monitoring as an index of fire impacts at each site.	Annually Annually	DEC Regional Fire Coordinator and GIS staff DEC regional monitoring team
	Number, mean area and variance of unburnt patches	An increasing trend in the number, mean area and variance of unburnt patches on an annual basis in high value conservation reserves, and for six major vegetation types (MAT2).	Analysis of remotely sensed (Modis) fire scar imagery to determine the number, mean area and variance of unburnt patches and intersected with vegetation mapping.	Annually	DEC Regional Fire Coordinator and GIS staff
	Distance between unburnt patches	A decreasing trend in mean distance between unburnt patches on an annual basis (MAT3).	Analysis of remotely sensed (Modis) fire scar imagery to determine average separation distances between unburnt patches on an annual basis. Determine average separation distances between unburnt patches in a 10kmx10km square centred around each cluster of fauna monitoring sites.	Annually Annually	DEC Regional Fire Coordinator and GIS staff DEC Regional Fire Coordinator and GIS staff
	Vegetation age class distribution	An increasing trend in the proportion of unburnt vegetation in older age classes (>3yrs old) for six major vegetation types (MAT4).	Analysis of remotely sensed (Modis) fire frequency and vegetation mapping data for large representative areas of each major vegetation type. Repeat analysis in a 10kmx10km square around fauna monitoring sites. Compare with VegMachine analysis of trends in canopy cover for the same sites.	Annually Annually	DEC Regional Fire Coordinator and GIS staff DEC Regional Fire Coordinator and GIS staff

2.Introduced and feral animals	Density of feral cattle in high value conservation areas.	A decreasing trend in feral cattle density in high value conservation areas to less than 10% of carrying capacity for each of the three major land systems (MAT5).	Use number of animals culled per 2hr sortie or per minute of culling time from aerial cull operations records as an index of cattle density. Compare records in same areas from year to year and estimate cattle density across the three major land systems. Record GPS coordinates and track each sortie for GIS analysis.	Annually	DEC LCI monitoring coordinator and shoot controller
	Impacts of feral cattle in high value conservation areas.	A decreasing trend in feral cattle impacts in high value conservation reserves and sensitive areas (MAT6).	Take aerial photographs along set transects at standard flying heights in the early dry season and compare density of cattle pads as an index of cattle impacts each year. Use feral cattle indicator scores collated during vegetation monitoring as an index of cattle impacts at each site.	Annually Annually	DEC regional monitoring team DEC LCI monitoring coordinator and shoot controller
	Density of feral horses, donkeys and pigs in high value conservation areas.	A decreasing trend in feral horses, donkeys and pigs from high value conservation reserves (MAT7).	Use total numbers of feral horses, donkeys and pigs sighted and culled in high value conservation reserves.	Annually	DEC LCI monitoring coordinator and shoot controller
	Presence of feral cats in high value conservation reserves	A decreasing trend in sightings of feral cats in high value conservation reserves, due to direct or indirect management actions (MAT8). Increasing support for feral cat research (MAT9).	Use number of feral cats sighted or culled per 2hr sortie from aerial cull operations as an index of feral cat density. Use motion cameras with baits set up near fauna monitoring sites and conduct spotlight transect surveys to detect presence of feral cats. Provide logistical and financial support for research programs into feral cat ecology and control methods.	Annually Annually As required	DEC regional monitoring team DEC regional monitoring team Regional Science Division staff
	Presence of introduced cane toads in high value conservation reserves	Maintaining existing area of high value conservation reserves free of cane toads (MAT10).	Conduct listening and spotlighting surveys during Nov-Apr to detect presence of male cane toads in susceptible areas. Assess density of calls per km of transect and estimate area free of cane toads.	Annually	State cane toad coordinator

		Increasing number of surveillance and public education activities to prevent introduction of cane toads entering high value conservation reserves (MAT11).	Conduct cane toad surveillance activities in likely points of invasion along tracks and coastline, erect signage and produce public information brochures.	Annually	State cane toad coordinator
3. Introduced declared plants and high priority environmental weeds	Area free of declared plants and high priority environmental weeds	An increasing area of high value conservation reserves that are free of declared plants and high priority environmental weeds (MAT12).	Map areas of declared plants and high priority environmental weeds in high value conservation reserves. Determine total area free of these weeds.	Annually	DEC regional NC leader and LCI coordinator
	Number of new populations of declared plants and high priority environmental weeds	A decreasing trend in the number of new populations of declared plants and high priority environmental weeds introduced into high value conservation reserves (MAT13).	Establish and regularly update list of weed populations for eradication, control or monitoring. Record GPS coordinates of all weed populations using DEC SOP.	Annually	DEC regional NC leader and LCI coordinator

TABLE 3: KIMBERLEY LCI MANAGEMENT ACTION PERFORMANCE REPORTING

SOUTH-WEST, CENTRAL AND EAST KIMBERLEY

SUB-REGIONAL MANAGEMENT ACTION GOAL: To enhance biodiversity values at a landscape scale in the south-west, central and east Kimberley, by reducing the detrimental impacts of inappropriate fire regimes, introduced animals and plants, and other threats on selected high value biodiversity ecosystems, including pathways for these identified threats that may impact on the north-west Kimberley.

