North Kimberley 2 *(NK2 – Berkeley subregion)*

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Subregional description and biodiversity values

Description and area

The subregion has medium rainfall and is less dissected than the Mitchell subregion. Also the upland of mainly Pentecost sandstones is more continuously mantled by (sandy) soils, and dominated by open savannah woodland. Savannah woodland of Northern woollybutt (*Eucalyptus miniata*) and Darwin stringybark (*Eucalyptus tetrodonta*) over high Sorghum grasses and *Plectrachne schinzii* hummock grasses on shallow sandy soils on outcropping Proterozoic siliceous sandstone strata. There are also savannah woodlands on *Eucalyptus tectifica - E. grandifolia* alliance over high Sorghum grasses on red and yellow earths mantling basic Proterozoic volcanics. Riparian closed forests of *Melaleuca* and *Pandanus* occur along drainage lines. Extensive Mangal occurs in estuaries and sheltered embayments. There appear to be less small patches of monsoon rainforest in this subregion where they tend to be confined to near coastal areas. The climate is dry hot tropical, sub-humid with summer rainfall. The subregional area for NK2 is 2, 540, 149 ha.

Broadscale vegetation mapping of the area describes the following components;

- Mangroves.
- *Eucalyptus* spp., *Eucalyptus miniata* (Northern woollybutt) +/- *Eucalyptus tetrodonta* (Darwin stringybark) open-woodland with *Triodia bitextura* (curly spinifex) and *Sorghum* spp. (sorghum) grasses.
- Small areas of *Eucalyptus tectifica* (Darwin box) +/- *Eucalyptus grandifolia* (large-leaved cabbage gum) +/- *Eucalyptus byrnesii* (fan-leaved bloodwood) woodland with *Sorghum* spp. (sorghum) and *Sehima nervosum* (white grass) tall grasses. This association is primarily found in the Mitchell subregion.
- Very small areas of *Eucalyptus miniata* (Northern woollybutt) grassy woodland.
- *Eucalyptus tetrodonta* (Darwin stringybark) and *Eucalyptus miniata* (Darwin Northern woollybutt) +/- *Eucalyptus bleeseri* (rusty-barked bloodwood) woodland with *Sorghum* spp. tall-grasses.
- *Melaleuca* spp. (paperbark and *Eucalyptus* spp. Low woodland with *Triodia bitextura* (curly spinifex) hummock grasses.
- Saline tidal mudflats +/- samphire.

Dominant land use

(see Appendix B, key b)

(x) Aboriginal reserves
(ix) Grazing – Native pastures
(xi) UCL and Crown reserves
(xiii) Conservation

Continental Stress Class

The Continental Stress Class for NK2 is 6.

Known special values in relation to landscape, ecosystem, species and genetic values

Rare Features:

- The subregion is fox and rabbit free and essentially uninhabited.
- Further studies and documentation is necessary with respect to this category.

Centres of Endemism:

- The lack of study of this subregion no doubt contributes to an inability to make definitive statements concerning degrees of endemism amongst species and communities.
- The declared rare flora species *Eucalyptus ceracea* is endemic to the subregion.
- A small number of rainforest patches have been studied on the western side of the subregion within the Drysdale River National Park and the north-east coast. This infers that these rainforest patches would be important for invertebrates such as Camaenid land snails and annelids. Camaenid land snails have a large number of endemic species and some endemic genera showing strongly localised patterns of endemism. All the rainforest patches studied to date have endemic earthworm species associated with them.

Refugia:

Refugia are generally poorly known in the subregion. They could include 'Dry' rainforest patches (which provide dry season refuges), mangroves and riparian zones. Further research is required to define the extent to which this may apply to sandstone country because of its ability to provide fire protection.

High Species and Ecosystem Diversity:

Sandstone communities may provide areas of high species and ecosystem diversity. Rainforests are defined by their vegetation associations and are resource centres for a variety of faunal taxa that are either directly linked to rainforests or are more widely ranging species that are dependent on them. Examples include fruit pigeons and flying foxes.

Existing subregional or bioregional plans and/or systematic reviews of biodiversity and threats

The CTRC report in 1974 System 7 formed the basis of the Department's publication "Nature Conservation Reserves in the Kimberley" which has itself been incorporated in a Departmental Draft Regional Management Plan. These reports were focused on non-production lands and those areas not likely to be

prospective for minerals. Action statements and strategies in the draft regional management plan do not go to the scale of subregion or even bioregion. A biological survey was undertaken of the Drysdale River National Park in the 1970's. There is a need to resample in this area for comparative purposes. Previous rainforest studies are applicable (McKenzie *et al* 1991).

Wetlands

Wetlands of National significance (DIWA listings)

Name and Code	Description[1]	Condition[2]	Trend[3]	Reliability[4]	Threatening Process[5]
Drysdale River WA062	B1	iii	iii	Unknown	vii, iv

[1]Appendix B, key d; [2]Appendix C, rank 2; [3]Appendix C, rank 3; [4]Appendix C, rank 1; [5]Appendix B, key e

Wetlands of subregional significance (in addition to the DIWA listed wetlands)

No additional wetlands have been identified yet.

Riparian zone vegetation

Name	Condition[1]	Trend[2]	Reliability[3]	Threatening Processes[4]
All fringing vegetation of riparian zones	iii	iii	ii	vii, iv, v (feral herbivores), x

[1]Appendix C, rank 2; [2]Appendix C, rank 3; [3]Appendix C, rank 1; [4]Appendix B, key e

Other ecosystems at risk

Threatened ecological communities (TECs)

There are no Threatened Ecological Communities (TECs) in NK2.

Other ecosystems at risk

Little investigation has occurred into threatened ecosystems in this subregion. For rainforests, for example, a level of threat is assumed because of their similarities to those found in the Mitchell subregion.

There are many widespread vegetation types across this subregion that are threatened by changed fire regimes.

Ecosystem	Status	NVIS[1]	Condition[2]	Trend[3]	Reliability[4]	Threatening Process[5]
Savannah communities of which *Callitris intratropica* is a component.	V	11	Unknown	iii	iii	vii
Rainforest patches of the Kimberley savannah generally. Example rainforest patches on the Mitchell Plateau and in the supratidal flats.	V	2	Unknown	iii	iii	iv, vii
Assemblages of permanent/ephemeral wetlands, damplands, and riparian habitat of the Kimberley region.	V	15, 38, 42	Unknown	iii	ii	iv, vii
Plant assemblages of sand plain seepage areas between/near sandstone ridges.	V	38	Unknown	vi	i	Unknown threatening processes

[1]Appendix B, key f; [2]Appendix C, rank 2; [3]Appendix C, rank 3; [4]Appendix C, rank 1; [5]Appendix B, key e

Species at risk

Fauna

Species	Status	Condition[1]	Trend[2]	Reliability[3]	Threatening
SCHEDULE 1; RARE/LIKELY TO BECOME EXTINCT, DIV 2 (BIRDS)					
Erythrura gouldiae	E	Unknown	iii	ii	vii
Falcunculus frontatus whitei	E	Unknown	vi	Unknown	Unknown threatening processes
Erythrotriorchis radiatus	V	Unknown	vi	Unknown	Unknown threatening processes
Malurus coronatus coronatus	V	Unknown	vi	ii	vii, iv
SCHEDULE 1; RARE/LIKELY TO BECOME EXTINCT, DIV 4 (REPTILES)					
Caretta caretta	E	Unknown	vi	Unknown	Unknown threatening processes
Lepidochelys olivacea	E	Unknown	vi	Unknown	Unknown threatening processes
Chelonia mydas	V	Unknown	vi	Unknown	Unknown threatening processes
Dermochelys coriacea	V	Unknown	vi	Unknown	Unknown threatening processes
Eretmochelys imbricata	V	Unknown	vi	Unknown	Unknown threatening processes
Natator depressus	V	Unknown	vi	Unknown	Unknown threatening processes
SCHEDULE 4; OTHER SPECIALLY PROTECTED FAUNA. DIVISION 2 (BIRDS)					
Chalcophaps indica yamashinai	S3	Unknown	vi	Unknown	Unknown threatening processes
SCHEDULE 4; OTHER SPECIALLY PROTECTED FAUNA. DIVISION 3 (REPTILES)					
Crocodylus johnstoni	S4	Unknown	iv	iii	Unknown threatening processes
Crocodylus porosus	S4	Unknown	v	iii	Unknown threatening processes
OTHER SPECIES AT RISK					
Dasyurus hallucatus	Near threatened	Unknown	iii	ii	Unknown threatening processes
Macroderma gigas	Near threatened	Unknown	vi	Unknown	Unknown threatening processes
Rhinonicteris aurantius	S1	Unknown	vi	Unknown	Unknown threatening processes
Neochmia ruficauda subclarescens	Near threatened	Unknown	vi	Unknown	vii
Falco hypoleucos	Near threatened	Unknown	vi	Unknown	Unknown threatening processes
Heteromunia pectoralis	Near threatened	Unknown	vi	Unknown	Unknown threatening processes
Ardeotis australis	Near threatened	Unknown	vi	Unknown	Unknown threatening processes