Threat	Threat Indicator	Monitoring Target	Methodology	Frequency	Responsibility
1. Inappropriate fire regimes	Proportion of landscape burnt in early dry season	An increasing trend in the proportion of landscape burnt each year by early dry season (Jan-Jun) fires (MAT1).	Analysis of remotely sensed (Modis) fire scar imagery to compare total area burnt by end of June and December each year. Ground truth transects to check sensitivity of analysis.	Annually	DEC Regional Fire Coordinator and GIS staff
	Number, mean area and variance of unburnt patches	An increasing trend in the number, mean area and variance of unburnt patches on an annual basis (MAT2).	Analysis of remotely sensed (Modis) fire scar imagery to determine the number, mean area and variance of unburnt patches.	Annually	DEC Regional Fire Coordinator and GIS staff
	Distance between unburnt patches	A decreasing trend in mean distance between unburnt patches on an annual basis (MAT3).	Analysis of remotely sensed (Modis) fire scar imagery to determine average separation distances between unburnt patches on an annual basis.	Annually	DEC Regional Fire Coordinator and GIS staff
	Vegetation age class distribution	An increasing trend in the proportion of unburnt vegetation in older age classes (>3yrs old), determined for main vegetation types and rainfall regions (MAT4).	Analysis of remotely sensed (Modis) fire frequency and vegetation mapping data for large representative areas of each main vegetation type and rainfall region.	Annually	DEC Regional Fire Coordinator and GIS staff
2.Introduced and feral animals	Density of feral cattle in buffer areas and high value conservation areas.	A decreasing trend in feral cattle density in buffer areas and high value conservation areas (MAT5).	Use number of animals culled per 2hr sortie or per minute of culling time from aerial cull operations records as an index of cattle density. Record GPS coordinates and track each sortie for GIS analysis.	Annually	DEC LCI monitoring coordinator and shoot controller
	Impacts of feral cattle in high value conservation areas.	A decreasing trend in feral cattle impacts in high value conservation reserves and sensitive areas (MAT6)	Take aerial photographs along set transects at standard flying heights in the early dry season and compare density of cattle pads as an index of cattle impacts each year.	Annually	DEC regional monitoring team

	Density of feral horses, donkeys and pigs in high value conservation areas.	A decreasing trend in feral horses, donkeys and pigs from high value conservation reserves (MAT7).	Use total numbers of feral horses, donkeys and pigs sighted and culled in high value conservation reserves.	Annually	DEC LCI monitoring coordinator and shoot controller
	Presence of feral cats in high value conservation reserves	A decreasing trend in sightings of feral cats in high value conservation reserves, due to direct or indirect management actions (MAT8).	Use number of feral cats sighted or culled per 2hr sortie from aerial cull operations as an index of feral cat density.	Annually	DEC regional monitoring team
	Presence of introduced cane toads in high value conservation reserves	Increasing number of surveillance and public education activities to prevent introduction of cane toads entering high value conservation reserves (MAT9).	Conduct cane toad surveillance activities in likely points of invasion along tracks and coastline, erect signage and produce public information brochures.	Annually	State cane toad coordinator
3. Introduced declared plants and high priority environmental weeds	Area impacted by declared plants and high priority environmental weeds	A decreasing area of high value conservation reserves that are impacted by declared plants and high priority environmental weeds (MAT10).	Map areas of declared plants and high priority environmental weeds in high value conservation reserves. Determine total area impacted by these weeds.	Annually	DEC regional NC leader and LCI coordinator
	Number of new populations of declared plants and high priority environmental weeds	A decreasing trend in the number of new populations of declared plants and high priority environmental weeds introduced into high value conservation reserves (MAT11).	Establish and regularly update list of weeds for eradication, control or monitoring. Record GPS coordinates of all weed populations using DEC SOP.	Annually	DEC regional NC leader and LCI coordinator

6.3 Monitoring site selection and methodology

Primary LCI monitoring field sites have been selected in the north-west Kimberley to collect long term trend data for reporting on the three main landscape health indicators (rainforest patch, native mammal diversity and vegetation canopy cover). Field sites are currently established in the Mitchell Plateau area on various land tenures, and in the King Leopold Range Conservation Park north of the Gibb River Rd. Additional sites are planned for the Drysdale River National Park and the Prince Regent River National Park, either side of the proposed Conservation Corridor.