[1]Appendix C, rank 2; [2]Appendix C, rank 3; [3]Appendix C, rank 1; [4]Appendix B, key e

Declared rare and priority flora

Species Name	Status	Condition[1]	Trend[2]	Reliability[3]	Threatening Processes[4]
DECLARED RARE FLORA					
Eucalyptus ceracea	V	Unknown	vi	Unknown	Unknown threatening processes
PRIORITY 2					
Blumea pungens	2	Unknown	vi	Unknown	Unknown threatening processes
Grevillea latifolia	2	Unknown	vi	Unknown	No known threatening processes
Minuria macrorhiza	2	Unknown	vi	Unknown	Unknown threatening processes
Myriophyllum costatum	2	Unknown	vi	Unknown	Unknown threatening processes
Utricularia aurea	2	Unknown	vi	Unknown	Unknown threatening processes

[1]Appendix C, rank 2; [2]Appendix C, rank 3; [3]Appendix C, rank 1; [4]Appendix B, key e

Analysis of appropriate management scenarios

Reservation priorities of ecosystems

The following North Kimberley vegetation associations are not reserved anywhere within the bioregion:

Beard Veg Assoc	Description	Area (Ha.)
12	Medium woodland-tropical; Darwin stringybark (*Eucalyptus tetrodonta*) and Northern woollybutt (*Eucalyptus miniata*).	7,274
43	Low forest; mangroves.	8,657
60	Grasslands, tall bunch grass savannah woodland, Darwin box (*Eucalyptus tectifica*) and cabbage gum over ribbon grass (*Chrysopogon* spp).	47,170
61	Grasslands, tall bunch grass savannah woodland, coolibah over ribbon grass (*Chrysopogon* spp).	17,443
75	Grasslands, curly spinifex, low tree savannah woodland; scarlet gum (*Eucalyptus phoenicea*) and *Eucalyptus ferruginea* over *Triodia bitextura*.	1,193
125	Bare areas; salt lakes.	89
589	Mosaic: Hummock grasslands, grass steppe; curly spinifex (*Triodia bitextura*).	26
744	Grasslands, tall bunch grass savannah sparse low tree; *Acacia suberosa* and bauhinia (*Bauhinia cunninghamii*) over Mitchell and ribbon/blue grass (*Astrebla* spp./*Chrysopogon* spp./*Bothriochloa* spp.) on black soil.	4,249
754	Shrublands, pindan; *Acacia tumida* shrubland with Northern woollybutt (*Eucalyptus miniata*) and cabbage gum (*Eucalyptus grandifolia*) medium woodland over ribbon grass (*Chrysopogon* spp) and curly spinifex (*Triodia bitextura*).	9,915
773	Grasslands, high grass savannah low tree; bloodwood (*Eucalyptus* spp.) and Darwin box (*Eucalyptus tectifica*) *over* white grass (*Sehima nervosum*) and/or upland tall grass.	10,672
800	Grasslands, high grass savannah woodland; Darwin stringybark and Northern woollybutt (*Eucalyptus miniata*) over (upland tall grass and) curly spinifex (*Triodia bitextura*).	267,377
807	Grasslands, tall bunch grass savannah sparse low tree; acacia over grass on black soil.	1,346
808	Grasslands, curly spinifex (*Triodia bitextura*), low tree savannah; snappy gum (*Eucalyptus brevifolia*) over curly spinifex (*Triodia bitextura*).	5,255
814	Hummock grasslands, low steppe woodland; silver-leaved box (*Eucalyptus pruinosa*) and *Melaleuca* over *Plectrachne*.	61,579
835	Grasslands, high grass savannah woodland; Darwin box (*Eucalyptus tectifica*) and *Eucalyptus greeniana* over spinifex and white grass (*Sehima nervosum*).	59,510
838	Grasslands, high grass savannah woodland; ghost gum (*Eucalyptus bella*) and bloodwood (*Eucalyptus polycarpa*) over spinifex and tall upland grass.	3,579
902	Hummock grasslands, low tree steppe; scattered low rare eucalypts in open curly spinifex (*Triodia bitextura*).	11,322
907	Grasslands, high grass savannah woodland; ghost gum (*Eucalyptus bella*) and bloodwood (*Eucalyptus polycarpa*) over ribbon (*Chrysopogon* spp.) and tall upland grass.	10,954
914	Grasslands, high grass savannah woodland; Darwin box (*Eucalyptus tectifica*) and *Eucalyptus greeniana* over kangaroo (*Themeda australis*) and white grass (*Sehima nervosum*).	4,312
Beard Veg Assoc	Description	Area (Ha.)
8001	Grasslands, curly spinifex (*Triodia bitextura*), low tree savannah; bloodwood (*Eucalyptus* spp.) and Northern woollybutt (*Eucalyptus miniata*) over curly spinifex (*Triodia bitextura*) on islands.	209,565

Poorly represented ecosystems subject to threat:

Black Spring Mound Community.
Theda Soak Rainforest.
Walcott Inlet Rainforest Swamp.
Roe River Swamp Rainforest
Organic mound springs of the southern North Kimberley Bioregion.
Savannah communities of which *Callitris intratropica* is a component.

Mount Elizabeth Mounds.
Flora and fauna assemblages of upland swamps of the Kimberley. On lateritic plateaux and sandstone [Airfield Swamp and Beverley Springs Station].
Assemblages of permanent/ephemeral wetlands, damplands, and riparian habitat of the Kimberley region.
Invertebrate community in creek near Pago Mission.
Eucalyptus tectifica community of the Gibb River and Mt Barnett regions.
Eucalyptus jensenii woodlands of Gibb River and Mt Barnett regions.

Note: the lack of study in some areas precludes statements about the level of reservation required.

Subregional constraints in order of priority

(see Appendix B, key g)

Other: Our knowledge of biodiversity patterns across the subregion's landscape does not have enough resolution to accurately define all acquisition priorities on the ground.

Competing Land Uses: Until joint management arrangements between Aboriginal groups and conservation agencies can be negotiated there continues to be a perception that conservation interest is a competitor for existing Aboriginal lands and land sought under native title.

Bioregional and subregional priority for reserve consolidation

The North Kimberley has a ranking priority under the preliminary bioregional NRS priorities of 4 (see Appendix D, and Appendix C, rank 4). However this may need to be 3 due to the continued impact of inappropriate fire regimes and uncontrolled stock grazing. There is a lack of adequate data on the condition of the Berkeley subregion to compare this to the Mitchell subregion in terms of prioritising between the two.