Monitoring field sites have been stratified into one of six major vegetation types (rainforest, riparian, dissected sandstone shrubland, sandstone savanna woodland, laterite savanna woodland, volcanic savanna woodland and laterite forest) although not all these are represented in each major conservation reserve. Table 4 outlines the expected monitoring field site coverage for the main LCI landscape health indicators, based on current resourcing in the Kimberley region. Additional sites will be selected during 2012 to increase the replication of vegetation types for assessing vegetation canopy cover and structural trends and to test predictions about impacts.

These sites were also selected to represent the range of fire and cattle disturbance attributes expected in the north-west Kimberley, although this was not a rigorous process. Fire frequency mapping from 2004 to 2010 accessed from the North Australian Fire Information (NAFI) website (Appendix 1) was used to classify sites as being burnt 0 to 7 times in the last seven years. This mapping is reasonably coarse scale with a pixel size of 100m x 100m with accepted inaccuracies with respect to quadrat information but does provide a useful indication of likely fire impacts.

Cattle impacts were more difficult to attribute as there has been no comprehensive survey of cattle or other introduced feral animals in the north-west Kimberley. Mapping of potential cattle carrying capacity according to land systems (Speck *et al.*, 1960) provided useful information on the areas likely to be unsuitable, or sustain very low, low, moderate or high feral cattle densities (Appendix 1). In addition, aerial transect survey and shoot data from the past five years indicated those areas more likely to have high cattle density and impacts.

The fire frequency and cattle density information was used to select monitoring sites that were expected to have a range of fire and cattle impacts from low to high. However, these impacts are correlated and it was not possible to have fully replicated sites for each impact separately. Furthermore there is no expectation in the LCI program to deliberately leave any "untreated" areas to act as experimental controls. Rather, the intention is to implement management actions to maintain low impact sites in the same or enhanced condition, and to improve the condition of high impact sites. Due to these confounding factors and the high cost of monitoring mammals, analysis of mammal monitoring data will be constrained to comparative case studies (i.e. before and after management treatment, high and low impacts).

Monitoring field sites were also selected where there was fauna and vegetation data from earlier surveys: 1974 (Miles and Burbidge, 1975), 1975 (Kabay and Burbige, 1977), 1976/77 (Western Australian Museum, 1981), 1987/89 (McKenzie *et al.*, 1991) and 2003/04 (Start *et al.*, 2007). Prescribed burning on a large scale

commenced in the north Kimberley around 2004, while culling of feral cattle and donkeys has been in operation in the north Kimberley since about 2003, so previous survey data will provide useful historical comparisons with current trends.

Other secondary field sites will be selected in appropriate locations to monitor trends in significant environmental weed populations and impacts from pigs and other introduced herbivores. Many of the performance indicators will be monitored using remote sensing and air photography which will require monitoring sites to ground truth the imagery data, e.g. fire scar mapping, vegetation canopy cover, rainforest extent. These sites are in the planning stage and should be in place during 2012. Appendices 2 and 3 provide greater detail for the methodology of vegetation and fauna monitoring, respectively.

TABLE 4. The number of sites selected at each location in the north-west Kimberley for the Landscape Conservation Initiative performance reporting program, grouped according to their sites types.

SITE TYPE			LOCATION AND NUMBER OF SITES				
Geology	**Landform**	**Vegetation Type**	**Mitchell Plateau**	**Prince Regent River NP**	**King Leopold Range CP**	**Drysdale River NP**	**Total**
Laterite and Volcanics	Protected upper slopes and breakaways	Rainforest	5	2	-	-	**7**
Volcanics	Drainage lines and flats	Riparian /wetland woodland	4	2	2	2	**10**
Sandstone	Dissected upland	Hummock grassland and open shrubland	4	2	2	2	**10**
Sandstone	Sand plains	Savanna woodland	4	2	2	2	**10**
Volcanics	Lower slopes	Savanna woodland	4	-	2	-	**6**
Laterite	Plateau	Savanna woodland	4	-	-	-	**4**
Total			**25**	**8**	**8**	**6**	**47**

7.0 MANAGEMENT OF PERFORMANCE REPORTING PROGRAM

7.1 Staffing and coordination

The LCI performance reporting program and assessment will be undertaken by a DEC Kimberley Region team comprised of regional and Science Division staff engaged in undertaking the various monitoring actions detailed in Tables 1 and 2. Coordination of the overall LCI performance reporting will be the responsibility of the DEC Regional Leader for Nature Conservation in the Kimberley, or a person specially appointed to this coordination role, in collaboration with the Science Division and Nature Conservation Division. This person will be responsible for coordinating all aspects of the performance reporting program and will work closely with the LCI implementation team to ensure that monitoring work programs are kept to schedule, data is entered and summarised data are reported to the coordinator within the nominated timeframe.