Reserve management standard

The bioregion is ranked at poor (i) to fair (ii) (see Appendix C, rank 5). Apart from the donkey control program undertaken by the Department of Agriculture (WA) there are no concerted feral animal control programs in place. Limited strategic aerial prescribed burning along with some burning along with some opportunistic hand burns with the latter being confined to very small areas of the Mitchell subregion. Extent of other threatening processes, for example weeds, yet to be determined. Due to uncontrolled stock access, changes are occurring within parks particularly in valley systems and noticeably within the Mitchell subregion. The lack of work within the Drysdale River National Park (the only reserve within the Berkeley subregion) precludes definitive statements.

Estate	Rank	Issues
NATIONAL PARKS		
Mitchell River	ii	Management ability is being developed. Currently one ranger on location during the tourist season. Full extent of threatening processes (Fire, weeds, feral animals) need to be documented. Stock impact occurring.
Lawley River	i	Remote and inaccessible. Issues have not been identified. Inappropriate fire regimes of note.
Drysdale River	i	No documentation of impacts over time. Biological survey undertaken in the 1970's. No knowledge of visitation.
CONSERVATION PARKS		
Laterite	ii	Location makes the park accessible. Small amount of biodiversity assessment being undertaken. Full extent of threatening processes (Fire, weeds, feral animals) need to be documented. Stock impact occurring.
Camp Creek	i	Rainforest monitoring being undertaken on the impact of stock grazing and fire. Stock impact occurring.
NATURE RESERVES		
Prince Regent River	i	Full extent of threatening processes (Fire, weeds, feral animals) need to be documented. Stock impact occurring. Biological survey undertaken in the 1970's.

[1]Appendix C, rank 5

Off reserve conservation

Priority species or groups

- Threatening processes operate from the species to landscape level.
- Little is known of the status of critical weight range mammals in the Berkeley subregion.
- Action is required to identify appropriate fire regimes.
- The effect of fire and cattle on critical weight range mammals, granivorous birds and savannah composition and structure are of concern.
- Changed grassland structures are of concern.
- There is evidence that changes have, and continue, to occur for the balance between annual and perennial grasses.
- Landscape level threatening processes also bring about changes to the organic profile layer in soils, water infiltration rates and surface flow velocity after rain.
- Impacts on rainforest patches of inappropriate fire regimes and specifically rainforest fire / cattle interaction is of concern.
- Changes to riparian zones due to the impact of changed fire regimes, grazing and the indirect effects from changed hydrology.
- Action is required to identify what is at risk and components of the biota at most risk then recommend and research appropriate management.
- Little is known of the distribution, status and impact of weed species.

Existing species recovery plans

The Action Plan for Australian Bats
The Action Plan for Australian Birds 2000
Action Plan for Australian Marsupials and Monotremes
Gouldian Finch Recovery Plan.
Draft Kimberley Region Management Plan (various strategies).

Appropriate species recovery actions

Fire Management: Move to biodiversity driven approaches to fire management strategies. Avoid frequent, broadscale, hot, late dry-season burning in savannah.

Industry Codes of Practice: Need to define weeds priorities both in an agricultural resource sense and an environmental sense. Resources required for already identified State and regional weed strategies.

Capacity Building: Need organisational responsibility for coordinating management efforts across tenure and management responsibilities. Local adoption of strategies. Capacity building in pastoral industry and Aboriginal groups to optimise biodiversity and savannah productivity. Minimise loss of the mineral A horizon and protection of organic layers.

Environmental Management Systems: Removal of feral stock from conservation estate and management of stock on other lands e.g. close order husbandry of cattle herds to prevent overgrazing. Eradication of feral animals is necessary, especially cattle, donkeys and pigs.

Ecosystems and appropriate recovery actions

This is a general savannah issue and fire is the main driver in addressing this. The next most important, and linked, issue is grazing. Actions that are required are linked to management research and better-coordinated efforts between Government agencies, the pastoral grazing industry, traditional owners and the broader community.

Existing ecosystem recovery plans

There are no relevant recovery plans for Ecosystems at Risk in NK2.

Subregion priority for off reserve conservation

The subregional priority for off park conservation in NK2 is (iii) (see Appendix C, rank 6), indicating that relatively limited off park effort will result in significant biodiversity gains.

Conservation actions as an integral part of NRM

Existing NRM actions

Legislation: Pastoral lease inspections are undertaken by the Department of Agriculture and leaseholders notified of any problems via the Pastoral Lands Board. Final scenario is that the Commissioner for Soil Conservation can institute formal proceedings if issues are not being addressed. The last is rarely undertaken.

Threat Abatement Planning as Part of NRM: There is a concerted and coordinated effort by the Department of Agriculture in the control of donkeys. The investigation of further development of feasible actions within this subregion is warranted.

Feasible opportunities for NRM

Environmental Management Systems: Research is needed on the mechanism and impacts of threatening processes. Outputs of this should assess potential cost / effective solutions. There has been some development in the co-ordination of multiple research initiatives and communication of this; Environmental planning across tenure (weeds, fire and feral animals) coordinated through Land Conservation District Committees.

Legislation: Improved implementation of existing legislation.

Capacity Building: Improved communication required between all stakeholders and an acknowledgement of differing land management objectives.

Other Planning Opportunities: Shire plan incorporating biodiversity objectives incorporating an acknowledgement of the worth of the natural environment e.g. tourism including the cost of management, such as making national parks accessible.

Integration with Property Management Planning, Catchment Planning and Landcare: Development of catchment and regional plans involving all stakeholders.

Impediments or constraints to opportunities

A limited financial resource is a major constraint. The number of people available to implement strategies is a constraint. There is a need to increase awareness of conservation values throughout the community.

Subregions where specific NRM actions are a priority to pursue

A more coordinated approach to land management would be for the priority for the Mitchell subregion. This is because of differing and potentially competing land uses, the increase in multiple land uses and landscape threats. Whilst still important the Berkeley subregion appears to have fewer stakeholders to deal with however research into issue identification for this subregion may change the priority. The rank for both subregions is (ii) (see Appendix C, rank 7), indicating that there are significant constraints to integrate conservation as part of production / development system.

Data gaps

Gaps in data needed for the identification of biodiversity values and management responses

Vegetation and Regional Ecosystem Mapping: Much finer scale (at 100,000:1 or better) vegetation / regional ecosystem mapping required for most of the widespread surfaces. This needs to align with soil maps and environmental geology maps and these do not yet exist at better than 1:250 000 scale.

Systematic Fauna Survey: No systematic quadrat based fauna and / or flora sampling programme across the subregion to provide a basis for modeling species distribution / status.

Floristic Data: Very sparse, some potential for adapting WARMS monitoring methodology.

Ecological and Life History Data: Lacking on the habitat requirements of fauna species.

Other Priority Data Gaps Include:
Further research is required on the conservation status of many fauna and flora taxa as well as the effects of threatening processes such exotic predators (cats), stock (cattle, donkeys and pigs), fire and weeds.

Sources

References cited

No.	Author	Date	Title	Publication Details	Pub. Type
714	Dostine, Peter	(1998).	Gouldian finch recovery plan, *Erythrura gouldiae*	Parks & Wildlife Commission of the Northern Territory, Darwin	R
258	Duncan, A., Barry Baker, G. and Montgomery, N.	(1999).	The Action Plan for Australian Bats.	Environment Australia.	R
298	Garnett, S.T. and Crowley, G.M.	(2000).	The Action Plan for Australian Birds.	Environment Australia, Canberra.	R
483	Maxwell, S., Burbidge, A.A. and Morris, K. (eds).	(1996).	The 1996 Action Plan for Australian Marsupials and Monotremes. Wildlife Australia Endangered Species Program Project Number 50.	Environment Australia, Canberra.	R
495	McKenzie, N.L., Johnston, R.B. and Kendrick, P.G. (Eds.)	(1991).	Kimberley Rainforests of Australia.	Surrey Beatty and Sons.	B

R = Report; J = Journal article; O = Other.

Other relevant publications

See reference numbers 018, 094, 100, 118, 132, 173, 268, 418, 492, 551, 556, 592, 626, 634, 635, 636, 637, 648, 692 and 693 in Appendix A.