The coordinator will also be required to liaise with partner organizations, such as the AWC, Dunkeld Pastoral Company and various native title groups, where these organizations are contracted to deliver performance reporting information. Negotiation will be required to ensure standard monitoring targets and protocols are followed and a core set of equivalent monitoring data is collated from each property that contributes to overall monitoring evaluation. The coordinator must ensure that proposed monitoring sites are approved by the relevant Native title group, but liaison regarding attendance of traditional owners and training for ranger groups or fee for service contracts for monitoring is the responsibility of the LCI program leader. The regional scientist in the Kimberley will be responsible for maintaining animal ethics approval and reporting for this program.

The LCI monitoring coordinator and monitoring staff will be mentored by two senior Science Division research staff (0.1FTE each) who will provide ongoing appraisal and support by travelling to the Kimberley three to four times per year and being available for during monitoring activities. This level of scientific support will provide the necessary technical discipline and scientific rigor required to generate meaningful monitoring outcomes.

7.2 Data management and analysis

The coordinator must ensure the quality of data acquired is maintained and data is entered in a suitable format (database or spreadsheets) that can be validated and accessed for auditing purposes, including data from partner organisations. The data must be clearly set out with metadata attached to allow for smooth transition should staffing positions change. The coordinator will be responsible for undertaking the detailed analysis of all monitoring results (including projections and liaison with external experts as required) and preparation of annual performance reports and presentations detailing long and short term trends against the established targets. Standard data analysis and graphing templates should be used to ensure consistency in reporting formats from year to year. The coordinator will also identify and report on any problems encountered in undertaking required monitoring within established protocols, timelines and schedules and be able to recommend changes to LCI management and monitoring programs.

Intellectual property agreements must be completed with native title groups and partner organizations to ensure clarity of data ownership and sharing arrangements for publications.

7.3 Reporting timeframe, presentations, publications and peer review

Annual performance reports will be presented by the coordinator at an annual workshop in December for regional staff, LCI partners and Steering Committee, native title groups and interested public in the Kimberley and repeated in Kensington for the Kimberley Strategy Steering Group, Department of Premier and Cabinet, and DEC Nature Conservation, Regional Services and Science Divisions. A written annual report with executive summary will accompany the presentations. Other media articles and scientific publications will be prepared from time to time as appropriate in collaboration with DEC media and Science Division staff, respectively.

The performance reporting program will be reviewed at the annual presentations and workshops with a major peer review every five years to assess information learnt for adaptive management purposes. This performance reporting program document will be updated to reflect any changes made to the management actions, indicators or monitoring methodology. The Director of the Nature Conservation Division will be requested to sign off the annual reports and five yearly reviews.

8.0 BUDGET

An LCI performance reporting budget has been prepared for the next four years based on approved estimates (Table 5) and is expected to continue in the foreseeable future. These figures may vary from year to year depending on logistical constraints of working in remote areas and will be reviewed annually to assess significant variation of expenditure from budget estimates. The LCI monitoring budget does not include the costs of monitoring the fire indicators which is covered under the regional LCI fire management program.

The budget also does not include any costs involved with liaison with the AWC, pastoralists, native title groups, traditional owners and indigenous ranger groups. Some monitoring may be contracted to these parties in time but these negotiations are at an early stage of development and are not reflected in the budget. AWC has been contracted in a linkage partnership with DEC to implement similar LCI management actions and monitor their performance on two Kimberley pastoral stations, Tablelands and Artesian Range/Charnley River.

TABLE 5. Budget estimates for the LCI performance reporting program 2011 – 2015. Table includes an estimate of in-kind salaries (recurrent budget) of regional staff and an annual payment to the Science Division for ongoing mentoring and technical support.

Item	2011/12	2012/13	2013/14	2014/15
Regional and Science staff salaries and overheads for field trips	240,000	240,000	240,000	240,000
Regional and Science staff travel allowance	15,000	15,000	15,000	15,000
Monitoring coordinator, high level reporting	30,000	30,000	30,000	30,000
VegMachine project establishment, contract	25,000	5000	5000	5000
Database establishment, consultant	35,000			
Vehicles, fuel, repairs	15,000	15,000	15,000	15,000
Helicopter hire	20,000	20,000	20,000	20,000
Materials and equipment	10,000	5,000	5,000	5,000
Sub-total for LCI funding	**390,000**	**330,000**	**330,000**	**330,000**
Salaries for planning, data analysis and reporting (recurrent)	238,620	238,620	238,620	238,620
Science Division salaries and travel expenses (N. McKenzie and G. Keighery)	40,000	40,000	40,000	40,000
Total	**668,620**	**608,620**	**608,620**	**608,620**

Hi Norm and Greg,
Thanks again for your time up here, it is really appreciated. I hope it was useful for you.
I have deleted the appendices from this version to let me email it to you, and I still have a bit of tidying up to do, and add references.